

**Relationships among higher secondary students'
beliefs about mathematical ability, goals, learning
strategies, and mathematics achievement, in the
Maldives:
A three-path mediational analysis**

BY

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Dedicated to my beloved parents:

Mohamed Ibrahim & Moomina Abdulla

Thank you for inculcating in me the value of knowledge and perseverance in life

ABSTRACT

Structural equation modelling techniques were used to test a three-path mediational model of mathematics achievement on the relationships among higher secondary students' beliefs about mathematical ability, achievement goals, learning strategies, and mathematics achievement. Participants were higher secondary students ($n = 341$) who were studying advanced level mathematics at the Centre for Higher Secondary Education, one of the largest school that provides higher secondary education in the Maldives. Questionnaires were used to collect self-report data. Students' final year mathematics results (i.e., standardised test results) were used as the achievement data. Incremental beliefs had a positive relation with mathematics achievement, mediated by mastery goals and deep-learning strategies. Incremental beliefs had a negative relation with mathematics achievement, mediated by performance-approach goals and surface-learning strategies. Entity beliefs had a negative relation with mathematics achievement, mediated through performance-avoidance goals and surface-learning strategies. Incremental beliefs also had an overall indirect positive relation, and entity beliefs had an overall indirect negative relation with the achievement. The results of the mediational model showed the best possible pathways that students could follow in the academic setting as far as performance and building capacity in mathematics were concerned. The results might be useful to teachers and educators with respect to making decisions aimed at creating a better learning environment for students and to improve the quality of mathematics education provided to higher secondary students in the Maldives.

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CHAPTER 1: GENERAL INTRODUCTION

1.1 Introduction

Competition is fairly widespread when students enter into school, and grows stronger as they progress through the grades (Johnson & Johnson, 1991). In a competitive learning environment, students attempt to outperform each other, or attempt to avoid being less competent than others. Specifically, competitive learning environments are performance-focussed, where the emphasis is on grades, public displays of ability, and performances that are compared to those of others (Anderman & Wolters, 2006). One factor that promotes a performance-focused learning environment is an emphasis on school examinations, which is a dominant form of assessment in secondary schools (Johnson & Johnson, 1988; Nazeer, 2006). In such an environment, students' academic success is based largely upon the marks they achieve in the examinations held at school and national levels. Consequently, lower and higher secondary students spend a large percentage of their time preparing for the examinations. However, educators are trying to find ways to motivate students by creating mastery-focussed learning environments where the emphasis is on students' effort, continuous understanding, and improvement in the subject. Such environments focus on students' interest and knowledge acquired in the subject area, rather than the performance outcome of the subject.

The Maldives is a small island nation where the competition for education is so high that sayings such as "education makes one a man" and "without it one is like a tree without a trunk" are common. Education in the Maldives is considered foundational to the nation's development. Over the years, there has been a tendency for Maldivians to judge students' capabilities based on their grades. It is common for parents to judge their children as 'intelligent', 'bright', 'smart', and 'clever', or 'stupid', 'weak', 'slow', and 'brainless', depending on the marks the child receives at school. Parents also compare their children's scores and judge their children's intelligence based on these scores, with the result that parents view their children as less competent when they score worse than other children. Hence, a highly competitive learning environment exists in the country's education sector.

The Maldives has universal access to primary and lower secondary education; however, universalising the access to higher secondary education is one of the biggest

challenges to the education sector. As there are only a few schools that provide higher secondary education, entry into higher secondary education is based on the test scores from lower secondary education. Therefore, students have to earn the best grades possible at the lower secondary level to secure a seat in a higher secondary school. At the same time, students at the higher secondary schools compete against each other for grades to earn post-secondary education scholarships. In the Maldives, these scholarship opportunities are very limited, and of the students who complete their higher secondary education, only a very limited number have the opportunity to further their studies. Consequently, as students progress through the different levels of education, competition becomes more intense, and of all the levels of education in the country, higher secondary is the level at which performance-oriented learning is the most prevalent.

The Maldivian education system has imposed a lot of pressure on students to prepare for the external examinations held during their final year at secondary school (Shareef, 2010). Currently, the quality of the entire education system is judged by the marks students achieve on international examinations such as the Cambridge University-based General Certificate of Education (GCE) O Levels and the University of London-based A Levels. The competitive nature of the educational system and the pressure on exam preparation can affect how students learn in academic settings. For instance, Chan and Lai (2006) found that students who compete to outperform each other were more likely to use surface-level learning strategies, and were less likely to use deep-level learning strategies. In addition, competitive learning in a high-stakes testing environment has also been criticised for its link to high anxiety levels, selfishness, the promotion of cheating, and interference with the problem solving ability (Johnson & Johnson, 1992).

Further, the Maldives has been an Islamic nation since 1153 AD. The traditions, the lifestyle and the ways of learning are centred on the values of Islamic culture. In the Maldives, like most Islamic cultures, reading of the Quran and learning of other Islamic texts, including the rules of prayers and ablution, are obligatory. For all Muslims it is also advisable to read and memorize some chapters of Quran as these are used in the prayers. The Quran and other Islamic materials are taught to children as formal Islamic teachings, and children learn these texts mostly through repetition and memorisation. Thus, memorization techniques and the repetition of texts are widely used strategies in

the Maldives. As religion, culture, and traditions cannot be separated from the learning environments they are embedded in, they are highly related to the ways students learn in general. O'Shaughnessy (2009) and Ugail (2012) indicate that from the very early stages of their academic lives, Maldivian students are encouraged to use memorisation techniques to pass examinations, which in turn limits their critical thinking ability.

Thus, despite the cultural context and the prevailing performance-oriented learning environment in the Maldives, there is limited empirical research on the relations among students' goals, learning strategies, and academic achievement. For example, are there students who adopt learning goal orientations? Are performance approach goals associated with high achievement? These are some of the questions that have yet to be addressed.

1.2 Scenarios I experienced

I have worked as a research analyst in the Policy, Planning and Research Section of the Ministry of Education in the Maldives. My responsibilities as a research analyst included developing performance criteria for lower and higher secondary students and conducting performance analysis at the national level. From my experience, I found that very little research had been conducted in the field of education in my country, particularly in the area of students' academic achievement. As a mathematics teacher and as a research analyst, I developed a strong interest in the way students learn, and the motivational factors that affect academic achievement, and mathematics achievement in particular.

Later, I realised that psychological and motivational factors which affect students' learning and academic performance have not been explored at any level of education in the Maldives. Hence, a study of motivation in the area of mathematics education would be potentially beneficial to the education sector. It is expected that identifying motivational factors, such as achievement goals and students' beliefs, and their connection to mathematics achievement through students' choice of learning strategies, could contribute to the development of students' motivation and encourage them to choose effective learning strategies in classroom settings.

From my experience as a mathematics teacher I have found that many students – higher secondary students in particular – compete against each other for good grades. Some of them go to school or for private coaching to get high marks and to get a reward

from school or from their parents. Reward, praise, and public displays of their ability are of the utmost importance for these types of students. There were also students who did not want to be the student with the lowest score in the class. However, for others, results did not matter much as long as they learned something. These students studied and worked hard because they wanted to increase their mathematical knowledge, develop their skills in learning, and improve their capacity in the subject, but there were comparatively fewer students who demonstrated these qualities.

Generally, there were students who liked to 'outperform someone', or 'not to be the last student among their peers', or 'to increase their knowledge in the subject'. These are some of the purposes and the reasons for achievement behaviours and the "ways of approaching, engaging in, and responding to achievement types of activities" (Ames, 1992, p. 261). Ames (1992) named these purposes and reasons, 'achievement goals'. Moreover, the specific types of goal adopted are posited to create a framework for how students experience, interpret, and act in achievement situations (Dweck, 1986; Elliot & Church, 1997). Thus, achievement goals are important in the field of achievement motivation for understanding students' reasons for learning and for their academic achievement.

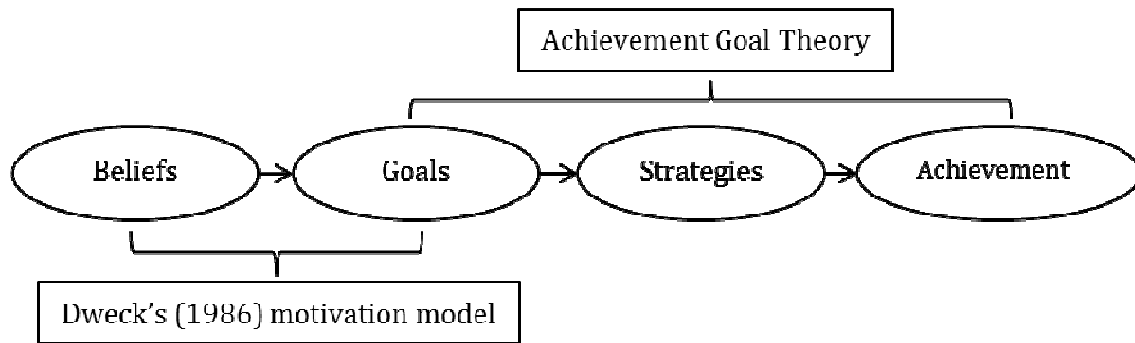
1.3 Origins of Achievement Goal Theory

Students with similar ability levels who complete the same academic tasks can differ in terms of the goals they set, the effort they put in, and the way they study (Miller, 2010). Educational psychologists have long been interested in the role of motivation to understand these differences in the way students learn and achieve in education settings. Despite its pivotal role in educational psychology, most definitions of motivation have focused less on what motivation does and more on what motivation is (Anderman & Wolters, 2006). Specifically, motivation can be described as the energy that initiates, sustains and directs behaviour towards goal-oriented activities (Schunk, Pintrich, & Meece, 2008). Many psychological and motivational theories have been used to explain motivation and to predict behaviour in achievement situations. One such theory is achievement goal theory, which has been one of the most influential theories of motivation in educational research for the last 25 years (Senko, Hulleman, & Harackiewicz, 2011). The theory was developed to describe and understand students' adaptive and maladaptive responses to achievement challenges (Dweck, 1986; Nicholls,

1984; Senko et al., 2011). According to Elliot (2005), the foundational idea of achievement goals emerged from unpublished (e.g., Nicholls & Dweck, 1979) and published (e.g., Maehr & Nicholls, 1980) papers that focussed on achievement motivation. Two primary types of goals emerged: 1) learning goals or mastery goals, which focus on seeking to develop skills by learning or mastering tasks; and 2) performance goals, which focus instead on demonstrating one's competence by outperforming others. Ames and Archer (1988) and Pintrich (2000) showed that students' achievement goals are related to their study behaviours, which in turn are related to their achievement. Thus, achievement goal theory explains and predicts the relations among goals, strategies, and achievement. However, what precedes goals? That is, why do students pursue certain types of goals?

In 1980s, Carole Dweck, a prominent researcher, posed a similar question. In an attempt to explain why students with similar ability levels in similar situations have different goal orientations, Dweck (1986) came up with an idea of implicit theories of intelligence. Consequently, Dweck (1986) developed a motivation model to describe the relation between beliefs about intelligence and goals orientations. According to Dweck's motivation model (Dweck, 1986), beliefs about the nature of intelligence predict students' goals and subsequent behaviour. Thus, the present study sought to extend previous research by investigating relations among implicit theories of intelligence, goals, learning strategies, and achievement in the Maldives. Specifically, the present study aimed to build and test a mediational model on the relations among beliefs about mathematical ability, goal orientations, learning strategies, and mathematics achievement for higher secondary students in the Maldives. Figure 1 depicts the overarching theoretical framework of the present study.

Figure 1: *Theoretical model*



1.4 Setting for the Study

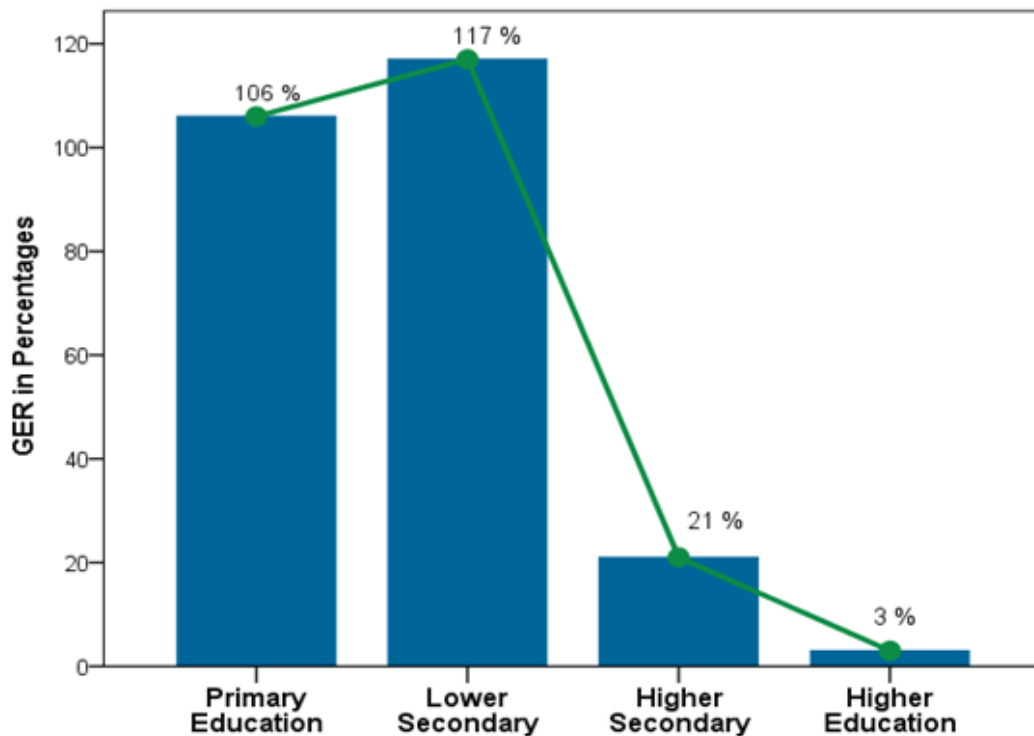
This study focussed on higher secondary education in the Maldives. The aim was to investigate the mediational relations among beliefs about mathematical ability, achievement goals, learning strategies, and mathematics achievement for students at the Centre for Higher Secondary Education (CHSE). Therefore, in the next section I will present a brief background of the Maldives setting, information regarding the history of the country's educational system, and information about the target high school, the CHSE.

1.4.1 Background

The system of education in the Maldives is dispersed across the 26 isolated atolls. Education in the Maldives has been recognised as the key component of successfully building citizens who can contribute to the development of the country. Education in the country has also been recognised as an invaluable tool for maintaining the social frame with peace and harmony. From the time when people started living in these small islands, some form of education has been provided. At different times, the provision of education was in different forms and at different levels. The earliest education was provided in people's homes by parents to their children, in the form of religious teachings. However, in 1668, what developed into a traditional system of education was introduced in some islands in the country, with schools known as edhuruge, makthab, madhrasa. In these schools, instructional content focused on basic Quran, Dhivehi literacy, and basic numeracy. This form of education continued until 1958.

Today, education has spread to every corner of the country, across each and every isolated island, giving access to universal primary and lower secondary education to the people of the Maldives. According to the Maldives Ministry of Education (2007), lower secondary education has spread to every atoll of the country, and the provision for students to have access to 12 years of education is one of the biggest challenges to the education sector. Today, relatively small percentages (21%) of students who complete lower secondary education have the opportunity to go on for higher secondary studies (see Figure 2), and only 3% of the students who complete higher secondary education continue on to tertiary education (Harsha, 2012). The main reason for the sharp drop in gross enrolment rates for higher secondary is the limited number of higher secondary places available across the country. Currently, out of 225 schools in the country, only 38 schools provide students with access to higher secondary education.

Figure 2: *Gross enrolment rates (GER) across levels of education*



Source: Word Bank Education Statistics 2012

Therefore, extending the provision of higher secondary education in the country is a big challenge for the Ministry of Education. Recently, the criteria for opening new

higher secondary schools across the country has been relaxed somewhat in order to give more islands the opportunity to have access to higher secondary education. In spite of this, providing a quality education to lower and higher secondary students with equity of access across the islands is also a major challenge to the sector. Therefore, it is also essential to understand how students can be motivated to learn and perform well in educational settings with the current standard of teaching and the resources the Maldives have in the lower and higher secondary schools.

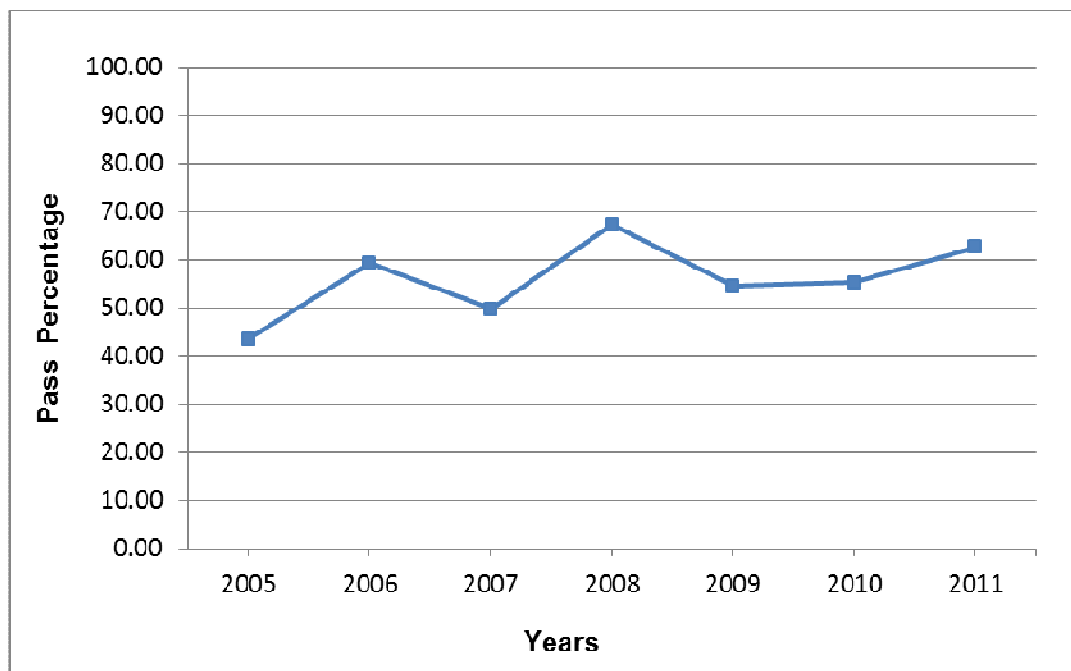
1.4.2 Mathematics at the Centre for Higher Secondary Education

The CHSE, previously known as the Science Education Centre (SEC), is located in the capital city of Male' and was the country's first higher secondary education provider, inaugurated in 1979 with 47 students and 4 teachers (Centre for Higher Secondary Education, 2010a). In 2010, when the data for the present study were collected, the school accounted for more than half of the total higher secondary population in the country (Ministry of Education, 2009). In 2009, there were 1685 students – 725 boys and 960 girls – studying in the Centre, with 870 students in their final year (Ministry of Education, 2009) completing their studies in May/June 2010. One of the aims of the school was to give those students who complete lower secondary studies an opportunity to study at higher secondary level, and to develop the knowledge, skills and capacity to undertake further studies at universities abroad. The CHSE places importance on the intellectual, moral, and psychological development of students along with their academic achievement (Sofoora, 2010). Due to the limited access to and high demand for higher secondary education in Male', however, the school recently made its admission criteria more stringent. In 2012, more than 10,000 students completed lower secondary education across the country and it was difficult for the Maldivian government to provide higher secondary opportunities to all students. Therefore, students need to work hard in lower secondary school to gain the grades that can earn them the opportunity to gain access to the higher secondary schools, and to get an opportunity at the CHSE. Consequently, the students who are enrolled at the CHSE are the students who have achieved the best results among those who have completed lower secondary education. Students have the opportunity to take three subjects from the Science, Business and Art stream, including Mathematics, Islamic Studies and English Language. Of the subjects that are offered in the CHSE, there is strong interest in

mathematics, which the majority of students undertake. In 2010, of 870 students enrolled in the final year, 460 students undertook mathematics as an elective, contributing more than 52% of the total enrolments in mathematics.

According to the CHSE website launched in December 2010, learning and understanding mathematics at an advanced level is understanding the world in which mathematics and its applications play a crucial role in science, commerce and technology, where it helps students to develop their capacity of logical reasoning and apply this in everyday situations where rational decisions are important (Centre for Higher Secondary Education, 2010b). There are two different types of mathematics that are taught in the Centre: mathematics with mechanics (Math-M) and mathematics with statistics (Math-S). Students who take either of the mathematics subjects have to complete six courses: four in core mathematics and two from either mechanics or statistics. Students sit examinations for all six courses and the final results are based on the average of the six scores.

Figure 3: *Pass percentage of A-level mathematics results*



Note: The data for the above figure was provided by the Ministry of Education, Maldives.

A final semester examination (mock examination) is conducted in April every year at the end of the 2-year period of study at the Centre, to assess the overall performance of Grade 12 students in various subjects. In addition to the school examinations, students' final assessments are based on GCE advanced level examinations, conducted in May/June every year. Figure 3 shows the average pass percentages (from grade A-C) of A Level mathematics results of students in the CHSE from 2005 to 2011. The average results of CHSE ranged from 40-63%.

Mathematics is also one a compulsory subject that is taught at every level of education in the Maldives. Internationally, research into students' cognitive and affective dispositions in the domain of mathematics education has increased over the past few decades (Kilpatrick, 1992), and has explored effective teaching and learning strategies. Mathematics is also one of the prerequisites for enrolment in tertiary level courses in the Maldives. Rose and Betts (2001) found the skills acquired in learning advanced level mathematics tended to be associated with obtaining a higher level of tertiary education and high earnings in the future. They also found that learning advanced level mathematics helped students' learning in other academic settings. In addition, "as children enter adolescence and begin to engage in higher level mathematics, their beliefs about ability related to performance in mathematics and other subjects become more differentiated" (Stipek & Gralinski, 1996, p. 403).

1.5 Purpose of the Study

The purpose of this study was to test a mediational model to see if students' beliefs about mathematical ability are related to higher secondary mathematics achievement, mediated by goal orientations and learning strategies. Different specific pathways were tested in the model to examine the indirect relation of beliefs about mathematical ability with mathematics performance, via achievement goals and learning strategies. Based on achievement goal theory and students' beliefs about mathematical ability, the achievement model was tested on the Grade 12 students of the CHSE who were undertaking mathematics and completed their final year in 2010.

1.6 Overview of the Thesis

The thesis consists of seven chapters. Chapter one gives an introduction to the thesis and outlines its objectives. After this, the chapter provides background information about the context of the Maldivian education system. Then, the chapter gives information on the target school and research on mathematics education in the Maldivian context. Finally, it explains the significance of the study.

Chapter two presents a review of the literature. The chapter begins with an introduction to the theories and an explanation of the variables in the study. After this, the relationships between the variables in the study are explored. Then, the use of mediational relationships in psychology is reviewed. Finally, the role of mediational relationships along with various methods of mediational analysis is discussed.

Chapter three provides a rationale for the present study by identifying the gaps in the literature relating to the relationships among beliefs, goals, learning strategies and achievement. This section also gives an overview of the present study that includes building the hypothetical mediational model of the study and the research hypotheses to be tested in the research.

Chapter four provides the design and methods of the present research. The chapter outlines a quantitative research methodology which focuses on SEM techniques. The outline includes the research design, instruments, procedures, sample size, the steps in the data analysis, and the procedure to test specific mediational pathways.

Chapter five presents the preliminary analyses of the study. This chapter reports an exploratory factor analysis for the items to identify the constructs of the present study. The chapter also reports the descriptive statistics, normality, and the assessment of convergent and discriminant validity of the constructs. Finally, it provides the evaluation of the measurement model with all the constructs, and the structural model with all the variables, before estimating the relationships in the structural model.

Chapter six presents the results of the study. First, it presents the full structural equation model, and reports the direct and indirect relationships among the variables. Then the chapter investigates the research questions by testing the hypotheses of the study. Finally, this chapter tests alternative models to examine a need for the mediational relationships and the limitations of the original model.

Chapter seven presents the discussion. First, it discusses the general findings and then the research questions and accompanying hypotheses. Next, it outlines the

limitations, and the theoretical and practical implications of the research. It also suggests directions for future research. The chapter ends by highlighting the main conclusion drawn from the thesis as a whole.

1.7 Summary

The purpose of the present study was to test a mediational relationship among students' beliefs about mathematical ability, their achievement goals, learning strategies, and mathematics achievement for students at the CHSE in the Maldives. The chapter provided a general rationale for the study in the context of the Maldives by giving relevant background information. Finally, this chapter ended with an overview of the present thesis.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature for the present study. Furthermore, I identify the specific variables measured in the study and the relationships among these variables. As indicated in the Introduction, the present study uses implicit theories of intelligence as a precursor to achievement goals, and also uses achievement goal theory to predict students' achievement-related behaviours, and subsequent achievement in academic settings. To develop the research framework for the present study, this chapter is divided into twelve main sections. The present section introduces the chapter. The second section provides a description of the search strategy used to identify relevant research articles. The third section gives a description of achievement goal theory. The fourth provides definitions for the learning strategies and the role of deep and surface learning in mathematics. In the fifth section, the relation among goals, strategies and achievement is described. The sixth section focuses on implicit theories of intelligence as antecedents to goals. Then, the relation between beliefs about intelligence and goal orientations is explored. In the eighth section, the role of beliefs and goals in learning environments is presented. In the ninth section, the relationships among beliefs, goals, strategies, and achievement are explored. Next, the use of mediations in education psychology is discussed, along with various methods of mediational tests. The last section provides a summary of the chapter.

2.2 Search Strategy for the Relationships among the Variables

Different combinations of the four variables used in the present study have been used in previous studies. However, very few previous studies have investigated relationships among all four of these variables. Nonetheless, there have been numerous studies that have investigated relationships among at least two of these variables, which still provided useful information for documenting the relationships between/among those variables. As a result, with different attempts I searched for articles that focused on at least one of the following relationships. First, I looked for articles that focused on the relationships among achievement goals, learning strategies, and achievement. Second, I tried to find articles that focused on the relationship between implicit theories

of intelligence and achievement goals. Third, I tried to find articles that focused on the relationships among implicit theories of intelligence, achievement goals, learning strategies, and achievement. Fourth, I focused on studies that investigated mediational relationships among three or four of the variables used in the present study.

To conduct these searches, published studies, journal articles, and conference proceedings were searched, using four different electronic databases: Google Scholar, Electronic Resources Information Centre (ERIC) (via ProQuest), A+ Education, and PsycINFO. Search terms used were “beliefs”, “implicit theories”, “implicit theories of intelligence”, “goals”, “goal orientations”, “achievement goals”, “learning strategies”, “study strategies”, “learning behaviour”, “achievement”, “mathematics achievement”, “performance”, “mathematics performance”, “mediation”, and “mediational analysis”. The following subsections detail the criteria adapted for the four separate searches of the literature.

2.2.1 Search Criteria for Relationships among the Variables

2.2.1.1 Relationships among achievement goals, learning strategies, and achievement

This search focused on studies that looked at the relationships among goals, learning strategies, and achievement. Specifically, the studies searched included trichotomous goals, deep and surface-learning strategies, and achievement in different academic domains. Seventeen studies were identified from this search (e.g., Albaili, 2006; Bandalos, Finney, & Geske, 2003; Cao & Nietfeld, 2007; Chan & Lai, 2006; Diseth, 2011; Diseth & Kobbeltvedt, 2010; Elliot et al., 1999; Greene et al., 2004; Ho & Hau, 2008; Liem et al., 2008; Phan, 2009; Roebken, 2007; Schraw, Horn, Thorndike-Christ, & Bruning, 1995; Seo & Taherbhai, 2009; Simons et al., 2004; Vrugt & Oort, 2008; Wolters, 2004).

2.2.1.2 Relationship between implicit theories of intelligence and achievement goals

This search focused on studies that looked at implicit theories of intelligence and goal orientations (either dichotomous goals or trichotomous goals). When searching for the relationship between implicit theories of intelligence and achievement goals, some of the studies in this category included learning strategies or some form of learning behaviour as a third variable. Eight studies were identified from this search (e.g., Abdulla, 2008; Braten & Strømsø, 2004; Cury et al., 2006; Dupeyrat & Mariné, 2001; Li,

Solmon, Lee, Purvis, & Chu, 2007; Robin & Pals, 2002; Shih, 2007; Vermetten, Lodewijks, & Vermunt, 2001).

2.2.1.3 Relationships among beliefs, achievement goals, learning strategies, and achievement

This search focused on studies that looked at the relationships among implicit theories of intelligence, achievement goals, learning strategies, and achievement, together in single study. The studies could have had any number of implicit theories, goal orientations, any learning strategies or learning behaviour, and general or domain-specific achievement. Four studies were identified from this search (Blackwell et al., 2007; Dupeyrat & Mariné, 2005; Jones et al., 2012; Law, 2009; Miller, 2010).

2.2.1.4 Mediation relationships among the four variables

This search focused on studies that explored mediational relationships among three or four of the variables on which the present study focussed (i.e., beliefs, goals, strategies, and achievement). Such studies should have included some form of mediational tests of the relationships among the variables studied. Five studies were identified from this search (Blackwell et al., 2007; Diseth, 2011; Diseth & Kobbeltvedt, 2010; Elliot et al., 1999; Jones et al., 2012).

2.3 Achievement Goal Theory

Achievement goal theory explains and predicts how students' motivation to learning in achievement situations. The central component of the theory is the role of goals in students' motivation (Maehr & Nicholls, 1980; Nicholls & Dweck, 1979). The term *goal* has a long history in the study of motivation (Anderman & Wolters, 2006). In general, a goal serves as a concrete point of reference for directing our actions in fulfilling our needs (Shah & Kruglanski, 2000), while motivation initiates, directs and sustains behaviour towards goal-oriented activities (Schunk et al., 2008). In recent years, the study of goals has contributed immensely to the field of achievement motivation. A prominent and highly researched area in the study of goals with respect to achievement motivation is *achievement goal theory*, also known as goal orientation theory (Anderman & Wolters, 2006). Achievement goal theory has been used to explain how students' goals influence their motivation and achievement-related behaviours, and to explain differences in their learning and academic achievement (Ames, 1992;

Dweck, 1986; Dweck & Leggett, 1988; Midgley et al., 1998; Pintrich, 2000). A number of researchers have investigated the role of goal orientations in achievement motivation (e.g., Ames & Archer, 1988; Anderman & Maehr, 1994; Anderman & Wolters, 2006; Dweck & Leggett, 1988; Elliot & Harackiewicz, 1996; Harackiewicz, Barron, & Elliot, 1998; Kaplan & Midgley, 1997; Maehr & Anderman, 1993; Meece, Blumenfeld, & Hoyle, 1988; Meece & Miller, 2001; Pintrich, 2000a, 2000b; Urdan, 1997; Wolters, Yu, & Pintrich, 1996). For example, Meece et al. (1988) used structural equation modelling to validate a goal model for conceptualizing the influence of individual and situational variables on students engagement in science activities. Task-mastery goals were related to higher active cognitive engagement, while the goals which were concerned with the social recognition were related to lower level of active cognitive engagement. It was also found that these goals were related to the differences in students' intrinsic motivation and attitudes towards learning.

Goal theory originally consisted of two main goal types: learning goals and performance goals (Dweck, 1986; Dweck Leggett, 1988). These two types of goals have also been described as mastery goals and performance goals (Ames & Archer, 1988), task-involved goals and ego-involved goals (e.g., Maehr & Nicholls, 1980; Nicholls, Cobb, Wood, Yackel, & Patashnick, 1990) and task-focused goals and ability-focused goals (Maehr & Midgley, 1991). Learning goals are associated with the development of competence and task mastery through directed effort and persistence. Students who adopt learning goals are intrinsically motivated, persist in the face of difficulty, and seek challenging tasks (Ames, 1992a; Dweck, 1986; Nicholls, 1984). In contrast, performance goals are associated with demonstrating one's ability and competence to others. Students who adopt performance goals tend to be more extrinsically motivated, persist minimally in the face of difficulty and avoid challenging tasks (Ames, 1992a; Dweck, 1986; Nicholls, 1984). Research on achievement goal theory suggests that mastery goals produce more adaptive cognitive and affective outcomes, and performance goals produce less adaptive outcomes (Dweck, 1988; Kaplan, Gheen, & Midgley, 2002; Kaplan & Midgley, 1999; Karabenick & Collins-Eaglin, 1997; Roeser, Midgley, & Urdan, 1996; Tapola & Niemivirta, 2008). For example, Kaplan and Midgely (1999) built on 'goal theory' analysis of adaptive behaviour by examining the relationships among task and ego goals, perception of school emphasis on the task and ego goals, and the indices of well-being and disruptive behaviour. The results indicated that task goals and

perception of school as emphasizing task goals were related to positive psychological well-being, while ego goals and perception of school as emphasizing ego goals were related to negative psychological well-being. The results implied that tasks goals are associated with positive feeling about oneself, and facilitate learning, while ego goals are associated with negative feelings, and disrupt learning.

Elliot and colleagues updated Dweck's dichotomous goal framework with a trichotomous framework by dividing performance goals into approach and avoidance dimensions, creating three independent goals: mastery, performance-approach, and performance-avoidance goals (Elliot & Church, 1997; Elliot & Harackiewicz, 1996). Mastery goals focus on task mastery of the subject, and developing knowledge and skills in the area. Performance-approach goals focus on one's ability to outperform others, and displaying one's competence in the subject. Students with performance-approach goals seek to look competent and receive favourable judgements from others. Performance-avoidance goals, on the other hand, are associated with a fear of failure, and the need to avoid looking incompetent compared to others. Individuals who hold performance goals tend to focus on their appearance relative to others, whereas individuals with learning goals tend to focus on improving their knowledge and skills.

More recently, motivational theorists have posited a more comprehensive form of goal orientation, a 2 x 2 goal framework whereby mastery goals are divided into mastery-approach and mastery-avoidance goals, and are added to the two types of performance goals (i.e., performance-approach and performance-avoidance) forming four independent goal orientations (Elliot & McGregor, 2001). Mastery-approach goals in a 2 x 2 framework, which are synonymous with mastery goals or learning goals in the earlier dichotomous and trichotomous frameworks, focus on learning and mastery of the subject, and increasing knowledge and competence through effort. Mastery-approach goals are the most favourable goal type for promoting and maintaining students' interest in academic activities (Harackiewicz, Barron, Pintrich, Elliot, & Thrash 2002; Midgley, Kaplan, & Middleton, 2001; Schunk & Zimmerman, 2008).

Mastery-avoidance goals, in contrast, emerge from the need to avoid failure and misunderstanding in learning (Elliot & Murayama, 2008). An example of a statement reflecting mastery-avoidance goals is "I worry that I may not learn all that I possibly could in this class" (Elliot & McGregor, 2001, p. 504). Mastery-avoidance goals have been a relatively recent addition to the theory and are the least understood type of goal,

with the 2 x 2 framework seldom tested or validated (Chan & Lai, 2006). Empirical studies to date have not provided a clear link between mastery-avoidance goals and indicators of performance, and an avoidance component of mastery-based goals is more difficult to envision than the avoidance component of performance-based goals (Van Yperen, Elliot, & Anseel, 2009). Ciani and Sheldon (2010) argued that mastery-avoidance goals have received less scrutiny because of their ambiguity and counter-intuitive nature, and the possibility that high scores for this goal might indicate participants' misinterpretation of items rather than actual avoidance goals. Hence, the trichotomous goal framework was adopted for the present study.

Goal orientation frameworks have been used to understand the role of goals in several academic disciplines. Evidence suggests that measurement of domain-specific goals may be more fruitful for understanding students' goals in those domains. For example, Shively (2009) who measured both general and mathematical goal orientations found that students were more learning and performance-oriented in academics in general compared to mathematics. Furthermore, many studies have used domain-specific items to represent goals in mathematics (Jones, Wilkins, Long, & Wang, 2012; Levpuscek & Zupancic, 2008; Ryan, Ryan, Arbuthnot, & Samuels, 2007; Seo & Taherbhai, 2009; Stipek et al., 1998; Summers, 2006). The goal orientation instruments used in these studies were written in relation to a mathematics context, and gave the researchers a better understanding of participants' goals and the underlying reasons they had for adopting goals in mathematics in particular, as opposed to general academic goals. Examples of items used to measure mastery, performance-approach, and performance-avoidance goals in the mathematical domain include: "I like math work. I will learn from it even if I make a lot of mistakes."; "I would feel really good if I were the only one who could answer the teachers' questions in math class"; and "One reason I would not participate in math class is to avoid looking stupid." (Seo & Taherbhai, 2009, p.196).

Studies have also highlighted that students' adoption of goals differs across studies in mathematics education (Levpuscek & Zupancic, 2008; Seo & Taherbhai, 2009; Shively, 2009; Summers, 2006). For example, Levpuscek and Zupancic (2008) found that a sample of Slovenian eighth-grade students, and Jones et al. (2012) found that a sample of American ninth-grade students, were predominantly mastery-oriented towards mathematics learning. Moreover, Seo and Taherbhai (2009), who used goal

orientation items from Midgley et al. (1998) to test a trichotomous framework in the mathematical domain for a sample of Korean elementary students found that participants' reported a greater performance-avoidance orientation towards mathematics learning than mastery and performance-approach orientations. Summers (2006) also tested a trichotomous goal framework for a sample of sixth-grade mathematics students in the US, and found that students were task-oriented towards learning in general, but that they were performance-approach-oriented towards learning mathematics. The students also reported adopting performance-avoidance goal orientations in mathematics, indicating that they also tried to avoid being less competent than their peers in their mathematics class.

The findings from the aforementioned studies (Jones et al., 2012; Levpuscek & Zupancic, 2008; Seo & Tahaerbhai, 2009; Summers, 2006) indicate three main points. First, students' adoption of goals differs in different academic disciplines, and students were more learning and performance-oriented towards academics in general as compared to mathematics (Shively, 2009). Second, students' dominant goal type in mathematics is not consistent across studies. Third, participants differed in their level of education across the studies, which might influence the goals they adopt. For instance, students in Levpuscek and Zupancic's (2008) and Jones et al.'s (2012) were secondary school students, whereas the students in Shively (2009) were university students.

In summary, achievement goal theory has been used to explain how students' motivation and achievement-related behaviours can be understood by considering the underlying goals they adopt in their academic tasks (Ames, 1992; Dweck & Leggett, 1988; Urdan, 1997; Wolters, 2004). In the trichotomous goals framework in the context of mathematics, individuals with mastery goals are concerned with intrinsic motivation, task mastery, and effort and persistence in the subject; individuals with performance-approach goals are concerned with outperforming others and receiving recognition in mathematics; and individuals with performance-avoidance goals are concerned with avoiding being perceived as less competent than others.

2.4 Learning Strategies

Why do students perform differently in learning environments? One possible answer is that they study differently or they use different learning strategies. Learning strategies can be defined as learner's behaviour that influence their learning process or the activities they "use to best approach new information and improve their learning" (Liu, 2009, p. 313). These behaviours and activities can be either adaptive or maladaptive, depending on the student's beliefs about the nature of their ability (e.g., Pacheva, 1998; Tapola & Niemivirta, 2008). Learning behaviour or learning strategies also play a prominent role as a mediator in predicting academic achievement with respect to goal orientation (Diseth, 2011; Diseth & Kobbeltvedt, 2010; Elliot, McGregor, & Gable, 1999; Blackwell, Trzesniewski, & Dweck, 2007). For example, Elliot et al. (1999) found that persistence and effort mediated the relationship performance-approach goals and exam performance, whereas disorganisation mediated the relationship between performance-avoidance goals.

Learning involves a combination of cognitive, affective, and metacognitive activities (Vermont, 1996). Studies have used different definitions and classifications of learning strategies (Pintrich & Garcia, 1991; Somuncuoglu & Yildirim, 1999; Weinstein & Meyer, 1991). However, the most common of these strategies are classified into cognitive and metacognitive learning strategies (Somuncuoglu & Yildirim, 1999). Cognitive strategies such as rehearsal, elaboration, and organisation are plans for coordinating "cognitive resources, such as attention and long-term memory to help reach a learning goal" (Weinstein & Meyer, 1991, p.17). Metacognitive strategies include planning, monitoring, and regulation of the learning process. The majority of studies have focused on cognitive strategies with respect to student motivation (Vermunt, 1996).

Furthermore, cognitive strategies are also classified into deep processing and surface processing (Somuncuoglu & Yildirim, 1999). Deep processing includes strategies such as elaboration and organisation, whereas surface processing includes rehearsal, memorisation and rote learning. Moreover, deep processing involves the use of strategies that commonly enhance learning, particularly when students spend more time studying and developing their understanding of a subject's content. Ramsden (2003) highlighted the advantages of deep-processing strategies over surface-processing strategies. He mentioned that deep-processing approaches are "associated

with a sense of involvement, challenge and achievement, together with feelings of personal fulfilment and pleasure” (Ramsden, 2003, p.57). In contrast, he added that when students adopt surface-processing strategies, they may just focus on passing the examinations and pleasing teachers and parents, rather than understanding the important concepts and applying knowledge to the real world. Subsequently, students who rely on this approach are more disorganised in their studies, easily give up in challenging situations, and are more likely to fail in examinations as they spend less and less time studying. Hence, to be successful in school, students are expected to use more deep-learning strategies than surface learning as they progress through grades. However, students learn different subjects at different levels of education and use mixed approaches for learning, at the same time using various approaches that are effective for them in building their capacity to be successful in educational settings.

In summary, learning involves processing information deeply and shallowly, which in turn influences their learning outcomes in various academic disciplines. However, research suggests that deep-processing strategies in general are more beneficial to students than surface-processing strategies (Liem, Lau, & Nie, 2008).

2.4.1 The Use of Deep and Surface Learning in Mathematics

Mathematics is an important subject that can be used in and out of educational settings. The application of mathematics is required in several fields, including engineering, science and management science (Mackie, 2002). Reform in mathematics education has led to an increased focus on the need for understanding mathematics, particularly with respect to expanding the use of science and technology (Furner & Gonzalez-DeHass, 2011). Learning mathematics requires skills such as formulating a problem in mathematical terms, tackling real-world problems, analysing them, and interpreting the problems’ solutions (Mackie, 2002). A recent reform in mathematics education has focussed on building learning environments for students, with an emphasis on learning mathematics for understanding (Kaya, 2007). Learning for understanding helps students to apply their mathematical knowledge to new topics and to solving new mathematical problems (Hiebert & Carpenter, 1992). Specifically, learning the underlying concepts in mathematics requires a deep approach to learning and the application of these concepts in real-world situations. Students who adopt a deep approach to learning mathematics tend to focus on mastering the subject, which is

useful when applying mathematical knowledge to new topics, whereas students who adopt a surface approach frequently focus on merely completing assessment tasks (Crawford, Gordon, Nicholas, & Prosser, 1998).

In addition to these distinctions between deep and surface learning, Mackie (2002), highlighted that deep and surface strategies are at two extreme ends of a continuum, and students typically fit somewhere in between these two extremes. That is, they use these deep and surface strategies together while they learn. Surface processing is also used to build a foundation for the use of deep-processing approaches (Yein & Mousley, 2005). Ryan et al. (2007) used semi-structured interviews to investigate how the differences in motivational and psychological processes might contribute to performance in high-stake maths assessment. They found that some students in high-stakes testing used critical and logical thinking when solving mathematics problems, while others used formulae and recalled what the teacher had them do in the classroom. Hence, it is also beneficial for mathematics teachers to know which strategies work and for whom so that they can facilitate students' development of successful strategies and mathematical competence.

In summary, learning mathematics involves a combination of several strategies including deep and surface-learning strategies. At the same time, learning mathematics requires a deep understanding of the subject material. Empirical research on students' learning and achievement has indicated that deep processing is more adaptive than surface processing and generally has a positive association with students' performance, whereas surface processing is less adaptive (e.g., Liem et al., 2008; Simons, Dewitte, & Lens, 2004).

2.5 Relationships among goals, strategies and achievement

Achievement goal theory explains and predicts the relations among goals, achievement-related behaviours, such as learning strategies, and achievement in academic settings (Ames, 1992; Dweck, 1986; Dweck & Leggett, 1988; Midgley et al., 1998; Pintrich, 2000). A large number of researchers have investigated relations among these variables (e.g., Albaili, 2006; Bandalos, Finney, & Geske, 2003; Cao & Nietfeld, 2007; Chan & Lai, 2006; Diseth, 2011; Diseth & Kobbeltvedt, 2010; Elliot et al., 1999; Greene et al., 2004; Ho & Hau, 2008; Liem et al., 2008; Phan, 2009; Roebken, 2007;

Schraw, Horn, Thorndike-Christ, & Bruning, 1995; Seo & Taherbhai, 2009; Simons et al., 2004; Vrugt & Oort, 2008; Wolters, 2004).

Many of these studies provided a foundation for the present study, and the present study aimed to build upon or extend their findings. I grouped these studies in three categories based on how they differed from the present study, which also served as a basis for justifying the inclusion of the variables measured in the present study.

The first category included studies that measured dichotomous goals rather than trichotomous goals (Albaili, 2006; Bandalos et al., 2003; Cao & Nietfield, 2007; Greene et al., 2004; Phan, 2009; Schraw et al., 1995). For instance, Bandalos et al. (2003) investigated the relations among goals, processing strategies, and achievement for undergraduates who were taking a course in statistics. They found that mastery goals were related to deep processing, performance goals were related to disorganisation, and deep processing was related to achievement. However, although they measured learning and performance goals, they did not make a distinction between performance-approach and performance-avoidance goals. Thus, results from Bandalos et al. (2003) and similar studies provided a basis for investigating the relations among goals, processing, and achievement.

However, it is important to measure these relations for performance-approach and performance-avoidance goals because previous research has shown that these goals have different relations with learning strategies and achievement (e.g., Cutinho & Savia, 2008; Kaplan & Litchinger, 2009; Seo & Taherbhai, 2009). For example, Seo and Taherbhai (2009) found performance-approach goals were more strongly related to cognitive/metacognitive strategies and achievement than performance-avoidance goals, and Kaplan and Litchinger (2009) found performance-approach goals were more strongly related to study organisation than performance-avoidance goals. Further, Cutinho and Savia (2008) found students who adopt performance-avoidance goals were more disorganized in their studies than students with performance-approach goals, and found students' performance-approach goals were positively and performance-avoidance goals were negatively related to their achievement. Thus, a trichotomous goal framework was used in the present study to provide a more detailed investigation of the role played by different types of goals in mathematics achievement.

The second category consisted of studies that did not specifically include either or both the deep and surface-learning strategies (Ho & Hau, 2008; Phan, 2009; Roebken, 2007;

Schraw et al., 1995; Seo & Taherbhai, 2009; Wolters, 2004). For instance, Phan (2009) used structural equation modelling to investigate the relations among goals, deep processing, critical thinking, effort, and academic success for university students in psychology. They found that mastery goals were positively-related to deep learning strategies and performance-approach goals were positively-related to effort. However, neither effort nor deep learning strategies were related to either critical thinking or to achievement, as hypothesised in the model. Phan did not measure students' use of surface-learning strategies despite the fact that deep and surface strategies show different relations to goal and achievement (e.g., Bernerdo, 2006; Crawford et al., 1998). For example, Bernardo (2006) found deep learning strategies were positively-related to academic achievement, whereas surface learning strategies were negatively-related to academic achievement. Similarly, Crawford et al. (1998) found that deep learning strategies were positively-related to mathematics achievement, whereas surface strategies were negatively-related to mathematics achievement for university students. Thus, both deep and surface learning strategies were used in the present study to explore the role played by depth of learning in mathematics achievement.

In addition to the aforementioned two categories, there were eight studies that were closely aligned with the model and analyses used in the present study, and thus were more relevant for justifying the model to be tested. These studies used a trichotomous goal orientation, included both deep and surface learning strategies, and had a measure of achievement (Elliot et al., 1999; Chan & Lai, 2006; Diseth, 2011; Diseth & Kobbeltvedt, 2010; Liem et al, 2008; Simons et al., 2004; Vrugt & Oort, 2008). These studies also used either SEM or path analysis to investigate the relationships among these variables. Of these eight studies, three of the studies (Diseth, 2011; Diseth & Kobbeltvedt, 2010; Elliot et al., 1999) used mediational analysis and mediational tests in particular to investigate the relations among the variables and will be discussed later (refer section 2.10: Meditational Relationships). The remaining five studies are discussed in detail and will be linked to the proposed model (Al-Emadi, 2001; Chan & Lai, 2006; Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008).

Chan and Lai (2006) used path analysis to investigate the relations among goals (i.e., mastery, performance-approach, performance-avoidance), strategies (i.e., deep-processing and surface-processing), and academic achievement for secondary students (n = 1381) in Hong Kong. They found that mastery goals were positively related to both

deep-processing ($\beta = .80, p < .05$) and surface-processing ($\beta = .16, p < .05$). Conversely, performance-approach ($\beta = .16, p < .05$) and performance-avoidance goals ($\beta = .43, p < .05$) were positively related to surface-processing. Neither deep ($\beta = .14, p > .05$) nor surface processing strategies ($\beta = .08, p > .05$) were significantly related to achievement. While the relation between goals and strategies was expected, the lack of relations between strategies and achievement was surprising given that deep processing strategies are often positively related to performance, whereas surface processing strategies are often negatively related to achievement.

One possible explanation for these unexpected findings is that the students provided the achievement data rather than the school, and achievement was measured as a categorical variable (from 1 to 5) in the study. Thus, it is possible that weak students would have been reluctant to provide accurate achievement data for the study. Categorising the achievement data also affects the variability of the achievement scores and could have affected the strength of the relation between learning strategies and achievement. The sample size ($n = 1381$) was large enough to use path analysis and to measure the variables included in the study. However, effect sizes such as R^2 values or Cohen's (1992) f^2 values for the endogenous (dependent) variables were not reported, which are important for understanding the amount of variance explained from the endogenous variables (e.g., achievement variable). Thus, it is not possible to judge the explanatory power of the model along with the significant relationships demonstrated in the model.

In the another study, similar to that of Chan and Lai (2006) , Liem et al. (2008) studied the impact of trichotomous goals and learning strategies on English achievement for Year 9 students in Singapore. They found that mastery goals were positively related to both deep ($\beta = .32, p < .01$) and surface-learning strategies ($\beta = .55, p < .01$). Performance-approach goals were positively related to deep-learning strategies ($\beta = .16, p < .01$), whereas performance-avoidance goals were positively related to surface-learning strategies ($\beta = .15, p < .01$). The results also indicated that deep learning had a direct positive relation ($\beta = .11, p < .01$), and surface learning had a direct negative relation with English achievement ($\beta = -.28, p < .01$).

Similar to Chan and Lai (2006), this study in general showed the relation among goals, strategies and achievement but some differences appeared as far as the relations

demonstrated in the model. For example, Liem et al. (2008) found that performance-approach goals were positively related to deep-learning strategies, but this relation was non-significant in Chan and Lai's (2006) study. This difference could be because these two studies tested the variables in different academic contexts. For example, the academic context in Liem et al. (2006) was English language learning in Hong Kong while Chan and Lai (2006) focused on academics in general. From the methodological point of view, this study also had a large sample size ($n = 1475$) for conducting a SEM study. The model explained 44% of the variance (i.e., equivalent of .78 of Cohen's f^2) in English language achievement by goal orientations and learning strategies variables. According to Cohen (1992) a value of f^2 greater than .35 produces large effect size. The study also tested alternative models to identify the limitations of the original model and to increase the fit of the model used. However, the authors did not conduct a principal component analysis (PCA) or an exploratory factor analysis (EFA) procedure, which would have been important to test the dimensionality of the variables and extract the exact number of factors that accounted for the maximum number of the variance from the variables of the study.

Simons et al. (2004) also used path analysis to investigate the role of goals, study strategies, and achievement for Belgium students in a nursing program. For these students, mastery goals (referred to as task goals in the article) were positively related to deep processing ($r = .32, p < .001$), excitement, persistence and regular studying, and negatively related to surface level processing ($r = .32, p < .001$). Approach ego (performance-approach) ($r = .32, p < .001$) and avoidance ego (performance-avoidance) ($r = .32, p < .001$) goals were positively related to surface-level processing. However, both performance-approach ($r = .24, p < .001$) and performance-avoidance ($r = .22, p < .001$) goals were negatively related to deep learning strategies. The results also indicated that deep-level processing ($r = .32, p < .001$), persistence, and regular studying were positively related to students' performance, whereas surface level processing was negatively related to performance ($r = .32, p < .001$).

Similar to Chan and Lai (2006) and Liem et al. (2008), this study also used achievement goal theory to investigate the relations among goals, strategies, and achievement. However, results from Simon et al. differed from Liem et al. (2008). For example, in Liem et al. (2006) mastery goals were not related to surface learning strategies, but Simons et al. found a negative relation between mastery goals and

surface learning strategies. Similarly, Simon et al. did not find a relation between performance-approach goals and deep learning strategies, but Liem et al. (2008) found a positive relation between the two. These differences could be due to the fact that Liem et al.'s (2008) study used secondary students while Simon et al. (2004) used college students of 18-45 years or Liem et al.'s (2008) study was on English language while Simon et al.'s (2004) study was on nursing program.

Furthermore, in contrast with Chan and Lai (2006), and Liem et al.'s (2008), Simon et al. (2004) used principal component analysis (PCA) with varimax rotation to reduce the dimensionality of the factors used in the study. It is a strength of this study compared to Chan and Lai (2006) and Liem et al. (2008) which did not use any procedure to identify the dimensionality of the factors used. However, the method and the type of rotation used in the study can be questioned. PCA does not account for errors in doing the procedure and varimax rotation is one of the orthogonal rotations where the factors are assumed to be uncorrelated. That study, however, used many variables and tested the relation among them and assumed correlations among them. Exploratory factor analysis (EFA) which accounts for the measurement error while measuring the factors, a rotation (e.g., an oblique rotation) that assumes the correlation among the factors, could have been a better choice for Simons et al. Further, the effects size values were not provided to explain the percentage of variance in the achievement predicted from other independent variables. This was a limitation of the study.

Vrugt and Oort (2008) also used path analysis to investigate the relationships among achievement goals, learning strategies and achievement for Dutch students enrolled in a psychology course. The relationships were tested between group of students who were more effective and less effective at self-regulation. In both of the groups it was found that mastery ($\beta_1 = .14$, $\beta_2 = .20$, $p < .05$) and performance-approach goals were positively related to deep-processing strategies ($\beta_1 = .21$, $\beta_2 = .24$, $p < .05$). In both the groups, performance-approach goals were also positively related to surface-processing strategies ($\beta_1 = .10$, $\beta_2 = .20$, $p < .05$). However in the more effective group, performance-avoidance goals were not related to either deep or surface cognitive strategies whereas in the less effective group, performance-avoidance goals were negatively related to deep strategies ($\beta_2 = -.09$, $p < .05$), and were not related to surface strategies. Although surface-processing strategies in the both the groups

showed a negative effect on examination scores ($\beta_1 = -.13, \beta_2 = -.15, p < .05$), surprisingly deep processing strategies did not show any effect on examination scores.

Some of the Vrugt and Oort's results in general differed from Simons et al. (2004) study. For instance, Simons et al. (2004) showed that only mastery goals were related to deep-processing strategies, which in turn were related to achievement. However, in Vrugt and Oort's (2008) study, both mastery and performance-approach goals were positively related to deep-processing strategies, but no relationship between deep-processing strategies and examination scores was identified. The differences could be attributable to the fact that Simon et al.'s (2004) was on nursing students while Vrugt and Oort's (2008) was on psychology students and the items were measured in psychology domain.

Finally, in this category, Al-Emadi (2001) tested the relationships among goal orientation, study strategies, and achievement for 424 United Arab Emirates high school students who were enrolled in various introductory courses in different faculties, including humanities, social sciences, science, engineering, law and economics. The students completed questionnaires designed to measure trichotomous goal orientations (mastery, performance-approach and performance-avoidance) and specific learning strategies (deep processing, surface-processing). Mastery goals were positively related to deep processing ($\beta = .63, p < .05$), and surface processing ($\beta = .21, p < .05$); performance-approach goals were positively related to surface processing ($\beta = .32, p < .05$) but were not related to deep processing ($\beta = .08, p > .05$); performance-avoidance goals were positively related to surface processing ($\beta = .55, p < .05$), but were not related to deep processing ($\beta = .10, p > .05$). When surface processing strategies were positively related to achievement ($\beta = .32, p < .05$), deep processing strategies were not significantly related to the achievement. The study in general highlighted the importance of achievement goal theory and how goals are related to study strategies and subsequent achievement. However, Al-Emadi indicated the importance of doing further investigation of the psychometric proprieties of the same measures with non-western samples. Additionally, similar to Simon et al. (2004), the authors used a PCA, but with an oblique rotation to measure the dimensionality of the variables. However, an EFA which accounts for measurement error would have been a better methodology to investigate the dimensionality. The author further reported the effect size for the

achievement variable for the study, which was essential to judge the amount of variance explain by the model.

Take together, all the studies showed that mastery goals were positively related to deep learning strategies, while three studies (Al-Emadi, 2001; Chan & Lai, 2006; Simons et al., 2004) showed that mastery goals were negatively related to surface learning strategies. Only Liem et al. (2008) showed that performance-approach goals were positively related to deep learning strategies, while all the studies except Liem et al. (2008) and Al-Emadi (2001) showed that performance-approach goals were positively related to surface learning strategies. However, while four studies (Al-Emadi, 2001; Chan & Lai, 2006; Liem et al., 2008; Simons et al., 2004) showed performance-avoidance goals positively related to surface learning strategies, no studies showed that they related to deep learning strategies. Furthermore, three studies (Al-Emadi, 2001; Liem et al., 2008; Simons et al., 2004) out of five showed that deep learning strategies were positively related to achievement, and three (Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008) out of five showed that surface learning strategies were negatively related to achievement. Above all, along with the direct relations demonstrated in the above-mentioned studies, the SEM and path models in these studies pictorially represented that there could have some indirect relations among goals, strategies, and achievement. For instance, Simon et al. (2004) indicated the positive relation between mastery goals and deep learning strategies, which in turn indicated that there also existed a positive relation between mastery goals and achievement. Thus, in Simon et al.'s (2004) study mastery goals could be related to achievement, mediated through deep learning strategies. In general, by testing specific meditational pathways in the models described in the five studies, the researchers could have identified the mediating role of deep and surface processing strategies in the relationship between trichotomous goals and achievement.

Despite of the common and contrasting relations demonstrated by the above-mentioned five studies there were limitations common to all of these studies. First, in all of the above mentioned studies it was found that several causal claims were made as SEM and path analysis techniques were used to analyse the data and demonstrate the relations among the variables. In the past, SEM technique has been named as causal modelling, and theoretically uses the concept of cause-and-effects to build theoretical models. However, it is not wise to use causal claims in reporting the results as SEM and

path analysis are non-experimental designs which cannot practically prove causal statements. One of the potential limitations common to all of these studies is that they did not report testing of the convergent and discriminant validity of the measurement instruments. The convergent validity is essential to identify the extent to which two measures of the same construct correlates with each other, while discriminant validity of measurement instrument is essential to judge if a construct does not correlates with measures of another constructs. Moreover, all of these researchers mentioned the use of self-reported questionnaire to measure various goals and strategies but used Likert-scales to measure the variables. One of the disadvantages of Likert-scales in social science research are that it makes the respondents to choose from fixed responses from the scale, but the researchers treat them as interval scales. By taking the limitations of the above-mentioned studies into account, and developing a model similar to the models in above-mentioned studies would extend the achievement goals theory research base, which would in turn have more accurate, reliable and valid information on the relationships among goals, strategies and achievement.

Having introduced the achievement goal theory and what the theory explains and predicts, it is important to explore the antecedents of goals or what possibly predicts achievement goals. Thus, in the next section, I will define and explain 'Implicit theories of intelligence', one of the major component of Dweck's (1986; Dweck & Leggett, 1988) motivation model and an antecedent to achievement goals. It is believed that by understanding students' perception of their intelligence and abilities, educators can much better understand how students adopt and retain goals in academic settings (Hsieh, Cho, Liu, & Schallert, 2008).

2.6 Implicit Theories of Intelligence

Implicit theories of intelligence refers to the beliefs people have about the nature their intelligence and abilities. Dweck's motivational model (Dweck, 1986; Dweck & Leggett, 1988) describes two theories people can hold about the fundamental nature of their intellectual ability: an entity theory (also sometimes referred to as a fixed mind-set), and an incremental theory (or growth mind-set) – collectively known as implicit theories of intelligence or lay theories (Dweck, 1986; Murphy & Dweck, 2010). People who view their intellectual ability as fixed and stable have an entity theory of

intelligence, whereas people who view their intellectual ability as malleable and changeable have an incremental theory of intelligence.

Furthermore, these two implicit theories of intelligence are related to different motivational and behavioural pattern. For instance, Pacheva (1998) found that students who predominantly hold the view that intelligence is malleable demonstrate adaptive attributional patterns, whereas students who predominantly hold an entity view of intelligence demonstrate more maladaptive attributional patterns in their studies. In other words, students who have incremental views report more adaptive cognitive strategies and behavioural outcomes than students who have entity views (Dweck et al. 1995; Howell & Buro, 2008). Additionally, students with an incremental theory or growth mind-set who view intelligence as something that can be developed with hard work, attribute their success to effort and persistence (Dweck & Leggett, 1988). When success and failure are attributed to effort, incremental theorists persist not only in the face of difficulty but also in the pursuit of additional success (Perry, 2011). In contrast, students who hold an entity belief or fixed mind-set believe that their intelligence is stable and cannot be changed over the time, despite their effort and hard work. Furthermore, they attribute their failures to personal inadequacy such as their knowledge in the subject, memory, problem-solving ability, and intelligence as a whole.

2.6.1 Mathematics-specific Beliefs about Ability

Beliefs are domain specific. Students have different implicit theories of intelligence and attribution patterns in different domains (Pacheva, 1998). For instance, students' beliefs in mathematics/science can differ from their beliefs in language arts/social studies (Pacheva, 1998). Dweck's (1986) implicit theories have been used to examine specific beliefs in various areas including: personality differences (Erdley, Cain, Loomis, Dumas-Hines & Dweck, 1997; Erdley & Dweck, 1993); personal relationships (Knee, Patrick, & Lonsbary, 2003); motivation (Dweck & Leggett, 1988); leadership (Hoyt, Burnette & Innella, 2012); weight management (Burnette, 2010); and even criminology (Yeager, Trzesniewski, Tirri, Nokelainen, & Dweck, 2011). Implicit theories of intelligence have also been used more narrowly in academic subject areas including writing (e.g., Perry, 2011), reading (e.g., Hlava, 2007; Schraw & Bruning, 1999), science (Chen & Pajares, 2010), mathematics and social studies (Stipek & Gralinski, 1996), mathematics/science and social studies/art (Pacheva, 1998), and most importantly for

this study, mathematics (Cury, Elliot, Fonseca, & Moller, 2006; Jones et al., 2012; Shivley, 2009; Stipek, Givvin, Salmon, & MacGyvers, 2001).

In the present study, students' beliefs about their intelligence in mathematics are referred to as 'beliefs about mathematical ability'. Scales have been used in research to measure theories of intelligence in mathematics (e.g., Cury et al., 2006; Jones et al., 2012; Shivley, 2009; Stipek et al., 2001). An example of an item that has been used to measure an incremental view of mathematical ability is, "No matter who you are, you can change your math intelligence a lot" (Jones et al., 2012, p.6), while an entity view of mathematical ability has been measured with, "Mathematical ability is something that remains relatively fixed throughout a person's life" (Stipek et al., 2001, p. 218). Students' beliefs about the nature of mathematical ability, their mathematical knowledge and problem-solving skills are related to their learning in mathematics and to their level of attendance (Hassi & Laursen, 2009). According to Stump, Husman, Chung, and Done (2009), mathematics is an area in which students tend to hold entity views to a greater extent than in other content areas, such as reading and literature. Stump et al. (2009) found that university students who were enrolled in engineering predominantly had higher entity views than incremental views. Stump et al. further emphasised that students have entity views to a greater extent in mathematics because they believe that they are not able to learn sophisticated mathematical procedures even with the help of the most accomplished professors, indicating an entity view of mathematical ability. However, the role of beliefs has differed among studies that have investigated implicit theories in mathematics (e.g., Cury et al., 2006; Jones et al., 2012) and among the studies that have investigated implicit theories in mathematics and other domains (e.g., Pacheva, 1998; Shively, 2009). For instance, Pacheva (1998) found that 204 eighth-grade students (146 Asian-Canadian and 58 Caucasian-Canadian) more frequently attributed failure to effort (i.e., an incremental view) in social studies/arts and more often attributed failure to ability (i.e., an entity view) in mathematics/science. These findings are consistent with Stump et al.'s (2009) findings. Similarly, Shively (2009) found that over the course of a semester, university students consistently held incremental views of their general intelligence to a greater extent than they did of their intelligence in mathematics specifically, and had entity views of their mathematics intelligence to a greater extent than that of their general intelligence. In other words, although the students believed that their general intelligence could be developed, they

appeared to be hesitant in specifically believing that their individual mathematical ability could be developed (Shively, 2009).

In contrast with the findings from Pacheva (1998) and Shively (2009), Cury et al. (2006) found that 12- to 14-year-old French students had stronger incremental views than entity views towards their mathematical ability. Furthermore, Jones et al. (2012) also found that American high school students had stronger incremental than entity views about their mathematics ability. Taken together, these findings indicate that beliefs about intelligence in mathematics can differ from general beliefs about intelligence and that beliefs in mathematics ability can differ across studies. Additionally, it is difficult to identify the underlying factor/s that contribute/s to this difference among these studies.

In summary, implicit theories of intelligence are domain specific, and in mathematics education, these theories can be used to understand students' motivation and their learning in mathematics. Using Dweck's (1986) implicit theories as a basis for predicting students' beliefs in mathematics, it can be predicted that students with entity views of ability in mathematics think that their mathematical ability remains the same throughout the lifespan, and that hard work does not improve their mathematical knowledge and problem-solving skills. In contrast, students with incremental views of mathematical ability believe that they can increase and develop their mathematical ability by studying and practising mathematical problems, which in turn is related to their ability to perform well in the mathematical domain. Students who believe mathematical ability is malleable through effort and hard work tend to expend more effort in mathematics and achieve better outcomes than students who believe mathematical ability is fixed or unchangeable (Middleton & Spanias, 1999). However, the role of beliefs in mathematics differs across studies whose participants were drawn from different educational levels. Therefore, the present study will investigate the role of students' beliefs in their mathematical ability. Furthermore, the setting of the study is the Maldives, where the role of such beliefs has yet to be explored.

2.7 Relationship between Beliefs about Intelligence and Goal Orientations

Dweck (1986) postulated that people's interpretations of their intelligence are linked with two types of goals: performance goals and learning goals. She also found that people who held incremental beliefs strived to develop their ability and chose learning goals. Conversely, people who held entity beliefs indicated that intelligence was stable and chose performance goals. Subsequently, many researchers have highlighted the relationship between implicit theories of intelligence and goal orientation (e.g., Abdulla, 2008; Braten & Strømsø, 2004; Cury et al., 2006; Dupeyrat & Mariné, 2001; Li, Solmon, Lee, Purvis, & Chu, 2007; Robin & Pals, 2002; Shih, 2007; Vermetten, Lodewijks, & Vermunt, 2001).

Some studies (Abdulla, 2008; Li et al., 2007; Robin & Pals, 2002) reported findings that were consistent with Dweck's (1986; Dweck & Leggett, 1988) model of the relationship between beliefs and dichotomous goal orientations. More specifically, they found that incremental beliefs about intelligence were associated with learning goals, whereas entity beliefs about intelligence were associated with performance goals. For instance, Robin and Pals (2002) tested a path model that linked beliefs about intelligence, goals, helpless versus mastery-response patterns, and self-esteem, for 508 undergraduate students from the US. They found that entity theorists emphasised performance goals ($r = .21, p < .05$), whereas incremental theorists emphasised learning goals ($r = .21, p < .05$). In another study, whose participants were Malaysian primary school students, Abdulla (2008) investigated the relationship of children's implicit theories of intelligence with their goal orientations, self-efficacy and self-regulation. Correlational analyses showed that effort-beliefs (incremental beliefs) had a positive relationship with intrinsic goal orientations (learning goals) ($r = .37, p < .05$), whereas entity beliefs had a positive relationship with extrinsic goals (performance goals) ($r = .22, p < .05$). The findings of Robin and Pals (2002), and Abdulla (2008) were consistent findings with Dweck's model (1986).

Other studies have reported findings that provided partial support for Dweck and Leggett's (1986) model on the relationship between implicit theories and dichotomous goal orientations (e.g., Dupeyrat & Mariné, 2001; Li, Solmon, Lee, Purvis, & Chu, 2007; Vermetten, Lodewijks, & Vermunt, 2001). For example, in a study that examined the relationship between students' implicit theories of ability, dichotomous

goal orientations and preferred type of feedback for 115 undergraduate students in the US, Li et al. (2007) found partial consistency with Dweck (1986). Li et al. (2007) found that incremental beliefs were positively associated with task orientation ($r = .22, p < .05$), entity beliefs were negatively associated with task orientation ($r = -.25, p < .05$), and entity beliefs were not significantly associated with performance goals (the authors used the terms “ego orientations”, p. 288) ($r = .08, p > .05$). Dupeyrat and Mariné (2001) examined beliefs about intelligence, goal orientations, and self-perceptions of cognitive engagement in learning for 142 students in France. Theories of intelligence were measured as single rather than a dual factor, representing an entity view of intelligence. The reversed scores of entity view were taken as the incremental view of intelligence. They found that entity beliefs were negatively related to learning goals ($r = -.23, p < .01$), which indicated that incremental beliefs (i.e., rejecting entity view of intelligence) were positively related to learning goals. However, entity beliefs were not related to performance goals ($r = -.07, p < .05$). This partially supported Dweck’s model (1986). In another study, Vermetten et al. (2001) examined the role of personality traits (implicit theories) and goal orientations on strategy use for university students in Netherlands, and their findings were also partially consistent with Dweck’s (1986) model. Vermetten et al. (2001) also measured intelligence as single factor that represented entity view of intelligence and found a significant relationship between entity beliefs and performance goals (ego orientations) ($\beta = .24, p < .05$). However, incremental beliefs (i.e., rejecting entity view of intelligence) were not related to learning goals ($\beta = .24, p < .05$). The findings from Dupeyrat and Mariné (2001), Li et al. (2007), and Vermetten et al. (2001) generally showed the relation between implicit theories of intelligence and dichotomous goals, but the relation was only partially supported.

In addition to the above studies that identified relationships between beliefs about intelligence and dichotomous goal orientations, Cury et al. (2006), who tested Dweck and Leggett’s (1988) model and used a 2 x 2 achievement goal framework for 12 to 14-year-olds in France, found that incremental beliefs were positively correlated with mastery goals ($r = .27, p < .01$), and negatively correlated with performance-avoidance goals ($r = -.10, p < .05$), while entity beliefs were positively correlated with the adoption of performance-approach ($r = .23, p < .01$) and performance-avoidance goals ($r = .24, p < .05$). However, Braten and Strømsø (2004), who examined whether

implicit theories and epistemological beliefs were related to goals using the trichotomous goal framework with Norwegian undergraduates, found that entity beliefs were positively correlated with performance-avoidance goals ($r = .27, p < .05$), whereas incremental beliefs were negatively correlated with performance-avoidance goals ($r = -.32, p < .01$). Results also indicated that neither incremental nor entity beliefs correlated with either mastery or performance-approach goals. These results showed some inconsistencies with Dweck and Leggett's (1988) model.

Furthermore, Shih (2007) explored how motivational characteristics such as implicit theories of intelligence, goal orientations (trichotomous goals) and perceptions of classroom goal structures were related to upper-elementary-school Taiwanese students' decisions to avoid help-seeking in the classroom. Shih found that incremental beliefs positively correlated with both mastery goals ($r = .41, p < .01$), and performance-approach goals ($r = .34, p < .01$), while entity beliefs positively correlated with performance-avoidance goals ($r = .33, p < .01$), and negatively correlated with mastery goals ($r = -.25, p < .01$) which is inconsistent with Braten and Strømsø (2004) and Cury et al. (2006). Moreover, this study provided evidence an example of the relationship between implicit theories of intelligence and trichotomous goal orientations.

In summary, the studies above that examined relationships between implicit theories of intelligence and dichotomous goals, and those that examined the relationship between implicit theories of intelligence and trichotomous goals together indicated that incremental beliefs were related to learning goals, whereas entity beliefs were related to performance goals (e.g., Abdulla, 2008; Cury et al. 2006; Robin & Pals, 2002; Shih, 2007). Several studies provided results that were consistent (e.g., Abdulla, 2008; Robin & Pals, 2002), or partially consistency (e.g., Dupeyrat & Mariné, 2001; Li et al., 2007; Vermetten et al., 2001) with Dweck's (1986) model. While the above mentioned studies generally demonstrated the relation between implicit theories of intelligence and achievement goals (Dweck, 1986), they do not provide evidence about the relation between these variables and learning strategies and. Further, these studies with the exception of Cury et al. (2006) did not focus on domain specific beliefs about intelligence and achievement goals, which is important for understanding students' beliefs and goals in particular domains. It can be noted that, out of the eight studies reviewed in this section, six studies are on university or returning students, and two are

on primary, and none of these are on higher secondary students. While beliefs, goal, and learning strategies can differ in learning environments, and at different level of education, similar relationships focussing on higher secondary students of Maldives is important to fill the gap in the literature.

2.8 The Role of Beliefs, Goals, and Strategies in Learning Environments

Environmental factors can influence students' motivation and beliefs while they learn and acquire knowledge. Students bring their beliefs, norms and values into the classroom and in turn, the classroom can influence these personal factors. Consequently, beliefs from the learning environment can influence individuals' interpretations of their ability in achievement situations. For instance, Murphy and Dweck (2010) indicated that shared beliefs in various settings (e.g., academic, business, and other professional settings) can influence individuals' views of intelligence.

In addition, environmental factors can influence students' goal orientations. The goal structure of a learning environment can affect students' adoption of goals (e.g., Anderman & Anderman, 1999; Church, Elliot, & Gable, 2001; Greene, Miller, Crowson, Duke, & Akey, 2004; Tapola & Niemivirta, 2008). The adoption of mastery, performance-approach, and performance-avoidance goals in particular, are influenced in part by cues or goal-related messages that students perceive in an academic context (Ames, 1992; Urdan, 2004). Goal-related messages can create an environment in which students are encouraged to choose specific goal types, and are discouraged from choosing others. For instance, teachers and educators may highlight the importance of achievement and normative grades in the classroom, compare and favour students based on their performance, or give recognition to the highest achievers, thereby creating a performance-focussed learning environment. Conversely, the teacher could place a strong emphasis on developing knowledge and understanding, and mastering skills in the subject, thereby creating a mastery-focussed learning environment.

Table1: *Mastery-focussed and performance-focussed learning environments*

	Mastery-focussed	Performance-focussed
Define success as...	Mastery, improvement	High grades, doing better than others
Value placed on...	Effort, improvement	High grades, demonstration of high ability
Reasons for satisfaction...	Meeting challenges, hard work	Doing better than others, success with minimum effort
Teacher oriented towards...	Student learning	Student performance
View errors...	A normal part of learning	A basis for concern and anxiety
Reasons for effort...	Increasing understanding	High grades, doing better than others
Ability viewed as...	Incremental, malleable	An entity, fixed
Reasons for assessment...	Measure progress toward present criteria, provide feedback	Determine grades, compare students to one another

Source: (Anderman & Wolters, 2006; Pintrich, 2006)

Table 1 summarises the differences between the two most common types of learning environments with respect to students' beliefs and goal orientations (i.e., mastery-focussed and performance-focussed learning environments). Additionally, environmental 'lay theories' (i.e., implicit theories of intelligence) may affect goals (Murphy & Dweck, 2010). Learning environments that cultivate a culture of performance encourage people to compete and win in achievement situations, while environments that cultivate a culture of growth encourage people to learn and grow as knowledgeable people. Specifically, entity beliefs are associated with performance-oriented environments where the emphasis is on competition and examination performance. Incremental beliefs are associated with mastery-oriented environments where the focus is on seeking opportunities for learning and undertaking challenging tasks.

Researchers have indicated that mastery goals are adaptive and performance goals are maladaptive (Chan & Lai, 2008; Pintrich & Schunk, 2000). However, controversial research findings in the past have led researchers to argue about the maladaptive nature of performance goals (Chan & Lai, 2008). While mastery goals have positively predicted deep-learning strategies (Al-Emadi, 2001; Chan & Lai, 2006; Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008) and have negatively predicted surface-learning strategies (Chan & Lai, 2006; Simons et al., 2004), performance goals have positively predicted both deep-learning strategies (Liem et al., 2008) and surface-

learning strategies (Al-Emadi, 2001; Chan & Lai, 2006; Simons et al., 2004; Vrugt & Oort, 2008). For instance, Liem et al. (2008) found that like mastery goals, performance-approach goals produced adaptive learning outcomes for students from Singapore, whereas performance-avoidance goals produced maladaptive learning outcomes. Similarly, Ng (2000), who used mediational paths to investigate relationships among self-schema, goal orientations, learning approaches and performance for students from Hong Kong, found that a mastery-orientation was adaptive and led to higher achievement. However, performance-orientation split into two paths: one adaptive and other maladaptive. The pathway via performance-approach goals led to deep-learning strategies and anticipated higher performance, whereas the pathway via performance-avoidance goals leads to surface-learning strategies and anticipated lower performance.

A similar learning environment exists in the Maldives, where learning is highly competitive and examination-oriented, as was explained in the introductory chapter. In the Maldivian system of education, attention is also placed on the grades and marks students achieve in examinations, thereby promoting performance orientations. Additionally, there is an emphasis on working hard and putting a lot of effort into studying and preparing for examinations, consequently promoting mastery orientations to some extent. However, Nazeer (2006) who undertook a study on economics teaching at secondary schools in the Maldives indicated that teachers used exam-oriented approaches to teach and prepare students for the exams, where the emphasis is on rote memorisation and repetition of texts. Maldives is also an Islamic nation. The earliest form of education provided to the Maldivians was from *Madras and Makthabs* (names for Islamic education institutes). In Islamic educational environment a high value is placed on learning and reading of Quran and other Islamic materials necessary to follow religion. It is also advisable to memorise parts of Quran or some chapters of Quran. Therefore, from very early years of learning a high emphasis is placed on memorisation and repetition of materials as a form of learning strategy. It is believed that the practice of memorisation as a form of learning strategy continued throughout the whole learning environment in Maldives - from primary to higher secondary, and beyond where the students have more challenging subjects to learn and understand.

Furthermore, students at the CHSE (the target school of the present study) are in their early adolescent years, the age at which students begin to withdraw effort, resist novel approaches to learning, and avoid seeking help when they need it (Turner, et al.,

2002). At the same time, avoidance behaviour may be more frequent for students at this age than for younger students, as they move from the conception of ability as changeable with effort to the belief that ability is fixed (Nicholls, 1984; Turner et al., 2002). Adolescents show an increase in entity views, which are associated with performance-avoidance goals, which lead to helplessness and maladaptive learning outcomes.

Nonetheless, the adoption of both mastery and performance-approach goals could be adaptive and beneficial in an environment where achievement and social comparison are closely linked (Sampasivam, 2009). Thus, it is possible that Maldivian students may have a combination of mastery and performance-approach goals, which could be adaptive and beneficial, whereas only performance-avoidance goals could be maladaptive and non-beneficial. However, there is no empirical evidence relating to whether students' beliefs, goals, and choice of learning strategies are beneficial and lead to positive achievement outcomes in the educational environment in the Maldives. Hence, conceptualising and testing a model with the nature of students' beliefs, goal orientations, and learning strategies in the Maldivian context, which in turn lead to performance outcomes, can be a way to identify the beneficial and non-beneficial nature of these variables in the Maldivian learning environment.

2.9 Relationships among Beliefs, Goals, Strategies, and Achievement

This section reviews the studies that examined the relationships among the four constructs of interest: students' beliefs about intelligence, goal orientations, learning strategies, and achievement. After an extensive review of the literature, four studies (Blackwell et al., 2007; Dupeyrat & Mariné, 2005; Jones et al., 2012; Law, 2009; Miller, 2010) were identified that each investigated these four constructs. Within this group were studies that focused on the mediational relationships among the variables (Blackwell et al., 2007; Jones et al., 2012). The studies differed with respect to goal type, the type of learning strategies measured, the achievement domain, and the participants' level of education.

In the first study, Dupeyrat and Mariné (2005), examined the relationships among implicit theories of intelligence, goal orientations (i.e., performance goals, mastery goals, and work-avoidant) cognitive engagement (i.e., deep processing, surface processing and effort), and achievement. They proposed and tested a hierarchical model

of achievement motivation. Participants were 76 French students who were in a one-year diploma program. Questionnaires were used to assess various aspects of students' motivation and cognitive engagement. Path analysis was used to assess the relationships among the variables in the model. The items that measured the variables were formulated to measure domain-general beliefs, goals, and learning strategies. With respect to beliefs, entity beliefs were negatively related to mastery-goal orientation ($\beta = -.31, p < .01$) and incremental beliefs negatively predicted work-avoidant goals ($\beta = -.31, p < .01$). Neither incremental nor entity beliefs predicted performance goals. Mastery goals were positively related to deep strategies ($\beta = .48, p < .001$), while performance goals were positively related to surface strategies ($\beta = .28, p < .01$). Mastery goals were positively related to effort expenditure ($\beta = .28, p < .01$), which in turn were positively related to achievement ($\beta = .33, p < .01$). Neither deep processing nor surface-processing strategies were related to achievement. The relationships among implicit theories of intelligence, achievement goals, learning strategies, and achievement failed to emerge, suggesting the need for further investigation of the four constructs. Specifically, Dupeyrat and Mariné suggested using a more powerful statistical technique such as SEM that would enable a researcher to control for measurement errors. Although the study investigated the relationship among the four constructs, their hierarchical model failed to show that goal orientations and cognitive engagement mediated the relationship between implicit theories of intelligence and academic achievement.

In the second study, Miller (2010) investigated the relationship among students' beliefs about intelligence (entity and incremental beliefs), academic goals (mastery, performance-approach, and performance-avoidance), study behaviour (self-handicapping strategies and effort), perceived ability, and achievement. Participants were 152 undergraduate students in an introductory psychology course in the US. Using the correlation analysis it was found that incremental ($r = .31, p < .01$), and entity beliefs ($r = .18, p < .05$), were positively related to mastery goals, while no other relation between theories of intelligence and goal orientations were demonstrated. Mastery goals were positively related to effort ($r = .31, p < .01$), while none of the goal orientations showed relation with self-handicapping. However, self-handicapping were positively related to the achievement ($r = .31, p < .01$).

Several hypotheses were also developed, and the hypotheses were tested using single chi-square and analysis of variance. However, none of the hypotheses was

confirmed. The researcher suggested two broad reasons for the failure to support the hypotheses. First, Miller indicated that there could have been a problem with the research design and the sample. Second, he indicated that the model could be faulty; that is, relationships among the variables included in the model may not adequately reflect the actual relationships among the variables. Miller's (2010) findings underscore the importance of the study's design when testing hypotheses based on previous theories. Miller (2010) collected quantitative data using self-report questionnaires and tested Dweck's (1986) model, but did not ensure model fit before proceeding to test the hypotheses. In addition, item-level analyses were not performed to see whether the items loaded well onto the measured constructs. Further, Miller failed to test the mediations despite the fact that he claimed that he tested the interrelations among Dweck's model. I believe the researcher could have included the indirect or mediating effects of the model.

In the third study, Blackwell et al. (2007) conducted a two-part longitudinal study. They implemented an intervention and tested a mediational model of students' implicit theories of intelligence, positive effort beliefs, learning goals, low helpless attribution, learning strategies, and mathematics achievement. Participants were Grade 7 mathematics students at a public secondary school in New York City. The belief that intelligence is malleable was associated with an improvement in mathematics grades, whereas the belief that intelligence is fixed was not. The study included mediational relationships among the variables of interest. Blackwell and colleagues hypothesised seven different mediations from the model and tested the significance using ordinary least squares (OLS) regression and Sobel's (1982) test. The results of the seven tests performed indicated that the mediations were statistically significant. The results presented compelling evidence that an intervention can strengthen students' incremental beliefs and achievement. It also suggested that learning goals mediate the relationship between incremental beliefs and strategy use, and strategy use mediates the relationship between learning goals and mathematics achievement. However, when the four variables were linked in a hierarchical pathway, it was not clear from the mediational tests whether the independent variable (i.e., implicit theories of intelligence) predicted mathematics achievement as mediated through both learning goals and positive strategies. Additionally, although the research was based on achievement-related motivation and achievement in the mathematics domain, students'

implicit theories of intelligence, learning goals, positive strategies and other variables were measured with general items, rather than items specifically related to the domain of mathematics.

In the fourth study, Jones et al. (2012) replicated Blackwell et al.'s (2007) motivational model in the context of mathematics. The model hypothesised that incremental beliefs would lead to learning goals and positive effort beliefs, which would lead to improved grades in mathematics. Jones and colleagues believed that students' beliefs about intelligence could vary from subject to subject, although they felt that students' beliefs about the motivational variables in the model would be invariant across subject areas for the 163 ninth-grade participants. Jones et al.'s findings were similar to those reported by Blackwell et al. (2007). Both Blackwell et al. (2007) and Jones et al. (2012) focused on similar learning environments. According to Jones et al. (2012), an important future direction is to examine relationships between/among variables in other domains, grade levels and learning environments with motivational models similar to that of Blackwell et al. (2007).

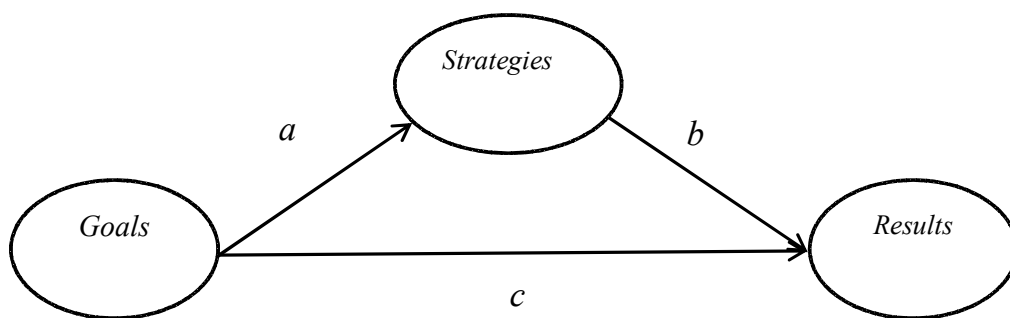
Taken together, the studies reviewed above indicate four main points. First, the studies have captured relevant information on the relationships among the implicit theories of intelligence, achievement goals, learning strategies, and achievement in several educational settings. Second, none of these studies performed item analysis such as PCA or EFA to identify the dimensions of the constructs used. Third, in all the studies it was found that they used Likert scales, rather than a continuous scale in the questionnaires to measure the responses from the participants. Fourth, two studies (Blackwell et al. 2007; Jones et al. 2012) tested mediational relationships among the variables and used Sobel's (1982) test for single mediations, to test the relationship in the three-path mediation model. Specifically, having tested the relations among beliefs, goals, strategies and achievement, these studies (Blackwell et al. 2007; Jones et al. 2012) did not examine the indirect relation of belief about intelligence with the achievement, mediated through, both goal orientations and learning strategies.

2.10 Mediational Relationships

Whether it is examining the impact of students' attitude on their behaviour and achievement or assessing their success in achieving specific goals, researchers often undertake research to understand the cause of certain outcomes. At the same time, they are also interested in knowing the process through which certain relationships occur, or the processes students that are associated with success in academic situations. Specifically, educational psychologists are interested in understanding the mediational processes that occur via relationships among variables. In a study in which a causal relationship exists, "a mediational analysis provides the researcher with a story about the sequence of effects that lead to something" (Kenny, 2008, p.354). A mediator or an intervening variable indicates the measure of the process through which an independent variable impacts the dependent variable (Iacobucci, Saldanha, & Deng, 2007).

In simple terms, mediation is a process by which "the influence of an antecedent is transmitted to a consequence through an intervening mediator" (James & Brett, 1984, p. 307). Mediation is essential to research because it allows the researcher to conduct scientific investigations, where the intriguing part is to explain how something comes about from something else (Kenny, 2008). Mediational effects are common in social sciences (Taylor, MacKinnon, & Tein, 2008).

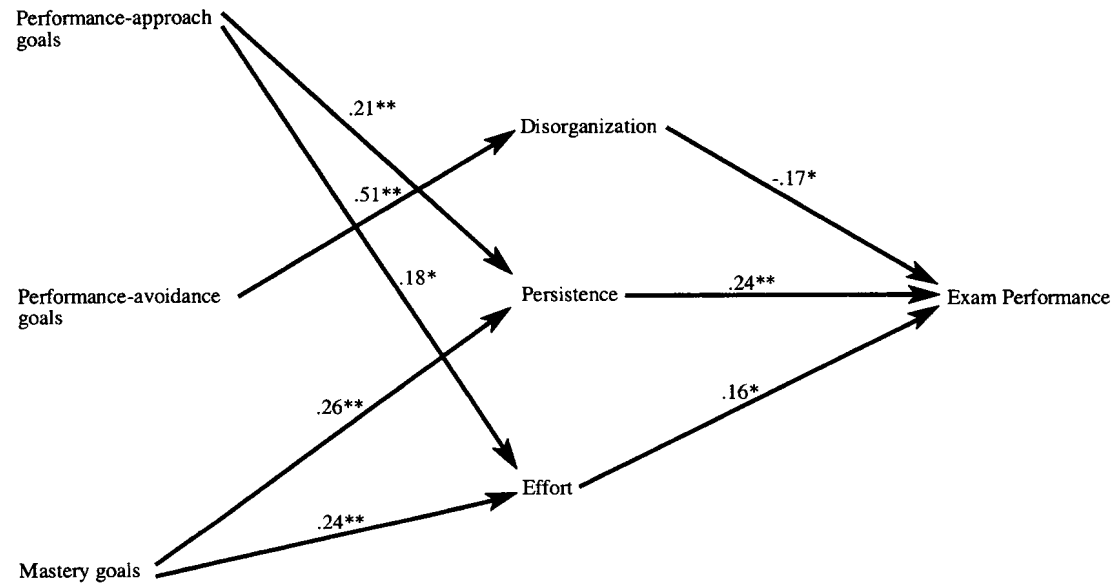
Figure 4: *Mediational model of the relationships among goals, strategies, and results*



A number of theoretical models in behavioural and organisational science rely on the test of mediation (Fletcher, 2006). For example, Alzen and Fisbien (1980) assessed the mediational effects of intentions, where attitude is thought to be related to behaviour (Taylor et al., 2008). A simple mediational model has a single mediator

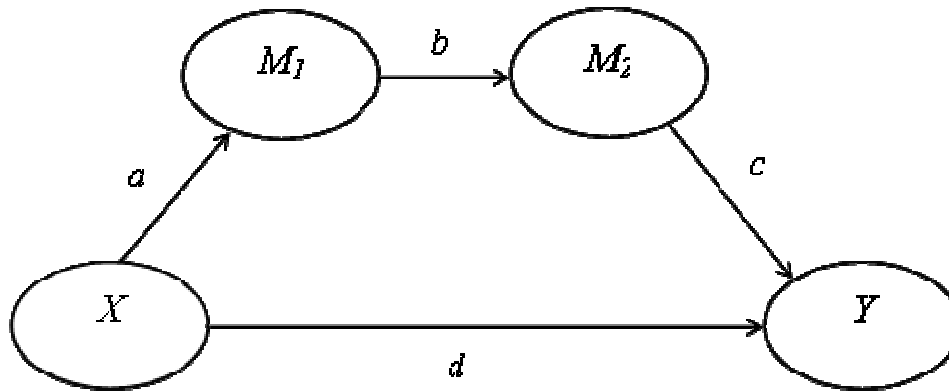
between the predictor variable and the outcome variable. In Figure 4, for example, goals affect results both directly and indirectly. The indirect relationship is mediated through strategies, via the path 'a' and 'b'. Here, the variable 'goals' is postulated to exert an effect on the outcome variable 'results', through the intervening variable 'strategies', sometimes called the mediator. When such a simple mediational model is further developed to have several mediating relationships between the predictor and the outcome, the model looks similar to that of the model in Figure 5. In this model, with many intervening variables, the indirect effect with a given intervening variable is called a specific indirect effect (Hayes, 2009). For example, performance-approach goals have a specific indirect effect on examination performance, through persistence.

Figure 5: *Mediational relationships among achievement goals and exam performance, mediated by disorganisation, persistence, and effort*



Note: The paths are standardised regression coefficients at * $p < .05$ and ** $p < .01$.
Source: (Elliot et al., 1999, p.558)

Figure 6: *Three-path mediation model*



Note: X = independent variable; M_1 = mediator one; M_2 = mediator two; Y = dependent variable.

In a more complex model, two or more mediators could exist in a single mediational pathway, depending on the complexity of the mediational chain (see Figure 6) (e.g., Blackwell, et al., 2007). Recently, mediational models have gained popularity in the field of educational psychology, including research on implicit theories of intelligence and achievement goal theory (e.g., Blackwell et al., 2007; Diseth, 2011; Diseth & Kobeltvedt, 2010; Elliot et al., 1999; Jones et al., 2012).

2.10.1 Testing Mediational Pathways

From simple to complex mediational chains, researchers have tried to develop ways to assess mediational relationships (e.g., Baron & Kenny, 1986; Judd & Kenny, 1981; MacKinnon, Fritz, Williams, & Lockwood, 2007; Sobel, 1982; Taylor et al., 2008). Hayes (2009) discussed the three most popular methods of testing hypotheses about intervening variable effects. They include the causal step approach popularised by Baron and Kenney (1986) (similar to that of Judd and Kenny, 1981), the product of coefficients approach mostly well-known as the Sobel test (Sobel, 1982, 1986), and the bootstrapping approach to generate confidence intervals of indirect effects (Hayes, 2009; MacKinnon, Lockwood, & Williams, 2004; Reynold, 2003).

The causal step approach (Baron & Kenny, 1986; Judd & Kenny, 1981) is the simplest and most widely-used approach to test mediated effects (Hayes, 2009). Elliot et al. (1999) followed this approach to validate and test the mediational relationships

among achievement goals, study strategies, and examination performance. As Figure 5 shows, the specific pathways in the model indicated the following: disorganisation mediated the relationship between performance-avoidance goals and examination performance; persistence mediated the relationship between performance-approach goals and examination; persistence mediated mastery goals and examination performance; effort mediated the relationship between mastery goals and examination performance; and effort mediated performance-approach goals and examination performance. However, Judd and Kenny's (1981) three criteria must be satisfied in order for the mediation to occur in the pathways. First, the relationships between the predictor variables were tested. Second, to test the first link, the relationships between the variable and the mediator were tested. Third, the relationship between the mediator and the outcome variable were also tested.

The main criticism of the causal step approach (Baron & Kenny, 1986; Judd & Kenny, 1981) is that it uses logical inference to deduce mediation rather than quantification of the intervening effects (Hayes, 2009; Reynolds, 2003). Despite this criticism, researchers have used the casual step approach extensively because of the simplicity of the steps and its understandability. However, this is not sufficient reason to use the method when there are better alternatives available (Hayes, 2009).

Sobel's (1986, 1982) coefficient approach provides a way to quantify the indirect effects rather than inferring their existence from a set of tests or constituent paths. For instance, the approach involves multiplying the indirect effect of 'goals' on 'strategies' (path *a*) with the indirect effect of 'strategies' (path *b*) on 'results' (see Figure 4), resulting in the product of coefficient *ab* (Reynolds, 2003). The test also involves the calculation of the standard error of *ab*, which tends to be non-normal, asymmetric and skewed. However, the product of *a* and *b* is compared with the critical value from a normal distribution for testing the null hypothesis that the 'true' indirect effect is zero (Hayes, 2009). The tests assume that the value *ab* is normal when it is actually not. According to Hayes (2009) it is not acceptable to use tests (e.g., the Sobel test) that assume normality of the sampling distribution when competing tests are available (e.g., the bootstrapping approach) that do not make this assumption and that are known to be more powerful than the Sobel's test (1986).

Bootstrapping is a re-sampling method that involves drawing a large number of samples with replacement, from the original sample used in the research (Taylor et al.,

2008). When bootstrapping, the model used in the study is estimated for each of the bootstrap samples, as in the original data. The bootstrapping approach, which tests specific mediations by generating confidence intervals, is the most powerful and valid approach used in mediational studies (Hayes, 2009; MacKinnon et al., 2004; Reynold, 2003). On the other hand, it requires advanced knowledge of statistical procedures and analyses, and proficiency in using computer software to generate confidence intervals. Therefore, researchers are required to understand particular software with built-in SEM techniques (e.g., Mplus) to perform the bootstrapping method in order to generate confidence intervals for specific mediations. Other software such as Analysis of Movement Structures (AMOS), used to analyse the data for the present study, can generate confidence intervals for overall mediations, but cannot test specific mediations by the bootstrapping method. Therefore, it is important for the researcher to have expertise needed to use the necessary software.

Alternatively, MacKinnon, Fairchild and Fritz (2007) drew on Stone and Sobel's (1990) work to suggest that for models with more than one mediator, use of the standard error (e.g., when using the Sobel test) is appropriate with a sample size of more than 200. MacKinnon and colleagues also added that similar results were obtained for the standard error of negative and positive path coefficients, undertaken in simulation studies for larger models with multiple mediators (MacKinnon et al., 2004).

Consequently, there are a number of studies in educational psychology that have used Sobel's (1982,1986) coefficient approach to test mediational models (e.g., Blackwell, 2002; Blackwell et al., 2007; Diseth; 2011; Diseth & Kobbeltvedt, 2010; Jones et al., 2012). These studies have hypothesised and tested mediational models that have used from simple to more complex mediational chains, including three-path (two-mediator) mediational pathways. More specifically, in these models there were hierarchical paths which were in the form, $X \rightarrow M_1 \rightarrow M_2 \rightarrow Y$, in which the effect of the antecedent (X) on the consequence (Y) is mediated by Mediator 1 (M_1) and Mediator 2 (M_2) (Fletcher, 2006) (see Figure 6).

Take for instance Blackwell et al.'s (2007) mediational model. Three-path (two-mediator) relationships existed within the mediational model that examined the relationship between implicit theories of intelligence and grades. As has been indicated before, Blackwell and colleagues hypothesised the relationships in the model for single mediations, and tested those single mediations using OLS regression and the Sobel

(1982) test, even though most of the pathways in the mediational model were relationships that indicated two-mediator (three-path) mediations. An example of a single-mediator hypothesis included, “learning goals mediate the relationship between incremental theory and positive strategies” (Blackwell et al., 2007, p.253). The results of the seven hypothesis tests performed using the Sobel test (Sobel, 1986) indicated that all of the seven single-mediator effects were statistically significant (i.e., z-score values ranged from 2.14 to 8.56, $p < .05$). The results of these single-mediator effects thereby explained the indirect relationship between implicit theory of intelligence and grades.

Similarly, Diseth and Kobeltvedt (2010) investigated the relationship between achievement motives, achievement goals, learning strategies (deep, surface, and strategic), and achievement in a hierarchical three-path model, in which achievement goals and learning strategies mediated the relationship between achievement motive and achievement. Using a three-path model, Diseth (2011) also investigated the mediator effects of self-efficacy, goal orientations, learning strategies between preceding and subsequent achievement. Similar to Blackwell et al. (2007) and Diseth (2011), Diseth and Kobeltvedt (2010) hypothesised single mediator effects and used the Sobel (1986) test and OLS regression to test the effects in the three-path mediational model. After adapting Blackwell et al.’s (2007) mediational model to mathematics, Jones et al. (2012) also applied the same procedure used by Blackwell et al. to test specific mediations, and to examine the relationship between implicit theories of intelligence in mathematics and mathematics grades.

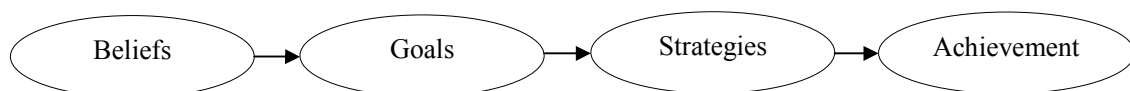
The studies together indicated two points: (1) although the mediational models in these studies portrayed three-path or more complex mediational chains, only single-mediator relationships were hypothesised and tested; and (2) the researchers used a product coefficient approach for testing specific, single-mediator mediations. For example, when using the Sobel tests to examine the indirect effect of X on Y, mediated through M_1 and M_2 , two steps are followed. First, the mediating effects of M_1 between X and M_2 , are tested and then the mediating effects of M_2 between M_1 and Y are tested. To investigate the effect of the predictor variable on the outcome variable through two or more variables, one hypothesis can be made. Thus, three-path (two-mediator) models, like the one in Figure 6, are becoming increasingly popular in educational psychology (e.g., Blackwell et al., 2007; Diseth, 2011; Diseth & Kobeltvedt, 2010; Haye, 2009; Jones et al., 2012). Sobel’s (1982) product coefficient approach, when used in the single-

mediator context, is not appropriate to use when testing three-path (two-mediator) models or models with more complex mediational chains.

Taylor et al. (2008) introduced six methods for testing three-path mediated effects and compared them in a Monte Carlo study in terms of their Type I error, power and coverage. The six methods included the causal step method (i.e., the joint significant test), the three product-of-coefficients methods (the multivariate delta variance estimator, the unbiased variance estimator, and the extract variance estimator), and two bootstrap methods (the percentile bootstrap and the biased corrected bootstrap method). These methods are documented in Appendix A. In the present study, some of the hypotheses were tested using the multivariate delta variance estimator, which is an extension of Sobel's (1982) product coefficient approach, applicable to three-path mediated effects, and others were tested using the biased corrected bootstrap method. These two methods are further discussed in the methodology and results sections.

In sum, section 2.5 dealt with the literature representing the direct relationship between goal orientation and learning strategies, and learning and achievement, section 2.7 dealt with the literature representing the direct relationship between implicit theories of intelligence and goal orientations, and section 2.9 dealt with the literature representing the relationship among beliefs, goals, learning strategies and achievement. Taken together, these sections provide evidence that beliefs about intelligence are related to goal orientations, goal orientations are related to learning strategies, and learning strategies in turn predict are related to academic achievement. Connecting these relationships shows a hierarchal linear flow of a mediational chain starting from beliefs about intelligence and ending at achievement. Specifically, Figure 7 represents a three-path (two-mediator) relationship in a mediational chain of beliefs, goals, learning strategies and achievement.

Figure 7: *Three-path mediational chain of the relationships among beliefs, goals, strategies, and achievement*



Graphically, the figure shows that goals mediate the relationship between beliefs and strategies. Strategies mediate the relationship between goals and achievement.

Goals and strategies mediate the relationship between beliefs and achievement. Given the support from the literature for these direct relationships, it is important to investigate whether beliefs are indirectly related to achievement via goals and learning strategies, by means of valid statistical tests. The figure is also in the form $X \rightarrow M_1 \rightarrow M_2 \rightarrow Y$, where the relation of antecedent (X) with the consequence (Y) is mediated by Mediator 1 (M_1) and Mediator 2 (M_2) (Fletcher, 2006).

This hierarchical mediational chain was used to build a model of mathematics achievement, in which the relation of beliefs about mathematical ability with mathematics achievement is mediated through goal orientation (M_1) and learning strategies (M_2), based on the possible relationships among the two types of implicit theories of intelligence, three different achievement goals, two major learning strategies, and achievement in mathematics.

2.11 Summary

This chapter provided a review of the literature on the relationships among students' beliefs about intelligence, achievement goals, learning strategies, and achievement. This chapter presented definitions of the variables relevant to the present study and explained how these variables were compatible with the achievement goal theory and Dweck's (1986) motivation model. This chapter also reviewed the studies that have looked at direct relationships between/among the variables. Further, it has presented studies which have examined the relationship among the four constructs of interest: students' beliefs about intelligence, goal orientations, learning strategies and achievement, including studies that examined mediational relationships. Additionally, research literature relating to students' beliefs, goals and study strategies in learning environments was reviewed to understand the type of learning environment that exists in the Maldives, the country in which the present study was conducted. Finally, the role of mediational relationships in educational psychology along with different procedures of testing mediational relationships was presented.

CHAPTER3: THE PRESENT STUDY

3.1 Introduction

This section provides a rationale for the present study and identifies gaps in the literature relating to the relationships among beliefs, goals, learning strategies and achievement, by taking into account all the sections reviewed in the literature chapter. This section also gives an overview of the present study including building the hypothetical mediational model for the study and the research hypotheses.

3.2 Rationale for the Present Study

The literature review indicated that students' reported beliefs about ability are related to their achievement goals, which are related to their choice of learning strategies, and their subsequent achievement. Most of the studies reviewed in the literature investigated the relation between beliefs about intelligence and goal orientations, while others examined the relation among goal orientations, learning strategies and achievement. However, few studies have investigated all four of these variables in a single study, and even fewer studies have focused on these variables in the context of mathematics. Furthermore, there is also limited research on mediational relationships in goal theory and achievement-related behaviour, and about how different goal orientations and learning strategies can act as potential mediators in motivational models. Moreover, such mediational studies in the area, specifically the studies that have looked at the above-mentioned four variables representing a linear hierarchal three-path (two-mediator) model (e.g., Blackwell et al., 2007; Jones et al., 2012), have not performed the appropriate statistical procedures to test the possible presence of three-path mediational pathways in such mediational models.

Lastly, I was unable to identify a study that included investigations of the relationships among students' implicit theories of mathematical ability, trichotomous goal orientations and the use of learning strategies in mathematics, and mathematics achievement. Moreover, testing a mediational model has the potential to provide insights into the beneficial and non-beneficial pathways for student achievement.

3.3 Hypothetical Model

The studies reviewed in the literature review showed six different relationships: (1) beliefs about intelligence are related to goal orientation; (2) goal orientation is related to learning behaviour; (3) learning behaviour is related to achievement; (4) goal orientation mediates the indirect relationship between implicit theories of intelligence and learning behaviour; (5) learning behaviour mediates the indirect relationship between goal orientation and achievement; and (6) goal orientation and learning behaviour mediate the indirect relationship between implicit theories of intelligence and achievement.

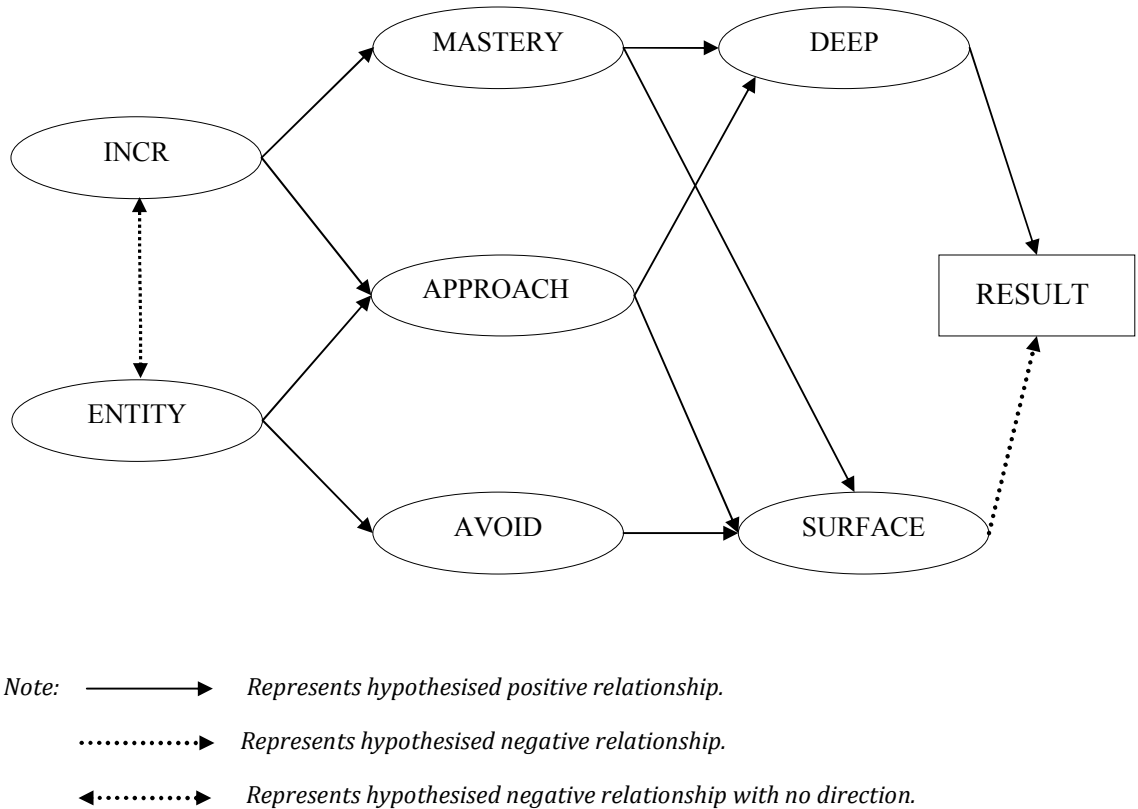
Furthermore, there appear to be no studies to date that have hypothesised a three-path (two-mediator) model to test the possible mediational pathways by which students' beliefs about mathematical ability are related to their mathematics achievement, mediated through goal orientations and learning strategies. Thus, it is necessary to fill the gap in the literature on students' achievement motivation by developing and testing a hypothetical mediational model that addresses all these factors in a single study, and explores the mediational relationships hypothesised in the model, for a better understanding of the role of goal orientations and learning strategies in mathematics education.

This study is important because identifying specific pathways through which students' beliefs about mathematical ability are related to their achievement may help students develop their achievement motivation to choose effective learning strategies in mathematics. Testing the mediational model will identify the pathways in mathematics education that are beneficial for students to follow. In addition, by identifying the role of beliefs, goal orientations and learning strategies in higher secondary mathematics education, teachers and educators can direct students towards the best strategies, thereby contributing to students' building their knowledge as well as performance in the subject.

Based on each of the variables and the direct relationships among these variables indicated in the literature, the following assumptions were made: (a) incremental beliefs will positively predict mastery goals and performance-approach goals; (b) entity beliefs will positively predict performance-approach and performance-avoidance goals; (c) mastery goals will positively predict deep-learning strategies and surface-learning

strategies; (d) performance-approach goals will also positively predict deep-learning strategies and surface-learning strategies; (e) performance-avoidance goals will positively predict surface-learning strategies; (f) deep-learning strategies will positively predict mathematics achievement; and (g) surface-learning strategies will negatively predict mathematics achievement. A hypothetical mediational model of mathematics achievement was developed by linking all of these propositions and is presented in Figure 8.

Figure 8: *Theoretical mediational model of mathematics achievement*



In Figure 8, the names of the variables are as follows: Incremental beliefs about mathematical ability (INCR), Entity beliefs about mathematical ability (ENTITY), Mastery goal orientations (MASTERY), Performance-approach goals (APPROACH), Performance-avoidance goals (AVOID), Deep-learning strategies (DEEP), Surface-learning strategies (SURFACE), and Mathematics achievement (RESULT).

3.4 Research Questions

1. Are higher secondary students' beliefs about their mathematical ability related to their mathematics achievement, as mediated by achievement goals and learning strategies?
2. What are the beneficial and non-beneficial pathways in the mediational model?
3. What are the possible alternative models for the sample studied?

3.5 Research Hypotheses

To answer research questions 1) and 2), and based on the mediational model developed, nine hypotheses were developed. Of these, five hypotheses (H_{1.1} to H_{1.5}) were posed for testing the effect of incremental beliefs on achievement, and the other four hypotheses (H_{2.1} to H_{2.4}) were posed for testing the effect of entity beliefs on achievement. The hypotheses are as follows:

3.5.1 Hypothesis 1.1

Incremental beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via mastery goals and deep-learning strategies (i.e., INCR->MASTERY->DEEP->RESULT).

3.5.2 Hypothesis 1.2

Incremental beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via mastery goals and surface-learning strategies (i.e., INCR->MASTERY->SURFACE->RESULT).

3.5.3 Hypothesis 1.3

Incremental beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via performance-approach goals and deep-learning strategies (i.e., INCR->APPROACH->DEEP->RESULT).

3.5.4 Hypothesis 1.4

Incremental beliefs about mathematical ability will have an indirect (positive or negative) relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., INCR->APPROACH->SURFACE->RESULT).

3.5.5 Hypothesis 1.5

Incremental beliefs about mathematical ability will have an overall indirect positive relation with mathematics achievement.

3.5.6 Hypothesis 2.1

Entity beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via performance-approach goals and deep-learning strategies (i.e., ENTITY->APPROACH->DEEP->RESULT).

3.5.7 Hypothesis 2.2

Entity beliefs about mathematical ability will have an indirect negative relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., ENTITY->APPROACH->SURFACE->RESULT).

3.5.8 Hypothesis 2.3

Entity beliefs about mathematical ability will have a indirect negative relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., ENTITY->AVOID->SURFACE->RESULT).

3.5.9 Hypothesis 2.4

Entity beliefs about mathematical ability will have an overall indirect negative relation with mathematics achievement.

3.6 Summary

This chapter has described the present study. It has also provided a rationale for the study by identifying the gaps in the literature, thus identifying the need to build a mediational model of mathematics achievement. This chapter also described the steps followed to build the hypothetical mediational model for the present study. Finally, this chapter formulated the research questions to be answered, and the hypotheses to be tested in the present study.

CHAPTER 4: METHODS

4.1 Introduction

The present study was aimed at testing a hypothesised mediational model of mathematics achievement by investigating if higher secondary students' beliefs about their mathematical ability were related to their mathematics achievement, mediated through achievement goals, and the use of learning strategies. To achieve this, the present study had two specific objectives. First, it aimed to test the specific mediational pathways hypothesised in the model by investigating if any specific goal orientation and learning strategy mediate this relationship. Second, it aimed to test the overall indirect relation of implicit beliefs of mathematical ability with mathematics achievement. This chapter presents the research framework and methodology of the present study, and is divided into 10 main sections: participants, sampling and missing data; pilot testing; instrument translation; questionnaires; procedure; research design; sample size; data analysis; and the method for testing specific mediations.

4.2 Participants, Sampling, and Missing Data

All 460 students who were undertaking advanced level mathematics at the CHSE, and were completing their studies in May/June 2010 were invited to participate in the study, after obtaining ethical clearance from the school's management. Of these students, 370 participated, constituting 80.43% of the mathematics students studying in 2010. Participants provided informed consent prior to any data collection. Of the 370 participants, 88.11% (326) answered every question. However, the data set contained missing data in 11.89% (44) of the cases, including 4.59% (17) of the students who were absent during data gathering and therefore did not respond to any questions despite consenting to participate. Of the 44 cases missing, 4.05% (15) of the students did not answer some questions, but filled in their demographic information. Thus, these students were approached again with the permission of the school management, so that they could complete the questionnaires. Missing data was also an issue with the demographic information on the front page of the questionnaires, where 2.16% (8) of the students did not fill in the required details. Additionally, 0.27% (4) of the students' mathematics achievement results were missing from the data sheet provided by the school, resulting in more missing data. Incomplete data cases such as those completely

missing data, cases missing demographic information, and cases with missing mathematics achievement results were removed from the data file. The final data file consisted of 341 students (178 girls, 163 boys), as the sample for the study. The final participants' ages ranged from 18 to 23 years, with a mean of 19.0 years.

4.3 Pilot Testing

The questionnaire items were pilot tested with over 100 students from three lower secondary schools: two government schools and one private. The schools' leaders were approached to get permission to conduct the pilot test. The questionnaires were given to students during normal class times. Once the pilot data were collected, they were entered into Excel sheets and then transferred to SPSS for the preliminary analysis and internal consistency assessments. The results indicated that the internal consistency of the belief items ($\alpha = 0.67$) and the deep-learning strategies ($\alpha = 0.69$) were relatively weak. However, the remaining variables had Cronbach's alpha values above 0.70. The reasons for the weak Cronbach's alpha value for beliefs and deep-processing items were believed to be due to students' misinterpretation of certain items. Based on the students' responses, minor changes were made to the beliefs items. Additionally, the whole questionnaire was restructured in order to increase the clarity and readability of the items.

4.4 Instrument Translation

The items taken from several different questionnaires to measure beliefs about mathematical ability, achievement goals and learning strategies were combined into one instrument. The questionnaire items were originally written in English. However, after the piloting it was thought that a translation of the questionnaire item into the Maldivian local language (Dhivehi) below each item in English would further help the respondents clearly understand and interpret the items. Thus, it was necessary to translate the items into Dhivehi. A Maldivian English language teacher was invited to undertake the task. In order to ensure that the Maldivian translation reflected the actual meaning of the original English items, the items were then translated back to English by two other teachers. Finally, the resulting questionnaire was given to five students to review and check that they clearly understood the items.

4.5 Variables Used in the Study

The dependent observed variable was measured using the mathematics achievement results collected from the school. Latent variables were measured using questionnaire items. All the questionnaire items for the latent constructs were adapted from previous research (Dweck, 1999; Elliot et al. 1999; Midgley et al., 1998). The items in these questionnaires were modified to represent the mathematical domain. As has been mentioned before, all instruments were piloted beforehand, and were finally provided to students along with a translation into their native language. The questionnaire items for all the variables were measured on a continuous integer scale (from -50 to 50), rather than a Likert scale. A continuous scale, in contrast to a Likert-type scale, allows the participant to express their opinion more precisely by allowing them to place a mark on anywhere on the scale. This avoids the problem of information loss and allows the researcher to apply more advanced statistical analyses (Treiblmaier & Filzmoser, 2011).

4.5.1 Beliefs about Mathematical Ability

4.5.1.1 Incremental beliefs about mathematical ability (*Variable INCR*)

Items relating to an incremental theory of intelligence were adapted from Dweck's (1999) items to relate specifically to the domain of mathematics. Students with incremental beliefs view their mathematical ability as malleable – something that can be increased with effort. Students' incremental belief about mathematical ability was measured using eight items on the continuous integer scale from -50 (strongly disagree) to 50 (strongly agree). An example of an incremental belief item is "When you learn new things in maths, your basic maths knowledge improves". The items that measured incremental and entity beliefs about mathematical ability are shown in Appendix B. Initially, the eight incremental items together had an inadequate reliability, with a Cronbach's alpha of $\alpha = 0.67$ (Hair, Black, Babin, Anderson, & Tatham, 2006).

4.5.1.2 Entity Beliefs about Mathematical Ability (*Variable ENTITY*)

The items relating to entity beliefs about mathematical ability were also adapted from Dweck's (1999) theory of intelligence items. Students with entity beliefs view mathematical ability as a stable quantity that cannot be changed with effort. Students'

entity beliefs about mathematical ability were measured using eight items on the same continuous integer scale. An example of an entity beliefs item is “You have a fixed amount of maths ability”. Initially, these eight items together had an acceptable reliability, with a Cronbach’s alpha of $\alpha = 0.72$ (Hair et al., 2006).

4.5.2 Achievement Goals

4.5.2.1 Mastery goals (*Variable MASTERY*)

A mastery-goal orientation is associated with the development of competence and task-mastery through effort and hard work, and was measured using five items on the same a continuous integer scale, ranging from -50 (strongly disagree) to 50 (strongly agree). The items used to measure this variable were adapted from Midgley et al., 1998 who reported the estimated reliability in their studies as $\alpha = 0.83$ for mastery goals. In the present study, the alpha value for the five items measuring mastery goals was found to have an acceptable reliability of $\alpha = 0.84$ (Hair et al., 2006). An example of a mastery goal item is “I like maths work that I learn from, even I make a lot of mistakes”. All the items used to measure achievement goals are shown in Appendix C.

4.5.2.2 Performance-approach goals (*Variable APPROACH*)

Performance-approach goals are associated with one’s own ability to outperform others. A performance-approach goal orientation was measured on the same continuous integer scale, using five items adapted from Midgley et al., 1998. These authors reported estimated reliability in their studies as $\alpha = 0.86$ for performance-approach goals. In the present study, the alpha value for performance-approach goals was found to be $\alpha = 0.82$. An example of a performance-approach goal item is “I would really feel good if I were the only one how could answer the teacher’s question in my maths class”.

4.5.2.3 Performance-avoidance goals (*Variable AVOID*)

Performance-avoidance goals are associated with a fear of failure, and attempts to avoid looking incompetent compared to others. Performance-avoidance goals were measured using five items on the same continuous integer scale. The items used to measure this variable were also adapted from Midgley et al., 1998, who reported an estimated reliability in their studies of $\alpha = 0.74$ for performance-avoidance goals. In

the present study, these five items together had an acceptable reliability of Cronbach's $\alpha = 0.81$ (Hair et al., 2006). An example of a performance-avoidance goal item is "I do maths work so others won't think I am dumb".

4.5.3 Learning Strategies

4.5.3.1 Deep-learning Strategies (*Variable DEEP*)

Deep learning includes strategies such as elaboration, organisation, and commonly the tasks that involve understanding and enhance learning. This is also one of the main learning strategies that are believed to be used by students in various disciplines, including mathematics. These learning strategies were measured using seven items on the same continuous scale. The items were developed with reference to Elliot et al. 1999, and were modified to specifically reflect mathematics learning rather than learning behaviour in general. These authors did not report the internal consistency of the items. The internal consistency for the seven items measuring deep learning for this study was initially at 0.69, less than the recommended value of 0.70 (Hair et al., 2006). An example of a deep-learning strategy item is "When studying, I try to combine different pieces of information from the course material in new ways". All the items that measured learning strategies are shown in Appendix D.

4.5.3.2 Surface-Learning Strategies (*Variable SURFACE*)

Surface learning involves memorisation and rote learning of the subject content. This learning strategy was measured using seven items on the same continuous integer scale. These items were also adapted from Elliot et al. 1999, and were modified to relate to mathematics learning in particular rather than general learning behaviour. In the present study, these seven items together had an acceptable reliability of Cronbach's alpha 0.80 (Hair et al., 2006). An example of a surface-learning strategy item is "When I study for the maths exam, I try to memorise as many facts as I can".

4.5.4 Mathematics Achievement (*Variable RESULT*)

Mathematics achievement is the dependent and outcome variable measured using the standardised test results collected from the school. The results are the average of the four core mathematics papers (C1, C2, C3, C4) undertaken by students at the school completion examinations. The results of these mathematics papers were taken

from the school completion examination held in May/June 2010. The mathematics results are given in percentages: 0 represents the lowest possible achievement score and 100 the highest.

4.6 Procedure

Prior to data collection, the Maldives Ministry of Education was provided with an information sheet for the study and agreed to allow the research to occur. The study was also discussed with the Head of the Policy, Planning and Research Section of the Ministry. The principal of the CHSE was informed of the study and she provided her consent for the study to be conducted. Once the consent had been obtained from the principal, the questionnaires were given to the students during class times, by approaching individual classes separately with the help of the school management. Students had to read and understand the information sheet provided with the consent form and agree to participate in the study before he/she could fill in the questionnaire.

Data collection was done during the revision week (final study week) of the academic year for the Grade 12 students. Hence, absenteeism was one reason for not getting the expected number of students for the survey. In order to increase the sample size of the study, students who were absent during the revision week were identified using their unique school index number. These students' details were sought from school management and after ringing them and their parents, they were approached at appropriate times during the day at their homes or other locations suitable for them. Each day after questionnaire administration, every questionnaire was checked for non-responses and incompleteness. Incomplete questionnaires and the respective respondents were identified from individual classes. Some students did not fill in the demographic information such as class index numbers in their questionnaires, while others answered none of the questions. These students were not approached for the second time, thinking that they were not willing to participate. However, the students who seemed to have mistakenly not responded to a few questions were approached the next day they were at school. These incomplete questionnaires were given to the respective students to complete and by doing this the minor incompleteness issue was addressed.

The mathematics results of the final examination were collected from the school records. The questionnaire responses were entered into an Excel spreadsheet and entered responses were then checked and verified. The collected school results were combined into a single sheet with the questionnaire data using the index numbers of the students with the help of the VLOOKUP function in Excel. Then these data were imported into SPSS (Version 19) as the data file for the initial analysis. The data file was later used by the AMOS (Version 19) program (Arbuckle, 2009) to test the model for the present study. The hypothesised model was developed in the graphical interface of the AMOS program, and the preliminary analysis and hypotheses testing were done afterwards.

4.7 Research Design

The design of this study is viewed as exploratory in that the research was aimed at testing if higher secondary students' beliefs about their mathematical ability were related to their mathematics achievement, mediated by achievement goals, and the use of learning strategies. To explore the mediational relationships among the variables, this study relied on quantitative self-report data collected using a survey method and mathematics achievement data collected from one of the higher secondary schools in the Maldives. To analyse the data for the mediational model this study used SEM techniques and confirmatory factor analysis. One of the advantages of using SEM is that this technique can be used as a viable tool to assess or correct measurement errors and provide explicit estimates for the relationship between variables (Kaya, 2007).

4.7.1 Structural Equation Modelling

SEM – also referred to as causal modelling, analysis of covariance structures, latent variable models and structural modelling (Bollen, 1989; Pedhazur & Schmelkin, 1991) – was used to test the mediational model for the sample of the study. SEM techniques involve a combination of confirmatory factor analysis (the measurement model) and path analysis (the structural model) (Jöreskog & Sörbom, 1993). A measurement model is run to check how the latent variables(also called latent constructs) are loaded on to the items (indicators) that represent every construct in the study. Specifically, the measurement model represents the relationship between the items and the constructs. Therefore, it is important for the items representing the latent

construct to have reasonably good factor loadings, normally > 0.60 (Kline, 2005). According to Teo and Schaik (2009) the major feature of SEM is its ability to handle latent variables, and its ability to measure random errors in the observed variables, giving a more realistic measurement. The latent constructs in SEM are also referred to as unobserved variables as these constructs cannot be directly measured, and the effects of these are shared among the variables that are observable. Latent constructs include abstract concepts such as beliefs, goals, and learning strategies, measured in the present study. Observed variables are the variables that can be directly measured, and are also called observed or manifest variables. In SEM, the observed variables include self-report responses to questionnaire items, scores on achievement tests, and coded responses to interview questions. Within an SEM context, observed variables act as indicators of the underlying constructs (Byrne, 2010).

The structural model deals with the relationships between the constructs, or between the constructs and other observed variable/s, if there are any in the model. In other words, this component of the structural equation model is responsible for exploring the relationship among the variables of interest in the study, based on existing theories. Testing a structural model with only observable variables is called path analysis, which was introduced in medical research by Wright (1918, 1921, 1934, 1960), in an attempt to show linear relationships among observed variables. Wright showed that connections among observed variables can be graphically represented in the form of diagrams called path diagrams (also called path models) (Jöreskog & Sörbom, 1993; Nguyen, 2002). The aim of a path analysis or structural model is generally to provide estimates and the significance of the relationships among the variables shown in path diagrams (Stage, Carter, & Nora, 2004). In other words, path analysis deals with exploring the strength of the relationships among the observed variables in the path diagrams and checking if these relationships are statistically significant, with respect to existing theories. Hence, path diagrams are one of the important aspects of path analysis, according to Bollen (1989). These diagrams graphically represent hypothesised relationships among variables to be examined both in studies conducted with SEM and those including only path analysis. One of the drawbacks of conducting a study with path analysis (without the measurement component) is that it assumes all observed variables are measured without error. On the other hand, in studies with SEM, the confirmatory factor analysis component deals

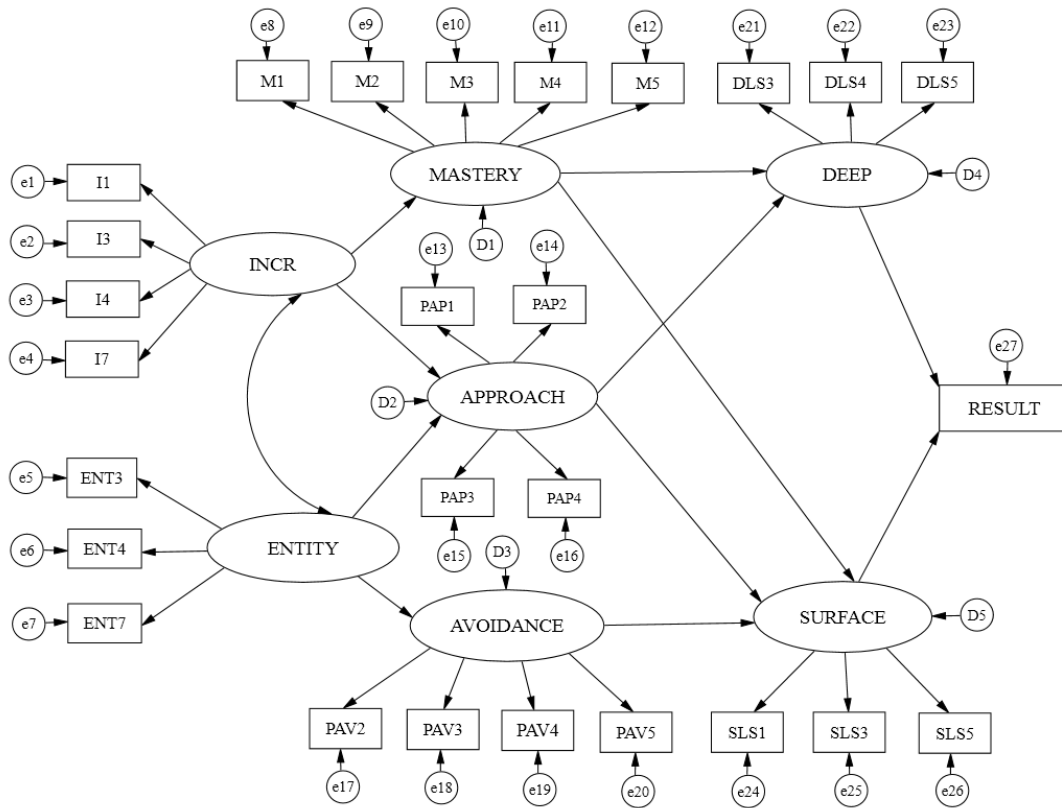
with the measurement errors when the latent constructs are being loaded on the items that represent the corresponding construct.

In addition to the measurement model and structural model, and terms such as observed and latent variables, two other important terms are associated with SEM: endogenous and exogenous variables (Schreiber, Nora, Stage, Barlow, & King, 2006). An exogenous variable is an independent variable, whereas an endogenous variable is a dependent, outcome variable. Endogenous and exogenous variables can be either observed or latent variables, depending on the model being tested (Schreiber et al., 2006).

For example, the Figure 9 above represents the relationship among the variables for the present study the rectangular shapes represent the observed variable. The ellipses or the circular shapes represent the latent constructs or the unobservable variables. The latent variables in this study are the construct that represent: incremental beliefs about mathematical ability (INCR); entity beliefs about mathematical ability (ENTITY); mastery goals (MASTERY); performance-approach goals (APPROACH); performance-avoidance goals (AVOID); deep-learning strategies (DEEP); and surface-learning strategies (SURFACE). The direct scores for the items of these constructs are the observed variables for their respective constructs. The observed variables are the questionnaire items: I1, I3, I4, I7, representing the latent construct INCR; ENT3, ENT4, ENT7; representing the latent construct, ENTITY; M1, M2, M3, M4, representing the latent construct, MASTERY; PAP1, PAP2, PAP3, PAP4, representing the latent construct, APPROACH; PAV2, PAV3, PAV4, PAV5, representing the latent construct, AVOID; DSL3, DLS4, DSL5, representing the latent construct, DEEP; SLS1, SLS3, SLS5, representing the latent construct, SURFACE. Additionally, mathematics achievement (RESULT) is also an observed variable which is indicated by the students' mathematics scores on a standardised mathematics examination.

In Figure 9, an arrow from one variable to another indicates the theoretically-based relationships among them. A one-headed arrow indicates that the relationship is unidirectional, whereas a double-headed arrow indicates that the relationship is bi-directional and the two variables are covariant to each other.

Figure 9: SEM model from the study



Note: I1, I3, I4, and I7 are the observed variables representing incremental beliefs (INCR); ENT3, ENT4, and ENT7 are the observed variables representing entity beliefs (ENTITY); M1 to M5 are the observed variables representing mastery goals (MASTERY); PAP1, PAP3, PAP4, and PAP are the observed variables representing performance-approach goals (APPROACH); PAV2, PAV3, PAV4, and PAV5 are the items representing performance-avoidance goals (AVOID); DLS3 to DLS5 are the observed variables representing deep learning strategies(DEEP); SLS1, SLS3, and SLS5 are the observed variables representing surface learning strategies(Surface); D1 is the disturbance variable (errors) associated with the construct, MASTERY; D1 is the disturbance variable (errors) associated with the construct, MASTERY; D2 is the disturbance variable (errors) associated with the construct, APPROACH; D3 is the disturbance variable (errors) associated with the construct, AVOID; D4 is the disturbance variable (errors) associated with the construct, DEEP; D3 is the disturbance variable (errors) associated with the construct, SURFACE; ; e1 to e27 are the errors associated with the observed variables.

The dependent or outcome variable (RESULT) is the exogenous variable, whereas the independent variable (e.g., INCR, ENTITY) is called the endogenous variable. Furthermore, variables such as MASTERY and DEEP mediate the relationship between INCR and RESULT. Therefore, MASTERY and DEEP are called mediating variables or just 'mediators', as are APPROACH, AVOID, and SURFACE. The mediating variables are also endogenous variables as these are affected by other exogenous or endogenous variables in the mediational model. For example, the exogenous variable, INCR, exerts a force on the endogenous variable, MASTERY, which in turn exerts a force on the endogenous variable, DEEP, and in turn exerts a force on the final outcome and endogenous variable, RESULT.

Furthermore, the model in the Figure 9 represents cause-and-effect relationships for the purpose of investigating the relationships among the variables. The presented links by single-headed arrows in the model show theoretical relationships from one variable to another. However, the model does not show potential reciprocal effects in the model. Hence, it can be noted that the model with these arrows was depicted for simplicity of model building and testing it by using a model-testing program.

4.8 Sample Size

SEM is a large sample technique (Kline, 2005). Sample size is an utmost importance issue in SEM studies, as it also affects some of the statistical estimates in SEM (Kline, 2005; Ullman, 2006). To get reliable estimations, 10 cases or more per parameter is considered as a desirable sample size (Chen, 2011; Kline, 2005; Jackson, Dezee, Douglas, & Shimeall, 2005). Ding, Velicer, and Harlow (1995) went further, and suggested using 100 participants for each model. However, Iacobucci (2010) believed that structural equation models can still perform well with smaller sample sizes (e.g., 50 or 100), suggesting that the traditional rule of thumb that samples should exceed 200 is just conventional and simplistic. These conditions are satisfied with the final sample of 341 students for the present study. Furthermore, a goodness of fit index that appears in AMOS, called Hoelter's (1983) Critical N (CN) tests the adequacy of sample size for a satisfactory model fit, and estimates values for both .05 and .01 levels (Byrne, 2010). In order to have reasonable sample size with satisfactory model fit the values for both .05 and .01 should be above 200 (e.g., Byrne, 2010). Both the .05 and .01 CN values for the hypothesised model were >200 (214 and 228 respectively), which indicated that the

size of the sample of the present study ($n = 341$) was satisfactory according to the Hoelter's benchmark of $CN > 200$.

4.9 Data Analysis

Data analysis was conducted using a model-fitting program named (AMOS) (Version 19) (Arbuckle, 2009) and IBM SPSS Statistics (Version 19). One of the advantages of using model-fitting programs over multiple regression procedures is that it explicitly notes the error variance associated with the variables in the model, and simultaneously assesses all the path coefficients of the entire model (Meryer et al., 2006). The general five-step procedure applied in the data analysis of most SEM studies involves: (a) model specification, (b) model identification, (c) model estimation, (d) model evaluation, and (e) model respecification (Bollen & Long, 1993; Schumacker & Lomax, 2004).

4.9.1 Model Specification

The first step, model specification, is concerned with developing a theoretical model by providing the hypotheses of causal relationships among the variables, based on substantive theories and previous research. This was initiated by exploring the studies that were most directly relevant to the four main constructs of the present study: beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement (see Chapter 2). Similarly, studies were explored to find the relationships between/among two, three or four of these constructs. Based on the review of these studies, hypotheses were developed to explore the relationships among the constructs (see Chapter 3). These relationships were then represented graphically in the form of a diagram (see Figure 8).

4.9.2 Model Identification

Model identification refers to the concept that a unique solution can be achieved for the parameters that cannot be measured directly in a model (Jackson et al., 2005). This can be achieved by identifying the amount of information (i.e., sample moments or the data points in the covariance matrix) that the data yields with respect to the parameters to be estimated. The number of observed variables included in the

models is 27, and based on the expression $p(p+1)/2$ [where p = number of observed variables], this study yielded 378 $(27[28]/2)$ sample moments. In this way, the order condition is satisfied for the model as the number of distinct parameters (free parameters) (65) to be estimated from the model were less than the number of distinct sample moments (distinct values) (378), provided in the covariance matrix.

Thus, the structural equation model looked over-identified as it contained $(378-65)$ or 313 degrees of freedom. Over-identification occurs when the number of distinct sample moments exceeds the number of distinct parameters with a positive number of degrees of freedom. Hoyle (1995) recommended using models that were over-identified in order to estimate the parameters and test the hypotheses regarding relationships among the variables. Additionally, Meyers, Gamst and Guarino (2006) warned not to use unidentified or just-defined models as they cannot be meaningfully interpreted when running the analysis. Parameter estimates are not to be trusted if the model is unidentified (Raykov & Marcoulides, 2006), and such models can be identified by imposing additional constraints and rules (Schumacker & Lomax, 1996).

4.9.3 Model Estimation

Model estimation involves estimating the parameters of the hypothesised model. This can be done with the help of statistical software packages with built-in SEM, such as LISREL (Jöreskog & Sörbom, 1993), EQS (Bentler, 2006), Mplus (Muthén & Muthén, 2006), and AMOS (Arbuckle, 2009). In this present study AMOS 19 was used to analyse the data and to produce the parameter estimates for the hypothesised models. AMOS employs the maximum likelihood function, an interactive – and the most preferred – estimation method used in most SEM analysis (Blunch, 2008; Burgess, 2010). Maximum likelihood requires iterative solutions and attempts to estimate the values of the parameters of the highest likelihood of the actual data matching the given model (Meyers et al., 2006). Additionally, with reasonably large sample sizes (refer section 4.8: Sample Size) this method provides asymptotically unbiased, efficient and consistent estimates, as the higher the sample size the lower the estimation of the error variance (Kline, 2005).

In the present study, the advantage of using AMOS for the estimation is that it provides an interactive user-friendly graphical user interface to do the complete analysis. The AMOS program allows the user to mathematically build and represent the

model at the user interface of the program before proceeding with the estimation. Once the model is built at the interface, the data file which is normally in SPSS or Excel is uploaded into AMOS, and the program is run using the “estimate” icon in the program. Once the program is run, the AMOS output files give the required statistics for the model fit and the relationships among the variables.

4.9.4 Model Evaluation

The fourth step is the evaluation of the model fit. In simple terms, the evaluation of the model fit involves assessing how well a model fits a particular data set (Steiger, 1990). To put it technically, Barrett (2007) defined model fit with associated degrees of freedom for a particular model as “a matter of testing whether the discrepancies (or residuals) are greater than would be expected by chance alone” (p. 816). Another perspective is given by Milfont and Fischer (2010), who stated that model fit determines “the degree to which the theoretical model as a whole is consistent with the empirical data” (p.117). Alternatively, the fit indices can be thought of as showing how well the observed data fit the hypothesised theoretical model (Milfont & Fischer, 2010). It would be erroneous and meaningless to interpret the parameter estimates if the model fits the data poorly (Brown, 2006). Therefore, it is important for the proposed model to have at least an acceptable model fit in order to proceed with the parameter estimates and the investigation of the relationships among the variables.

Different SEM programs give different fit indices, which can be used to compare the model fit for various alternative models, and interpret how well the empirical data fits the proposed model (Nguyen, 2002; Schumacker & Lomax, 1996). Researchers choose several goodness-of-fit indices in testing the fit that identifies an acceptable model for parameter estimation. Out of this, chi-square test (χ^2) is the most commonly used measure in the goodness of fit interpretation (Shook, Ketchen, Hult, & Kacmar, 2004). Kenny (2012) stated that with a sample size of 70-200, a chi-square value is a reasonable measure of absolute fit. However, when the sample size exceeds 200, the chi-square test alone is not enough as it is very sensitive to bigger sample sizes, and always statistically significant (Schumacker & Lomax, 1996). Furthermore, in their path analysis study, Stage et al. (2004) recommended at least two fit indices, the Tucker Lewis Index (TLI) and the root mean square error of approximation (RMSEA), while Kline(2005) advocated to use Chi-square, comparative fit index(CFI), RMSEA, and

standard mean square residual(SRMR). On the other hand, Brown (2006) suggested reporting at least one index from the three categories of fit indices in evaluating the overall the model fit: absolute, parsimonious, and comparative fit indices. For the present investigation, some of the fit indices which the AMOS program gives, including Chi-square value, CFI, TLI, RMSEA and RMR values, were chosen as the fit indices for evaluating the overall model fit. A number of studies in the past have used CFI, TLI, RMSEA and RMR as the fit indices in testing the overall model fit (e.g., Clough, 2008; De Ayala, 2009; Phelan, 2008; Tyson, 2008; Weekers, Brown, & Veldkamp, 2009).

Table 2: *Goodness-of-fit indices and acceptable fit*

Fit Indices	Acceptable threshold levels
<u>Comparative</u> Comparative Fit Indices (CFI)	> 0.95 reflects a good fit > 0.90 reflects an acceptable fit
<u>Absolute</u> Tucker Lewis Index (TLI) Standard Mean Square Residual (SRMR)	> 0.95 reflects a good fit > 0.90 reflects an acceptable fit < 0.05 indicates a good fit $0.05 \leq (\text{SRMR}) \leq 0.08$ reflects an acceptable fit
<u>Parsimonious</u> Root Mean Square Error of Approximation (RMSEA)	< 0.05 indicates a good fit $0.05 \leq (\text{RMSEA}) \leq 0.09$ reflects an acceptable fit

Further, Hu and Bentler (1999) suggest cut-off criteria for fit indexes that can be used in studies with SEM techniques. The cut-off criteria evaluate if there is a relatively good fit between the hypothesised model and the observed data (Hu & Bentler, 1999). Where model fit evaluation is concerned, these cut-off criteria are necessary as long as the maximum likelihood estimation methods are used in the analysis. The cut-off criteria suggested by Hu and Bentler (1999) are set at 0.95 for CFI and TLI, 0.08 for SRMR, and 0.06 for RMSEA. However, Marsh, Hau, and Wen (2004) found these criteria are more stringent and difficult to achieve in practice, especially when analyses are done at item level with multiple factors. Hence, Marsh and colleagues suggested using ‘conventional’ rules of thumb for an acceptable fit (i.e., CFI and TLI >

0.90; RMSEA < 0.08). Table 2 gives the goodness-of-fit indices used in the present study, with the acceptable fit criteria and their interpretations based on the fit statistics information provide in previous research (e.g., Clough, 2008; Iacobucci, 2010; Marsh et al., 2004; Nguyen, 2002).

4.9.5 Model Modification

The fifth step, model modification (also known as respecification) is done when the fit indices show a poor fit for the model. The fit of the model can be improved by adding and deleting some of the paths in the model. The modification indices (MI) can be used as a diagnostic tool for identifying the paths which are less significant and are problematic (Raykov & Marcoulides, 2006). Such paths can be deleted or removed as long as this does not conflict with the theoretical judgment of the overall model. Additionally, alternative models can be tested as an outcome of testing the original model presented in the study, as long as the relationships in the model are theoretically meaningful, according to the previous literature. Once the final model is accepted, reports on the fit indices follow, as well as direct and indirect effects of independent variables on dependent variables.

4.10 Testing Three-path Mediations

To test the three-path mediational relationships, this study used two different approaches. First, a bias-corrected bootstrapping approach was used to generate confidence intervals for the indirect effects of the hypothesised overall relation of beliefs about mathematical ability and achievement (i.e., for testing $H_{1.5}$ and $H_{2.4}$). Second, the multivariate delta standard error method was used for the specific mediations (i.e., for testing $H_{1.1}$ to $H_{1.4}$, and $H_{2.1}$ to $H_{2.3}$). As was indicated in the literature review, the best method for testing mediational relationships is the bootstrapping approach. However, the AMOS program, which was used to analyse the data, does not provide the statistics required for the specific mediating effects. Even with a bootstrapping approach, the program gives the overall indirect effect of the independent variable on the dependent variable, via all the mediating variables in the model.

The multivariate delta method is a causal step approach similar to Sobel's (1982) approach, formulated by Taylor et al. (2008) to be used for testing three-

path mediations. When testing the three-path mediating effects, the null hypothesis (H_0) is rejected if the 95% confidence interval = $\beta_1 \beta_2 \beta_3 \pm z_{.975} (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 \beta_2 S_{b3})^2 + (\beta_1 \beta_3 S_{b2})^2 + (\beta_2 \beta_3 S_{b1})^2$, $z_{.975}=1.96$, and S_{b1} , S_{b2} and S_{b3} are the standard errors associated with the unstandardised regression coefficients of β_1 , β_2 and β_3 , respectively (Taylor et al., 2008). The formula is manually evaluated for testing each of the specific mediations hypothesised in the present study.

4.11 Summary

This chapter provided the research framework and methods for the present study. It gave an overview of the participants, sample size, missing data, and pilot testing, including the instruments, design and procedures of the present study. The chapter also explained SEM techniques as the data analysis approach, including the steps followed in analysing the data for the present study. Finally, the chapter explained the approaches used to test the three-path mediated effects hypothesised in the mediational model of the present study.

CHAPTER 5: PRELIMINARY ANALYSES

5.1 Introduction

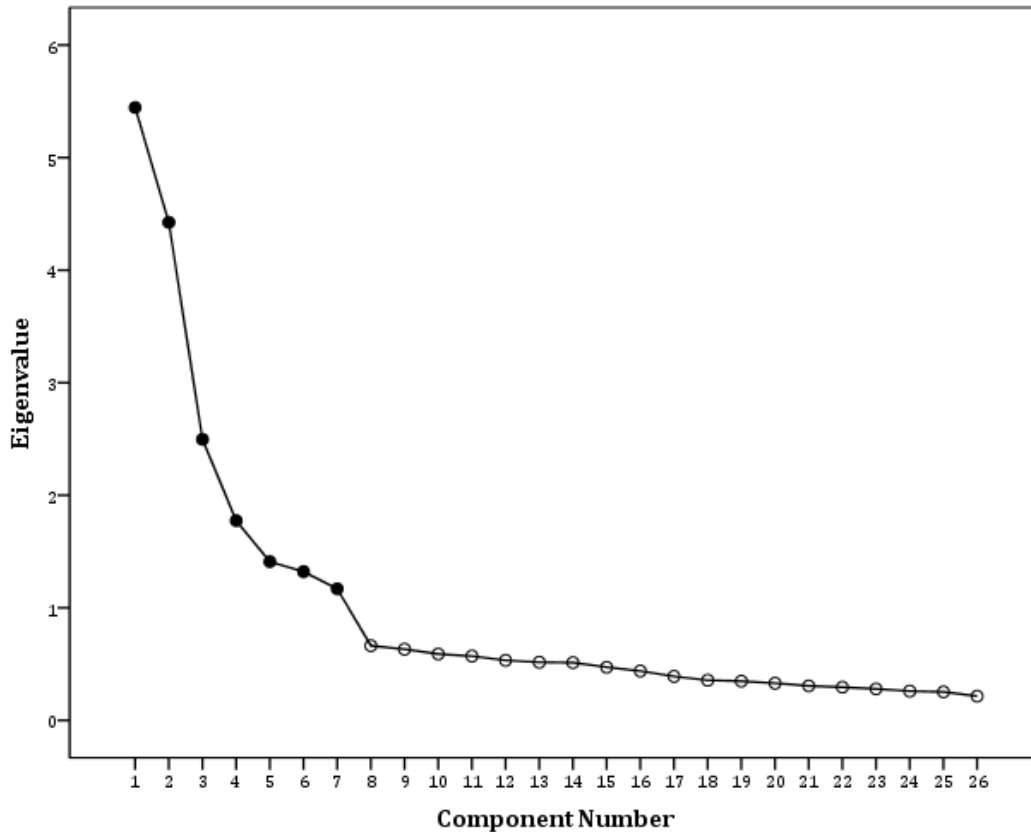
This chapter presents the preliminary analyses of the study. They are reported in seven main sections. The first section introduces the chapter. In the second section, the exploratory factor analysis was conducted on the items presumed to measure the seven factors of the present study. In the third section, the descriptive statistics were reported. In the fourth section, the convergent validity of the items was assessed. In the fifth, the discriminant validity of the items was assessed. In the sixth section, the measurement model with all the constructs was evaluated for its model fit. Finally, the structural model with all the variables in the study were evaluated for its model fit, before estimating the relationships in the structural model.

5.2 Exploratory Factor Analysis

Exploratory factor analysis (EFA) was conducted using IBM SPSS (version 19) to reduce dimensionality of the items by extracting the smallest number of factors that account for most of the variation in the original questionnaire data. The 'beliefs' 'goals', and 'strategies' items were adapted from previous studies, and had been modified and tailored for the mathematics domain. Thus, conducting an EFA with all the items was necessary to identify the factors (i.e., constructs) that would account for most of the variance in the observed variables (i.e., items). Initially, the dimensions for the 45 items were examined using maximum likelihood estimation method with the oblimin rotation, and before that, several well-known criteria that should be followed before conducting the EFA procedure were checked. Firstly, it was checked if all the items correlated with at least one other item with a value at least $r > 0.30$, and this criteria was satisfied. Then, Bartlett's test of sphericity was significant ($\chi^2 (325) = 4006.44$, $p < .001$, Kaiser-Meyer-Olkin's value (0.84) of the sample adequacy was above the recommended value of 0.60 , and finally the communalities of all the items were found to be above .3. Given all these criteria were satisfied, the dimensions were examined for the 45 items of the present study. From the very first analysis of the EFA results, some items were identified as not contributing to any factor structure, with factor loading less than 0.60, the recommended high value (Kline, 2005; e.g., Bodie & Worthington, 2010; Teo, & Koh, 2010; Teo & Schaik, 2009). Further, convergent validity requires factor loadings greater

than 0.60 (Bodie & Worthington, 2010; Ouyang, 2009). Thus, all of the items that had factor loadings less than 0.60 were removed each time an EFA was rerun on the remaining items. The factor loadings that represent each factor based on the final EFA with oblimin rotation for the remaining 29 items are given in Tables 3 to 9. The scree plot generated for the 29 items is shown in Figure 10.

Figure 10: Scree plot for the 29 items



Note: Eigen- values >1 represents the factors extracted

It is clear from the plot that seven factors, with eigen-values > 1 were extracted from the 29 items, which explained a total variance of 58.73%, which is closer to the average variance of 59.80% obtained by Costello and Osborne (2005) with similar analysis. The following subsections detail the analysis of the EFA results for the different factors that were extracted.

5.2.1 Beliefs about Mathematical Ability

5.2.1.1 Incremental beliefs

The latent variable for incremental beliefs about mathematical ability (INCR) originally included eight items. However, the EFA suggested that four items (i.e., I2 with the factor loading (FL) of 0.29: “If you fail in your exam, you blame yourself for not having studied enough.” I6 with FL of 0.44: “Maths ability can be changed.”, and I8 with FL of 0.24: “Criticism from others can help develop your maths ability.”), should not be retained for the analysis due to no contribution to any factor and having low factor loadings (< 0.60). Additionally, the item, I5 with FL of 0.39: “Practising maths task can develop maths ability.” was removed as it did not satisfy the multivariate normality (i.e., skewness $< |3.0|$, kurtosis $< |8.0|$) (Kline, 2005). The other four incremental belief items (i.e., I1, I3, I4, and I7, shown in Table 3) were retained because they had reasonably high factor loadings (Kline, 2005). The final EFA results for the four remaining items indicated that this factor contributed 2.97% of the variance. When the items with poor factor loadings were dropped, the composite reliability of the construct (i.e., Cronbach’s alpha value) increased from 0.69 to 0.80. The Cronbach’s alpha the construct for incremental beliefs was acceptable as it was greater than the recommended value of 0.70 (Hair et al., 2006).

Table 3: Factor loadings for incremental belief items based on EFA

		1	2	3	4	5	6	7
Variance (%)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
I1	You can develop your maths ability a great deal.	0.09	0.04	0.00	-0.01	0.05	0.00	0.77
I3	When you learn new things in maths, your basic maths knowledge improves.	0.08	0.00	0.04	0.05	0.06	-0.04	0.77
I4	Good preparation before a maths task is a way to develop your maths ability.	-0.07	-0.07	-0.16	0.01	-0.04	0.07	0.67
I7	If you work hard in learning maths, you can change your maths ability.	-0.08	-0.05	-0.12	-0.04	-0.14	0.07	0.65

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

5.2.1.2 Entity beliefs

The latent variable for entity beliefs about mathematical ability (ENTITY) originally included eight items. The initial and the subsequent EFA suggested that the five items (i.e., ENT1 with FL of 0.54: “You have fixed amount of maths ability.”; ENT2 with FL of 0.19: “High performance maths is a result of your maths ability.”; ENT5 with FL of 0.36: “If you fail in your maths exam, you blame your inborn ability.”, ENT6 with FL of 0.22: “Difficulties and challenges in solving maths problems prevent you from developing your ability.”; and ENT8 with FL of 0.24: “Encouragement from others does not help improve maths ability.”) with poor factor loadings (< 0.60) (Kline, 2005) should be dropped. As a result, only three items (i.e., ENT3, ENT4 and ENT7, see Table 4) were retained for the final analysis (Kline, 2005).

Table 4: Factor loadings for entity belief items based on EFA

		1	2	3	4	5	6	7
Variance (%)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
ENT3	Maths ability cannot be changed.	0.02	0.00	0.78	0.05	0.03	-0.00	0.00
ENT4	No amount of hard work in learning maths can change your ability.	0.02	0.03	0.84	0.04	0.02	0.03	-0.03
ENT7	Learning new concepts does not improve your basic level of maths ability.	-0.08	0.00	0.72	-0.06	-0.09	-0.01	-0.07

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

The final EFA results indicated that this factor contributed 8.05% of the variance. Furthermore, when the items with poor factor loadings were dropped, the Cronbach’s alpha of the construct value increased from 0.72 to 0.84. The composite reliability of the construct was acceptable ($\alpha = 0.84$) as it was greater than the recommended value of 0.70 (Hair et al., 2006).

5.2.2 Achievement Goals

5.2.2.1 Mastery goals

The latent variable for mastery goals included five items. The EFA for the mastery goals confirmed that all of the items were good (see Table 5) and should be retained for the analysis (Kline, 2005). The final EFA results indicated that this factor contributed 19.12% of the variance. The Cronbach's alpha of the construct ($\alpha = 0.84$) was acceptable as it was greater than the recommended value of 0.70 (Hair et al., 2006).

Table 5: Factor loadings for mastery goal items based on EFA

		1	2	3	4	5	6	7
Variance (%)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
M1	I do my maths work because I am interested in it.	0.85	-0.04	-0.09	0.00	-0.00	0.05	-0.07
M2	I like maths work best when it really makes me think.	0.72	-0.00	0.10	-0.07	-0.03	-0.05	0.06
M3	I do work in maths because I want to get better at it.	0.64	0.00	-0.06	0.04	-0.03	0.13	0.06
M4	I like maths work that I learn from, even if I make a lot of mistakes	0.62	-0.04	0.07	-0.00	0.00	0.15	0.18
M5	I do my maths sums because I like to learn new things.	0.73	0.020	-0.07	0.03	-0.05	0.00	-0.03

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

5.2.2.2 Performance-approach goals

The latent variable for performance-approach goals was originally measured using five items (see Table 6). However, the initial and the subsequent EFA suggested that one item (i.e., PAP5 with FL of 0.47: "I would feel good if I were the only one who could answer the teacher's questions in my maths class.") had weak factor loading (< 0.60) (Kline, 2005). Hence, PAP5 was dropped from the analysis. The final EFA results indicated that this factor contributed 3.96% of the variance. After PAP5 was removed from the analysis, the composite reliability of the construct for performance-approach goals increased from 0.82 to 0.83. The Cronbach's alpha of the construct was acceptable as it exceeded the recommended value of 0.70 (Hair et al., 2006).

Table 6: Factor loadings for performance-approach goal items based on EFA

		1	2	3	4	5	6	7
Variance (%)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
PAP1	Doing better than other students in my maths class is important to me.	0.14	-0.08	0.07	0.01	-0.77	-0.02	0.03
PAP2	I would like to show my maths teachers that I am smarter than other students in my class.	0.09	0.197	-0.07	0.00	-0.66	-0.11	0.03
PAP3	I would feel successful in maths class if I did better than most of others.	-0.11	0.12	0.04	0.06	-0.60	0.08	-0.02
PAP4	I want do better than other students in my maths class.	0.02	-0.08	-0.04	0.05	-0.86	0.04	-0.01

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

5.2.2.3 Performance-avoidance goals

The latent variable for performance-avoidance goals (AVOID) was originally measured using 5 items (see Table 7). The initial and the subsequent EFA indicated that the factor loading for one item (i.e., PAV1 with FL of 0.40: “One of my maths goals is to avoid looking like I can’t do maths.”) was less than the recommended value of 0.60 (Kline, 2005).

Table 7: Factor loadings for performance-avoidance goal items based on EFA

		1	2	3	4	5	6	7
Variance (%)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
PAV2	I do my maths work so others won’t think I am dumb.	-0.04	0.67	0.00	-0.06	0.00	0.00	-0.01
PAV3	It’s very important to me that I don’t look stupid in my maths class.	0.00	0.64	0.03	0.05	-0.24	0.04	0.06
PAV4	I do my maths work so I don’t embarrass myself.	-0.04	0.86	0.02	0.00	0.00	0.00	0.00
PAV5	I do my maths work so my maths teachers don’t think I know less than other students.	0.06	0.83	-0.01	0.10	0.08	-0.03	-0.04

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

Therefore, the item was dropped from the analysis, and the remaining four items (i.e., PAV2, PAV3, PAV4 and PAV5) with loadings (>0.60) were retained. The final EFA results indicated that this factor contributed 15.63% of the variance. The elimination of PAV1 from the EFA model improved the composite reliability of the construct from 0.81 to 0.83. The composite reliability of the construct for performance-approach goals was acceptable as it exceeds the recommended value of 0.70 (Hair et al., 2006).

5.2.3 Learning Strategies

5.2.3.1 Deep learning strategies

The latent variable for deep-learning strategies was originally measured using seven indicators. The initial and the subsequent EFA suggested that four items (i.e., DP1 with FL of 0.19: “When studying, I try to combine different pieces of information from course material in new ways.”, DP2 with FL of 0.38: “I draw pictures or diagrams to help me solve some problems.”, DP6 with FL of 0.31: “I classify problems into categories before I begin to practise for an exam.”, and DP7 with FL of 0.39: “When I work a maths problem, I analyse it to see if there is more than one way to get the right answer.”) with weak factor loadings (<0.60) (Kline, 2005) should be removed from the analysis.

Table 8: Factor loadings for deep learning strategies items based on EFA

		1	2	3	4	5	6	7
Variance (%)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
DLS3	I work several examples of the same type of problems when studying mathematics so I can understand the problems better.	0.00	0.00	0.08	-0.01	0.08	0.82	0.03
DLS4	I work practice problems to check my understanding of new concepts or rules.	0.14	-0.02	-0.09	0.06	-0.04	0.64	-0.08
DLS5	I examine example problems that I have already been worked to help me figure out how to do similar problems on my own.	0.00	0.02	0.00	-0.04	-0.04	0.65	0.06

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

After dropping these four indicators from the analysis, the number of indicators in the measurement model was reduced to three (i.e., DP3, DP4, and DP5, see Table 8). The final EFA results indicated that this factor contributed 3.53% of the variance. After the changes, the Cronbach's alpha of the construct improved from 0.69 to 0.72. The Cronbach's alpha of the construct for deep learning strategies was greater than the recommended value of 0.70 (Hair et al., 2006). Based on the items dropped, it seems appropriate to label this factor *practice strategies*. These still differ from surface strategies because practice strategies involve evaluation of to-be-learned information. However, I will continue to use the term *deep strategies* so that the terminology used in the literature review and numerous analyses will be consistent.

5.2.3.2 Surface learning strategies

The latent construct for surface learning strategies was originally measured using seven items (see Table 9). The initial and the subsequent EFA suggested that four items (i.e., SP2 with FL of 0.31: "When I study for maths tests I review my maths class notes and look at solved problems.", SP4 with FL of 0.27: "I find reviewing previously solved problems to be a good way to study for maths tests.", SP6 with FL of 0.57: "When studying maths, I read the problems and my notes over and over again to help me remember the sums.", and SP7 with FL of 0.45: "When I study for the maths exam, I try to memorise as many facts as I can."), had weak factor loadings (loadings >0.60) (Kline, 2005). After the changes the Cronbach's alpha of the construct for surface-learning strategies was improved from 0.80 to 0.85 and was acceptable as it exceeded the recommended value of 0.70 (Hair et al., 2006). Based on the items dropped, it seems appropriate to label this factor memorisation *technique or memorisation strategies*. These still differ from deep strategies or practice strategies because memorisation technique, like surface learning strategies involve recalling of learned information. However, I will continue to use the term *surface learning strategies* so that the terminology used in the literature review and numerous analyses will be consistent

Table 9: Factor loadings for surface learning strategies items based on EFA

		1	2	3	4	5	6	7
Variance (in %)		19.12	15.63	8.05	5.57	3.96	3.53	2.97
SLS1	I try to memorise the steps for solving problems presented in the text or in maths class.	-0.02	0.00	0.00	0.79	-0.07	0.02	0.01
SLS3	When I study for maths tests I use solved problems in my maths notes or in the book to help me memorise the steps involved.	-0.08	-0.01	0.00	0.82	-0.02	-0.02	0.06
SLS5	I try to memorise everything that I think will be in a maths exam.	0.06	0.02	0.02	0.83	0.05	-0.02	-0.05

Note: Factor 1 = Mastery goals; Factor 2 = Performance-approach goals; Factor 3 = Performance-avoidance goals; Factor 4 = Incremental beliefs; Factor 5 = Surface-learning strategies; Factor 6 = Entity beliefs; Factor 7 = Deep-learning strategies.

5.2.4 Summary

The EFA was originally performed with all the 45 items of the present study. However, with subsequent analyses the items were reduced to 29 with 7 factors, explaining a total variance of 58.73%.

5.3 Descriptive Statistics

In Table 10, descriptive statistics – minimum, maximum, and mean scores, standard deviation, skewness, and kurtosis – are presented for the acceptable items and students' achievement results. Some of these items have negative means because the instrument scale ranged from -50 (strongly disagree) to 50 (strongly agree). The individual construct mean indicated that the students overall had: higher incremental views of mathematical ability; lower entity views of mathematical ability; higher mastery goal orientations; higher performance-approach goal orientations; lower performance-avoidance goal orientations; higher use of deep-learning strategies; and lower use of surface-learning strategies(see Table 10). The standard deviations of the constructs ranged from 15.55 to 33.70, indicating a fairly wide spread of responses around the mean. Overall, students' mathematics results were slightly better than the 50% benchmark, with a fair spread of the results around the mean (M=63.02, SD=20.76).

Table 10: *Descriptive statistics for the constructs and mathematics results*

Constructs	Items	Min	Max	Mean	SD	Skewness	Kurtosis
INCR	4	-49	50	37.83	15.55	-1.91	5.22
ENTITY	3	-50	50	-30.22	25.36	1.56	1.81
MASTERY	5	-50	50	30.43	24.04	-1.62	2.29
APPROACH	4	-50	50	15.67	31.79	-0.74	-0.49
AVOID	4	-50	50	-14.89	30.02	0.45	-0.82
DEEP	3	-50	50	33.64	19.51	-1.67	3.24
SURFACE	3	-50	50	-4.01	33.70	0.06	-1.31
RESULT		0	98	63.02	20.76	-0.79	0.24

Note: INCR=Incremental beliefs; Entity=Entity beliefs; MASTERY=Mastery goals; APPROACH= Performance-approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies; RESULT=Mathematics results (observed variable); SD =Standard deviation; Min=Minimum; Max=Maximum.

Additionally, the skewness ranged from -1.91 to 1.56 and kurtosis ranged from -1.31 to 5.22. All skewness and kurtosis figures were within the recommend range (i.e., skewness < |3.0|, kurtosis < |8.0|) (Kline, 2005) indicating that the data for this study had no serious deviations from normality.

5.4 Convergent Validity

Convergent validity is the extent to which a measure is positively correlated with other measures of the same construct (Hair et al., 2006). Convergent validity of the items measuring each construct was assessed using the three steps proposed by Fornell and Larcker (1981): (1) the item reliability of each measure, (2) composite reliability of each construct, and (3) the average variance extracted. First, the item reliability was measured from the factor loading of each item for the underlying construct. The individual factor loadings of the retained items for the constructs ranged from 0.63 to 0.86 (shown in Table 11), indicating all the retained items exceeded the recommended value of .6 (Kline, 2005). These results indicated the convergent validity at the item level for each construct. Second, the composite reliability at the construct level was assessed using the value of Cronbach's alpha for each construct. The composite reliability (i.e., Cronbach's alpha values) for the seven constructs ranged from 0.80 to 0.89 (also shown in Table 11), and exceeded the recommended value of 0.7 (Hair et al., 2006). Third, the average variance extracted (AVE) was computed.

The AVE is an indicator of the amount of variance captured by the construct in relation to the variance due to random measurement error (Teo & Schaik, 2009). The AVE is calculated by adding the squared factor loadings of the items of the underlying factor, divided by the number of items in the factor. The AVE's above .5 are treated as indication of adequate convergent validity (Fornell & Larcker (1981). The AVEs for all the constructs ranged from 0.51 to 0.66, satisfying this criterion. The analysis results of the three procedures recommended by Fornell and Larcker(1981) demonstrate adequate convergent validity at the construct level for all the constructs.

Table 11: *Convergent validity for the measurement model*

Variable Name	Item Label	Factor Loading	Composite Reliability	AVE
INCR	I1	0.76	0.80	0.51
	I3	0.72		
	I4	0.70		
	I7	0.66		
ENTITY	ENT3	0.78	0.84	0.63
	ENT4	0.86		
	ENT7	0.74		
MASTERY	M1	0.86	0.84	0.54
	M2	0.69		
	M3	0.72		
	M4	0.64		
	M5	0.73		
APPROACH	PAP1	0.77	0.83	0.57
	PAP2	0.76		
	PAP3	0.63		
	PAP4	0.85		
AVOID	PAV2	0.65	0.83	0.57
	PAV3	0.64		
	PAV4	0.88		
	PAV5	0.83		
DEEP	DPS3	0.76	0.76	0.52
	DPS4	0.73		
	DPS5	0.67		
SURFACE	SPS1	0.83	0.85	0.66
	SPS3	0.80		
	SPS5	0.81		

Note: INCR=Incremental beliefs; Entity=Entity beliefs; MASTERY=Mastery goals;

APPROACH=Performance-Approach goals; AVOID= Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies; AVE = Average Variance Extracted; Composite Reliability is the Cronbach's alpha value for the construct; and the factor loadings for this table were taken from the AMOS output files.

5.5 Discriminant Validity

Discriminant validity is the extent to which a construct does not correlate with measures of another construct (Hair et al., 2006). Discriminant validity is said to be present when the amount of variance shared between a construct and its indicators is more than the amount variance shared among other constructs of the study (Fornell, Tellis, & Zinkhan, 1982). In general, discriminant validity checks whether the constructs are different from one another. To assess the discriminant validity for a particular construct, the correlations between the constructs are compared with the square root of the value of the AVE for that particular construct (Teo & Koh, 2010). In Table 12, the figures across the diagonal in bold represent the square root of the AVE values for the individual constructs. Other values represent the correlations among the constructs. Discriminant validity for a particular construct is present if the diagonal value for that construct is greater than the strength of correlations the construct has with other constructs. The data in Table 12 indicate that all the constructs satisfied this criterion, indicating that discriminant validity was satisfactory for all constructs.

Table 12: *Discriminant validity for the measurement model*

Construct	1	2	3	4	5	6	7
1. ENTITY	(0.79)						
2. INCR	-0.57**	(0.71)					
3. APPROACH	-0.08	0.21*	(0.75)				
4. MASTERY	-0.16*	0.42**	0.31**	(0.73)			
5. AVOID	0.24**	-0.21**	0.38**	-0.15*	(0.75)		
6. DEEP	-0.17**	0.42**	0.22**	0.56**	-0.13*	(0.72)	
7. SURFACE	-0.09	-0.02	0.33**	-0.00	0.38**	0.03	(0.81)

Note : INCR=Incremental beliefs; Entity=Entity beliefs; MASTERY=Mastery goals; APPROACH=Performance-approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies.

* correlation significant at $p < .05$

** correlation significant at $p < .01$

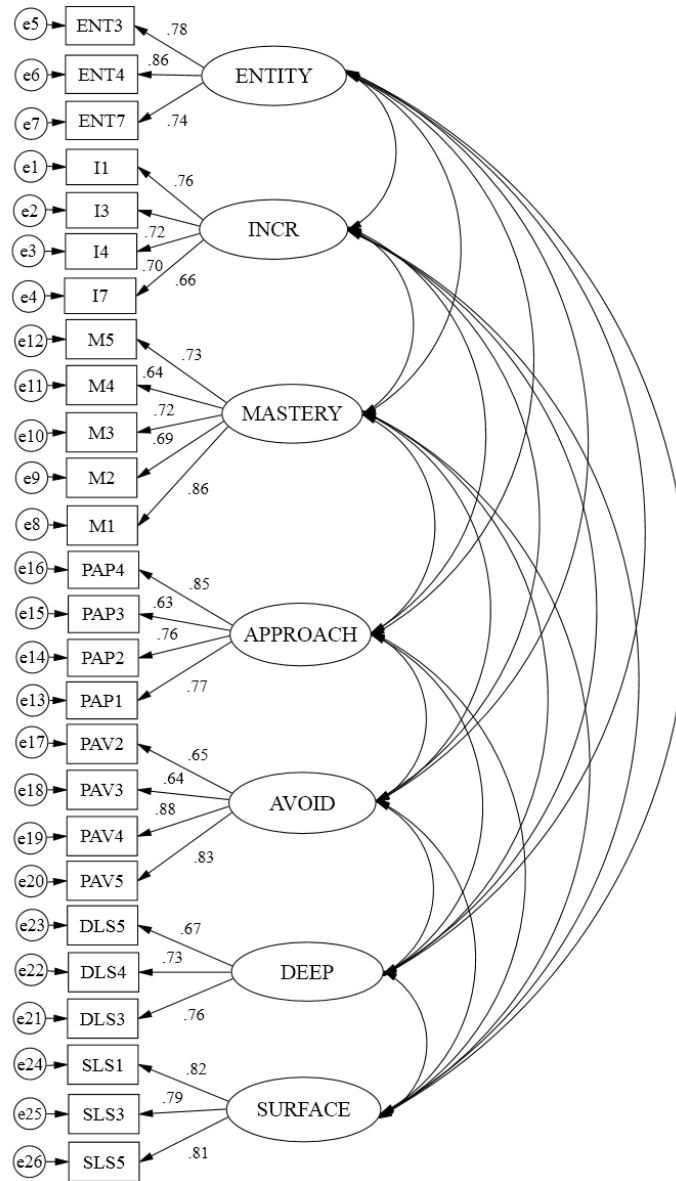
5.6 Evaluation of the Measurement Model

According to Fornell and Larcker (1981), one must demonstrate that the measurement model (i.e., all the constructs together) has a satisfactory level of validity and reliability before testing for a significant relationship in the structural model. The

previous sections have shown that all the constructs have satisfactory levels of validity and reliability. Therefore, the next step was the evaluation of the goodness-of-fit of the measurement model with all the latent constructs of the study. The measurement model of the structural equation model (shown in Figure 11) with all the latent constructs, depicts the relationship between the observed variables and their corresponding construct, with such patterns for all the constructs represented together in a single hypothesised model.

Researchers use measurement models to examine the extent of interrelationship and covariation among the latent constructs, before exploring the possibility of relationships among the latent variables (Schreiber, 2006). The AMOS program generated chi-square statistics (χ^2), associated degrees of freedom (df), and the probability value when maximum likelihood estimates are computed. The program also generated several other fit statistics including Comparative Fit Index (CFI), Tucker Lewis Index (TLI), root mean square error of approximation (RMSEA), and standardised root mean squared residual (SRMR). The fit statistics results indicated that the hypothesised model of relationships among the latent constructs fitted the observed data well (CFI = 0.96, TLI = 0.95, RMSEA = 0.04 [with 90% CI lower bound = 0.04 and upper bound = 0.05], SRMR = 0.06, $\chi^2[278] = 447.68$, $p = 0.00$, CMIN/DF = 1.61). The Hoelter values (Hoelter, 1983) at .01 and .05 level were greater than the recommended value of 200 (i.e., 242 and 256 respectively), indicating that the model had a reasonable model fit with reasonable sample size. Please note that the measurement model did not include the observed variable mathematics results (RESULTS) as it is not a latent construct. However, this variable will be included in the structural model.

Figure 11: *Measurement model*



Note: I1, I3, I4, and I7 are the items representing incremental beliefs (INCR); ENT3, ENT4, and ENT7 are the items representing entity beliefs (ENTITY); M1 to M5 are the items representing mastery goals (MASTERY); PAP1, PAP3, PAP4, and PAP are the items representing performance-approach goals (APPROACH); PAV2, PAV3, PAV4, and PAV5 are the items representing performance-avoidance goals (AVOID); DSL3 to DSL5 are the items representing deep learning strategies (DEEP); SLS1, SLS3, and SLS5 are the items representing surface learning strategies (SURFACE); e1 to e26 are the errors associated with the observed variables(i.e., items)

5.7 Evaluation of the Structural Equation Model: All Variables in the Study

The adequacy of the parameter estimates and hypothesised model as a whole were based on the adequacy of the model fit criteria (e.g., Byrne, 2010). Once the measurement model had acceptable model fit, the structural equation model, similar to the model in Figure 9(in Chapter 4) was developed with all the latent constructs along with the observed variable, mathematics achievement(RESET), and was evaluated for adequacy of the model fit.

Once the fit indices were generated, they were interpreted for the adequacy of the model fit. The initial fit for the structural equation model was an acceptable level (CFI = 0.93, TLI = 0.92, RMSEA = 0.05 (with 90% CI lower bound = 0.05 and upper bound = 0.06), SRMR = 0.09, χ^2 (313) = 600.23, p = 0.00, CMIN/DF = 1.92 (e.g., Iacobucci, 2010; Marsh et al., 2004; Nguyen, 2002). The values of fit indices except the value of SRMR (0.09) are within the acceptable limits of the 'conventional' rules suggested by Marsh et al. (2004) who found believed that the cut-off criteria proposed by Hu and Bentler (1999) are largely unobtainable in actual practice. While all the fit indices except the value of SRMR are within the acceptable levels, the overall fit of the model is acceptable. Additionally, the Hoelter values (Hoelter, 1983) at .01 and .05 level were greater than the recommended value of 200(i.e., 202 and 212 respectively), indicating that the model had a reasonable model fit with reasonable sample size.

The fit of the model could have been improved further by adding various other correlations between the error terms of several indicators. However, neither these changes nor any further changes were made because they were not hypothesised in the present study. Furthermore, obtaining optimum model fit was beyond the scope of the present study. Indeed, MacCallum, Roznowski, and Necowitz (1992) cautioned against modifying a model to further improve the fit as it could simply fit the idiosyncratic characteristics of the sample. However, within the theoretical boundaries of the study, an alternate post-hoc model is proposed at a later stage in this section as an outcome of the post-hoc modifications.

Given that the model fit was acceptable, the parameter estimations including the direct and indirect effects, and squared multiple correlations were generated and interpreted to investigate the relationships among the variables. The results are reported in the following chapter.

5.8 Summary

This chapter provided the preliminary analyses for the structural equation model used in the study. The results of exploratory factor analysis indicated that seven factors were extracted for the present study. The skewness and kurtosis were within acceptable limits for the items, indicating that there were no serious deviations from normality. The convergent and discriminant validities were satisfactory for the all the constructs measured in the study. The fit of the measurement and structural models were at acceptable levels to proceed with testing the relationships among the variables in the study.

CHAPTER 6: RESULTS

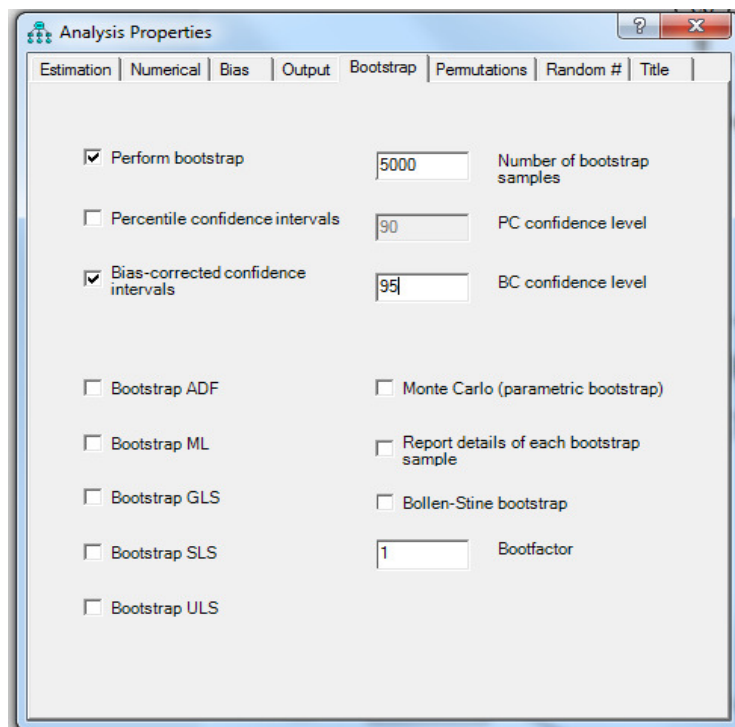
6.1 Introduction

This chapter presents the results of the study in three main sections. In the first section, the full structural equation model is evaluated to test the hypothesised relationships among the variables. To do that, standardised direct and indirect relationships are reported. Second, to address the research questions, the research hypotheses are tested using the output statistics generated by the bootstrapping method, and the three-path mediational tests. Finally, alternative models were tested to find a need for the meditational relationships and to address the limitations of the original model.

6.2 Relationships among Variables

The full model was run using AMOS 19 program and the parameters were estimated by performing a method called bootstrapping. Before calculating the estimates using the program, 'Bootstrap' in the 'Analysis Properties' was modified.

Figure 12: *Analysis properties*



Note: The figure above represents the user-interface of the Analysis Properties icon in AMOS

This was done by setting the 'Number of bootstrap samples' to 5000, and the 'Bias-corrected confidence interval' to 95 % in the user-interface of the AMOS program (see Figure 12). Before attending to the research questions and research hypotheses, direct and indirect relationships among the variables in the full structural equation model were examined to get an understanding of the mediating relationships among them. The Figure 13 shows the path coefficients (standard regression coefficients) of paths in the full structural equation model, highlighting the paths that are statistically significant at $p < .05$ level. The two-path specific indirect effects in the full structural model (i.e., in the Section 6.2.2 on Values of Indirect Paths) were calculated using Sobel's(1986) formula(see Table 19 in Appendix H & Table 20 in Appendix I), and the overall two-path indirect effects were calculated using biased-corrected bootstrapping method.

6.2.1 Values of Direct Paths

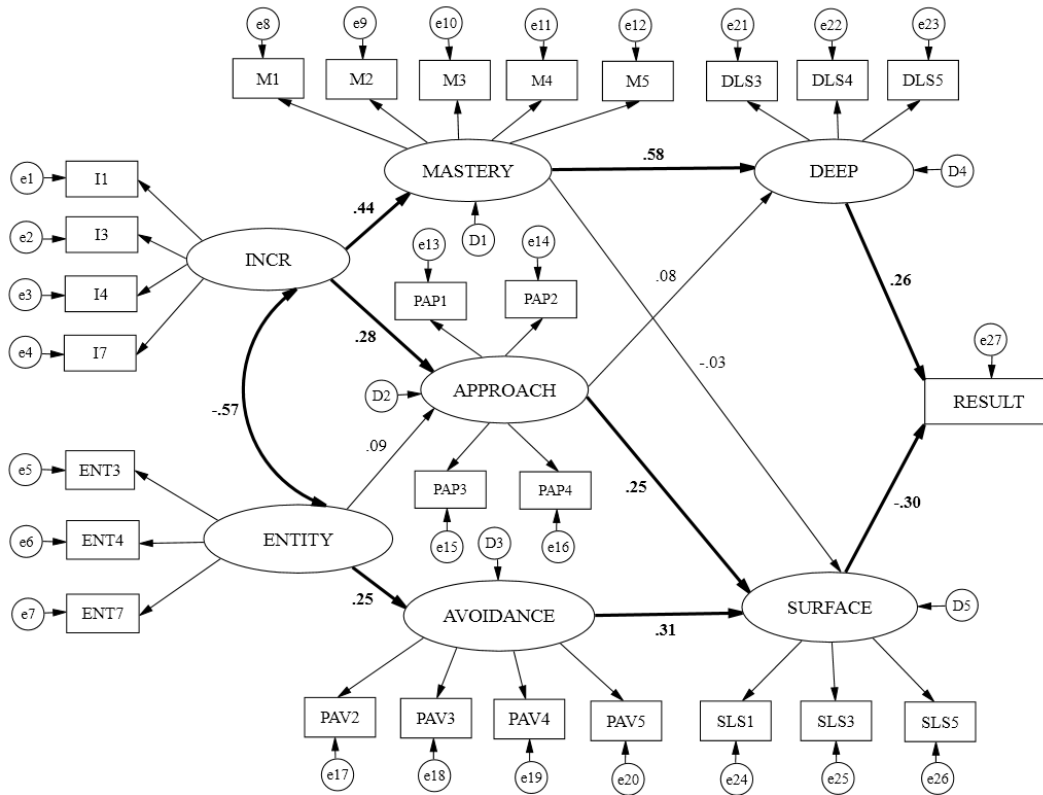
6.2.1.1 Beliefs to Goals.

Incremental beliefs about mathematical ability were positively related to mastery goals ($\beta = 0.44, p < .001$) and performance-approach goals ($\beta = 0.29, p < .001$). Entity beliefs about mathematical ability were positively related to performance-avoidance goals ($\beta = 0.25, p < .001$). However, entity beliefs were not significantly related to performance-approach goals ($\beta = 0.09, p > .05$) (see Appendix E, Tables 13 and 14).

6.2.1.2 Goals to Strategies

Mastery goals were positively related to deep-learning strategies ($\beta = 0.578, p < .001$), but were not significantly relate to surface-learning strategies ($\beta = -0.03, p > .05$). Both performance-approach ($\beta = 0.25, p < .05$) and performance-avoidance ($\beta = 0.31, p < .001$) goals were positively related to surface-learning strategies. However, performance-approach goals were not significantly related to deep-learning strategies ($\beta = 0.08, p > .05$) (see Appendix E, Tables 13 and 14).

Figure 13: Structural equation model: Beliefs, goals, strategies, and achievement



Note: I1, I3, I4, and I7 are the observed variables representing incremental beliefs (INCR); ENT3, ENT4, and ENT7 are the observed variables representing entity beliefs (ENTITY); M1 to M5 are the observed variables representing mastery goals (MASTERY); PAP1, PAP3, PAP4, and PAP are the observed variables representing performance-approach goals (APPROACH); PAV2, PAV3, PAV4, and PAV5 are the items representing performance-avoidance goals (AVOID); DLS3 to DLS5 are the observed variables representing deep learning strategies(DEEP); SLS1, SLS3, and SLS5 are the observed variables representing surface learning strategies(Surface); D1 is the disturbance variable (error) associated with the construct, MASTERY; D1 is the disturbance variable (error) associated with the construct, MASTERY; D2 is the disturbance variable (error) associated with the construct, APPROACH; D3 is the disturbance variable (error) associated with the construct, AVOID; D4 is the disturbance variable (error) associated with the construct, DEEP; D3 is the disturbance variable (error) associated with the construct, SURFACE; e1 to e27 are the errors associated with the observed variables.

The structural paths in bold are significant at $p < 0.05$

Model fit: CFI = 0.93, TLI = 0.92, RMSEA = 0.05 (with 90% CI lower bound = 0.05 and upper bound = 0.06), SRMR = 0.09, $\chi^2(313) = 600.23$, $p = 0.00$, CMIN/DF = 1.92

6.2.1.3 Strategies to Achievement

Deep-learning strategies were positively related to achievement ($\beta = 0.26, p < .001$), whereas surface-learning strategies were negatively related to achievement ($\beta = -0.31, p < .001$) (see Appendix E, Tables 13 and 14).

6.2.2 Values of Indirect Paths

6.2.2.1 Beliefs to Strategies via Goals

Mastery goals mediated the relationship between incremental beliefs and deep-learning strategies ($z = 5.38, p < .05$), but performance-approach goals did not mediate this relationship ($z = 1.21, p > .05$). Mastery goals and performance-approach goals mediated the positive relationship between incremental beliefs and deep-learning strategies ($\beta = 0.27, LCI = .148, UCI = .409, p < .001$). Mastery goals did not individually ($z = -0.055, p > .05$), or with performance-approach goals, mediate the positive relationship between incremental beliefs and surface-learning strategies ($\beta = 0.06, LCI = -0.005, UCI = 0.125, p > .05$). However, performance-approach goals individually mediated this relationship ($z = 2.28, p < .05$). Performance-avoidance goals individually ($z = 2.44, p < .05$), and with performance-approach goals, mediated the positive relationship between entity beliefs and surface-learning strategies ($\beta = .10, LCI = 0.027, UCI = 0.196, p < .05$), but performance-approach goals did not mediate this relationship individually ($z = 1.62, p > .05$). Neither did performance-approach goals mediate the relationship between entity beliefs and deep-learning strategies ($\beta = 0.007, LCI = -0.006, UCI = 0.044, p > .05$) (see Appendix F, Tables 15 and 16; Appendix G, Tables 17 and 18; also Appendix H, Table 19).

6.2.2.2 Goals to Achievement via Strategies

Deep-learning strategies individually ($z = 3.83, p < .05$), and with surface-learning strategies, mediated the positive relationship between mastery goals and achievement ($\beta = 0.16, LCI = 0.063, UCI = 0.275, p < .01$), while surface-learning strategies did not mediate this relationship individually ($z = 0.51, p > .05$). Deep-learning strategies neither individually ($z = 1.24, p > .05$), nor with surface-learning strategies, mediated the relationship between performance-approach goals and achievement ($\beta = -0.06, LCI = -0.125, UCI = .004, p > .05$). However, surface-learning

strategies mediated this relationship individually ($z = -3.02, p < .05$), and also mediated the relationship between performance-avoidance goals and achievement ($\beta = -0.09$, LCI = -0.156 , UCI = $-0.048, p < .05$) (see Appendix F, Tables 15 and 16; Appendix G, Tables 17 and 18; also Appendix I, Table 20).

6.2.2.3 Beliefs to Achievement via Goals and Strategies

The indirect relationships tested from *beliefs to learning strategies via goals*, and from *goals to achievement via learning strategies* gave a general picture of the indirect relationship beliefs about mathematical ability have with mathematics achievement, mediated through goal orientations and learning strategies. It also gave a picture of specific three-path mediational pathways starting from specific beliefs about mathematical ability and leading to mathematics achievement. These indirect relationships are further explored by attending to the research questions and hypothesis testing.

6.3 Effect Sizes for the Endogenous Variables

Cohen's (1992) effect size (f^2) values indicate the proportion of explained variance in the endogenous variable over the unexplained variance that was not explained from the model. Cohen's (1992) effect sizes (f^2) for the endogenous variables were reported by computing the squared multiple correlations (R^2 values). The R^2 values were computed using the AMOS program and Cohen's f^2 values were calculated using the formula ($f^2 = R^2 / 1 - R^2$). According to Cohen (1992) a value $\leq .02$ is small effect size, a value closer to .15 is moderate effect size, and a value $\geq .35$ is a large effect size. The model indicated large effect size for deep learning strategies (.56) ($R^2 = .35$), and medium effect size for mastery goals (.23) ($R^2 = .19$), for the achievement (.19) ($R^2 = .16$), and for surface learning strategies (.19) ($R^2 = .16$). However, the model indicated small effect size for performance-approach goals (.06) ($R^2 = .06$), and performance-avoidance goals (.06) ($R^2 = .06$).

6.4 Research Questions and Hypothesis Testing

The research questions were as follows:

1. Are higher secondary students' beliefs about mathematical ability related to their mathematics achievement, as mediated by achievement goals and learning strategies?
2. What are the beneficial and non-beneficial pathways in the mediational model?
3. What are the possible alternative models for the sample studied?

To answer questions 1 and 2, all nine research hypotheses ($H_{1.1}$ to $H_{1.5}$, and $H_{2.1}$ to $H_{2.4}$) were investigated. Research question 3 is attended to in section 6.4: Alternative Model Testing.

Hypotheses $H_{1.5}$ and $H_{2.4}$ involved investigating the overall effects or the three-path joint mediated effects, and were tested using a biased-corrected bootstrapping method. To do this, in AMOS program, the alpha level was set at .05 and the bias-corrected confidence interval was set at 95%, with the number of bootstrap samples set at 5000, to generate biased-corrected confidence intervals (CI) (see Appendix G, Tables 17 to 18). However, the AMOS program does not generate output to test specific mediations. Therefore, the hypotheses (i.e., $H_{1.1}$ to $H_{1.4}$, and $H_{2.1}$ to $H_{2.3}$), which related to specific mediated effects, were not tested using this approach. An alternative method, a product-of-coefficient approach known as 'multivariate delta standard error' or in short, the 'multivariate delta' method for three-path mediated effect, was used instead of bootstrapping. The formula for the 'multivariate delta' (Taylor et al., 2008) was evaluated using the unstandardised regression coefficients (see Appendix J) for different paths and the associated standard error for those paths, generated in the AMOS output file. The steps that followed to evaluate the formulae to test the specific three-path mediated effects were manually calculated (see Appendices K to Q). The hypotheses ($H_{1.1}$ to $H_{1.4}$, and $H_{2.1}$ to $H_{2.3}$) were investigated using the above-mentioned method. The results of the analyses of the hypotheses testing are presented next.

6.4.1 Hypothesis 1.1

Incremental beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via mastery goals and deep-learning strategies (i.e., INCR->MASTERY->DEEP->RESULT).

The 95% CI did not contain zero ($\beta_1 \beta_2 \beta_3 = 1.354$, LCI = 0.248, UCI = 2.459) (see Appendix K, Table 22), which indicated a significant three-path mediation. More specifically, mastery goals and deep-learning strategies mediated the positive relationship between incremental beliefs and achievement. Thus, this hypothesis was supported. This meant that students' incremental beliefs about their mathematical ability had a positive relation with their achievement if they adopted mastery goals and used deep-learning strategies in their mathematics learning.

6.4.2 Hypothesis 1.2

Incremental beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via mastery goals and surface-learning strategies (i.e., INCR->MASTERY->SURFACE->RESULT).

The 95% CI contained zero ($\beta_1 \beta_2 \beta_3 = 0.091$, LCI = -0.248, UCI = .430) (see Appendix L, Table 23), which indicated no significant three-path mediation, meaning this hypothesis was not supported. This means that when students held incremental beliefs about their mathematical ability, it had no significant relation with their mathematics achievement when they adopted mastery goals and used surface-learning strategies in their mathematics learning.

6.4.3 Hypothesis 1.3

Incremental beliefs about mathematical ability will have an indirect positive relation with mathematics achievement, mediated via performance-approach goals and deep-learning strategies (i.e., INCR->APPROACH->DEEP->RESULT).

The 95% CI contained zero ($\beta_1 \beta_2 \beta_3 = 0.123$, LCI = -0.118, UCI = 0.363) (see Appendix M, Table 24), which indicated no significant three-path mediation. Thus, this hypothesis was not supported. This means that when students held incremental beliefs about their mathematical ability, it had no significant relation with their mathematics

achievement when they adopted performance-approach goals and used surface-learning strategies in their mathematics learning.

6.4.4 Hypothesis 1.4

Incremental beliefs about mathematical ability will have an indirect (positive or negative) relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., INCR->APPROACH->SURFACE->RESULT).

The 95% CI did not contain zero ($\beta_1 \beta_2 \beta_3 = -.46$, LCI = -0.86, UCI = -0.05) (see Appendix N, Table 25), which indicated a significant three-path mediation. That is, performance-approach goals and surface-learning strategies mediated the negative relationship between incremental beliefs and mathematics achievement. Thus, this hypothesis was supported. This means that, when students held incremental beliefs about their mathematical ability, these beliefs had a positive relation with their mathematics achievement when the students adopted performance-approach goals and used surface-learning strategies in learning mathematics.

6.4.5 Hypothesis 1.5

Incremental beliefs about mathematical ability will have an overall positive indirect relation with mathematics achievement.

The 95% CI did not contain zero ($\beta = 0.054$, LCI = 0.002, UCI = 0.125), with $p < .05$ (see Appendix F, Tables 15 and 16; also Appendix G, Tables 17 and 18), which indicated significant mediations. The results indicate that there was an overall indirect positive relation of incremental beliefs with mathematics achievement. Therefore, this hypothesis was supported. Overall, this meant that when students held incremental beliefs about their mathematical ability, these beliefs were negatively associated with their mathematics achievement.

6.4.6 Hypothesis 2.1

Entity beliefs about mathematical ability will have a negative indirect relation with mathematics achievement, mediated via performance-approach goals and deep-learning strategies (i.e., ENTITY->APPROACH->DEEP->RESULT).

The 95% CI contained zero ($\beta_1 \beta_2 \beta_3 = 0.04$, LCI = -0.07, UCI = 0.15) (see Appendix O, Table 26), which indicated no significant three-path mediation, meaning this hypothesis was not supported. This means that when students held entity beliefs about mathematical ability, these beliefs did not relate with their mathematics achievement when they adopted performance-approach goals and used deep-learning strategies in mathematics learning.

6.4.7 Hypothesis 2.2

Entity beliefs about mathematical ability will have a negative indirect relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., ENTITY->APPROACH->SURFACE->RESULT).

The 95% CI contained zero ($\beta_1 \beta_2 \beta_3 = -0.15$, LCI = -0.45, UCI = 0.15) (see Appendix P, Table 27), which indicated no significant three-path mediation. Thus, this hypothesis was not supported. This means that when students held entity beliefs about mathematical ability, these beliefs did not have significant relation with their mathematics achievement when they adopted performance-approach goals and used surface-learning strategies in mathematics learning.

6.4.8 Hypothesis 2.3

Entity beliefs about mathematical ability will have negative indirect relation with mathematics achievement, mediated via performance-avoidance goals and surface-learning strategies (i.e., ENTITY->AVOID->SURFACE->RESULT).

The 95% CI did not contain zero ($\beta_1 \beta_2 \beta_3 = -0.49$, LCI = -0.90, UCI = -0.08) (see Appendix Q, Table 28), which indicated significant three-path mediation. Therefore, performance-avoidance goals and surface-learning strategies mediated the negative relationship between entity beliefs and achievement. Thus, this hypothesis was supported, meaning that when students held entity beliefs about mathematical ability, these beliefs were negatively related to mathematics achievement when they adopted performance-avoidance goals and used surface-learning strategies in mathematics learning.

6.4.9 Hypothesis 2.4

Entity beliefs about mathematical ability will have an overall indirect negative relation with mathematics achievement.

The 95% CI did not contain zero ($\beta = -0.029$, LCI = -0.064, UCI = -0.009), with $p < .05$ (see Appendix F, Tables 15 and 16; also Appendix G, Tables 17 and 18), which indicated significant mediations. The results show an overall negative indirect relation of incremental beliefs with mathematics achievement. Therefore, this hypothesis was supported. Overall, this means that fixed beliefs about mathematical ability had a negative indirect relation with mathematics achievement.

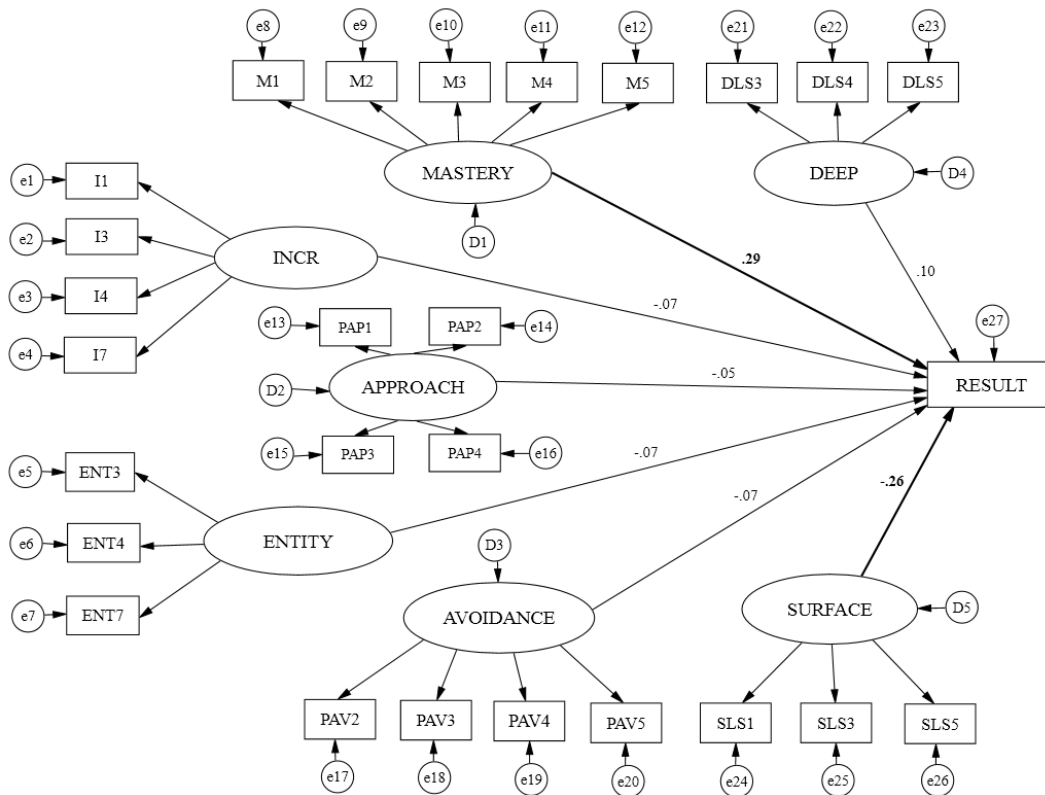
6.5 Testing Alternative Models

Alternative models provide information about the data using a different formulation of the variables used in the original model (Kaya, 2007). An alternative model is important when there are parameter estimates that are not meaningful and difficult to interpret, and when the proposed model is not parsimonious enough (Kaya, 2007; Kline, 2005; MacCallum, Wegener, Uchino, & Fabrigar, 1993). Therefore, a more parsimonious and a better fitting alternative model with meaningful parameter estimates is a better representation of the hypothesised relationships among the variables studied. Thus, possible alternative models are used to identify the need to hypothesize mediational relationships in the original model, and at the same time to explore the limitations of the original model tested in the present study.

6.5.1 Alternative Model 1

An alternative model (Alternative model 1) was tested by regressing the 7 factors onto achievement to examine if the factors have direct relations with the achievement. The Figure 15 below represents these relations. According to this model, the direct relation of incremental beliefs, entity beliefs, mastery goals, performance-approach goals, performance-avoidance goals with achievement should not be expected from the model in order to have the mediational model in Figure 10. Only the relation between mastery goals and achievement is statistically significant ($\beta = 0.29$, $p < .05$).

Figure 14: *Alternative model 1: Beliefs, goals, strategies, and achievement*



Note: I1, I3, I4, and I7 are the observed variables representing incremental beliefs (INCR); ENT3, ENT4, and ENT7 are the observed variables representing entity beliefs (ENTITY); M1 to M5 are the observed variables representing mastery goals (MASTERY); PAP1, PAP3, PAP4, and PAP are the observed variables representing performance-approach goals (APPROACH); PAV2, PAV3, PAV4, and PAV5 are the items representing performance-avoidance goals (AVOID); DSL3 to DSL5 are the observed variables representing deep learning strategies(DEEP); SLS1, SLS3, and SLS5 are the observed variables representing surface learning strategies(Surface); D1 is the disturbance variable (errors) associated with the construct, MASTERY; D1 is the disturbance variable (errors) associated with the construct, MASTERY; D2 is the disturbance variable (errors) associated with the construct, APPROACH; D3 is the disturbance variable (errors) associated with the construct, AVOID; D4 is the disturbance variable (errors) associated with the construct, DEEP; D3 is the disturbance variable (errors) associated with the construct, SURFACE; e1 to e27 are the errors associated with the observed variables.

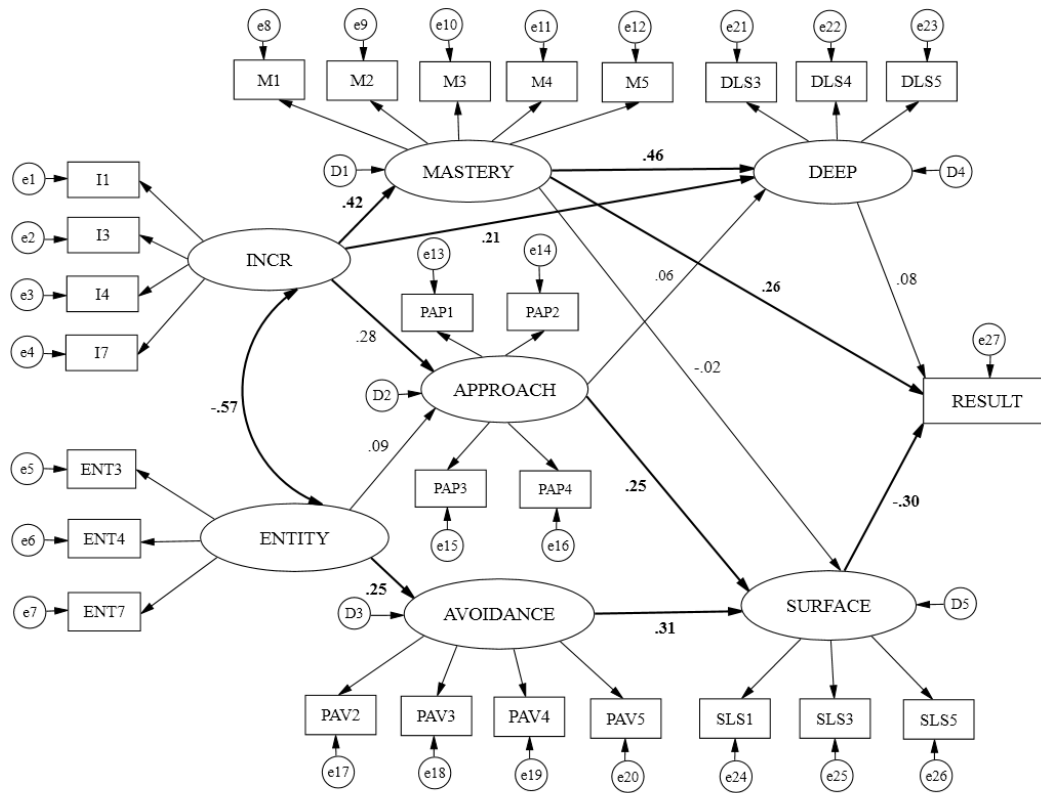
The structural paths in bold are significant at $p < 0.05$

Additionally, the model has a reasonably poor fit to the data (CFI = 0.89, TLI = 0.86, RMSEA = .07 (with 90% CI lower bound = 0.06 and upper bound = 0.07), SRMR = 1.42, $\chi^2(317) = 792.12$, $p = .000$, CMIN/DF = 2.49). Furthermore, the modification indices (MI) and the associated expected parameter change (EPC) values (labelled as “Par Change” in AMOS) specified for each parameter were checked. The modification indices indicate the value of χ^2 statistics with one degree of freedom (Jöreskog & Sörborm, 1993). In other words, MI represents the expected drop in overall χ^2 for each parameter specified in the model, if the parameter were to be estimated in the subsequent run (Byrne, 2010). The MI suggested that many links should have been there in the model in order to have a good model fit. This included the relation between incremental beliefs and mastery goals (INCR->MASTERY; MI=38.67, Par Change = 8.47), incremental beliefs and performance-approach goals (INCR->APPROACH; MI= 9.91, Par Change = 4.17), entity beliefs and performance-avoidance goals (ENTITY->AVOID; MI =15.49, Par Change = .37), mastery goals and deep learning strategies (MASTERY->DEEP; MI = 68.29, Par Change = 4.17), performance-approach goals and surface learning strategies (APPROACH->SURFACE; MI=27.22, Par Change = 4.17), performance-avoidance goals and surface learning strategies (AVOID->SURFACE; MI = 35.65, Par Change = 0.51). Thus, it is obvious that there is a need for the two-path mediational model tested in the present study.

6.5.2 Alternative Model 2

The original hypothesised model (see Figure 12) had an adequate fit. MI suggested correlating the disturbing variable of mastery goals (D1) and the disturbing variable of performance-approach goals (D2) (MI = 16.37, Par Change = 97.74), and D2 with the disturbing variable of performance-avoidance goals (D3) (MI = 44.06, Par Change = 162.48). However, these changes were not substantially meaningful. Additionally, the MI (MI = 6.26, Par Change = .14) suggested there should be a link from mastery goals to achievement (MASTERY -> RESULT) indicating a meaningful relationship. Similarly, another meaningful relation that suggested linking incremental beliefs and deep learning strategies (INCR->DEEP) was indicated from MI (MI= 6.13, Par Change = 1.93).

Figure 15: Alternative model 2: Beliefs, goals, strategies, and achievement



Note: I1, I3, I4, and I7 are the observed variables representing incremental beliefs (INCR); ENT3, ENT4, and ENT7 are the observed variables representing entity beliefs (ENTITY); M1 to M5 are the observed variables representing mastery goals (MASTERY); PAP1, PAP3, PAP4, and PAP are the observed variables representing performance-approach goals (APPROACH); PAV2, PAV3, PAV4, and PAV5 are the items representing performance-avoidance goals (AVOID); DSL3 to DSL5 are the observed variables representing deep learning strategies(DEEP); SLS1, SLS3, and SLS5 are the observed variables representing surface learning strategies(Surface); D1 is the disturbance variable (errors) associated with the construct, MASTERY; D1 is the disturbance variable (errors) associated with the construct, MASTERY; D2 is the disturbance variable (errors) associated with the construct, APPROACH; D3 is the disturbance variable (errors) associated with the construct, AVOID; D4 is the disturbance variable (errors) associated with the construct, DEEP; D3 is the disturbance variable (errors) associated with the construct, SURFACE; e1 to e27 are the errors associated with the observed variables.

The structural paths in bold are significant at $p < 0.05$

The original fit of the model was adequate (CFI = .93, TLI = .92, RMSEA = .05 (with 90% CI lower bound = 0.05 and upper bound = 0.06), SRMR = 0.09, $\chi^2(313) = 600.23$, $p = .000$, CMIN/DF = 1.92). Thus, adding the two direct links in accordance with the modification indices noticeably improved the SRMR value from .09 to .08, and the overall model fit (CFI = 0.93, TLI = 0.92, RMSEA = 0.05 (with 90% CI lower bound = .04 and upper bound = .06), SRMR = .09, $\chi^2(315) = 590.70$, $p = .00$, CMIN/DF = 1.89). Therefore, these changes were accepted as such changes were substantially meaningful according to the literature. In addition to these changes, the factor correlation table (in Figure 12) showed a number of significant correlations among the 7 factors that were not tested in the original model. For example, the link from INCR to ENTITY, ENTITY to MASTERY, ENTITY to DEEP and AVOIDACE to DEEP were shown from the table. However, none of these significant correlations constituted additional significant path in the original model. Hence, no other paths were included, and the alternative model 2 gave a better representation of the mediating relationships among the variables measured.

The alternative model 2 with all the paths, along with their corresponding standardised path coefficients, is presented in Figure 15. To analyse the impact of these changes to the mediating pathways in the modified model, the parameter estimates, and the extension of Sobel's (1982) formula for a single mediator relationship, formulated by Taylor et al. (2008) to address three-path mediational models can be used. However, before using Taylor et al. (2008) to test the three-path mediations, few changes were seen in this model when compared to that of the original model. These include the significant relation between incremental beliefs and deep learning strategies ($\beta = 0.21$, $p < .05$), and mastery goals and mathematics achievement ($\beta = 0.26$, $p < .05$). In addition to these significant additional relations that were seen here, the relation between deep learning strategies and achievement was found to be statistically non-significant ($\beta = 0.08$, $p > .05$). Furthermore, mastery goals mediated the positive relation between incremental beliefs and mathematics achievement. The hypotheses (H_{1.1} to H_{1.5}, and H_{2.1} to H_{2.4}) that were tested for the original model were also tested for the alternative model 1 to compare the results of both.

The results of these hypotheses for the alternative model 1 were found to be same as that of the results of for the original model, except for one hypothesis (i.e., H_{1.1}). The hypothesis (H_{1.1}) that beliefs about mathematical ability were related to

mathematics achievement mediated through mastery goals, and deep learning strategies was not supported for the alternative model.

6.6 Summary

In conclusion, the results indicated three main points. First, three significant mediational pathways emerged from the model tested. One mediational pathway indicated a positive relation with mathematics achievement, whereas two mediational pathways indicated negative relation with mathematics achievement. More specifically: 1) incremental beliefs were positively related to mathematical achievement, mediated through mastery goals and deep-learning strategies; 2) incremental beliefs were negatively related to mathematical achievement, mediated through performance-approach goals and surface-learning strategies; and 3) entity beliefs were negatively related mathematics achievement, mediated through performance-avoidance goals and surface-learning strategies. Second, incremental beliefs had an overall positive, and entity beliefs had an overall negative relation with mathematics achievement. Third, the alternative models tested suggested the need for the mediational relationships, and limitations of the hypothesised mediational model in the present study. The alternative model 2 showed some differences with the original model as far as the significant relationships among the variables were concerned. However, there was not much difference in their model fit, indicating that both of the models were acceptable.

CHAPTER 7: DISCUSSION

7.1 Introduction

This chapter is divided into eight main sections. The first section introduces the chapter. The second discusses the general findings of the present study, including the results of the preliminary analysis. In the third section, research questions along with the research hypotheses are discussed. The fourth section discusses the results of the alternative models tested. The fifth section outlines the limitations of the study. The sixth section outlines the theoretical and practical implications of the study's findings. The seventh section suggests directions for future search. The chapter concludes with the main conclusions drawn from the present study.

7.2 General Findings

The main objective of this study was to test a mediational model of mathematics achievement. To do this, I investigated whether higher secondary students' beliefs about mathematical ability were related to their mathematics achievement, mediated through achievement goals, and the use of learning strategies. The present study had two specific objectives: (1) to test the specific mediational pathways hypothesised in the mediational model by investigating whether goal orientation and learning strategies mediated this relationship; and (2) to test the overall indirect relation of implicit beliefs of mathematical ability on mathematics achievement.

To address these research questions, I adapted previously developed instruments to measure students' beliefs about mathematical ability, their achievement goals and learning strategies. The confirmatory factor analysis suggested that each item retained in the subscales that measured students' beliefs about mathematical ability, achievement goals, and learning strategies had good factor loadings ranging from .63 to .88. The associated composite reliability estimates for the latent variables were high (.76 to .86) (Hair et al., 2006), which indicated that they adequately represented their respective underlying latent variables in the structural model. Furthermore, the results of the preliminary analysis demonstrated that for all the constructs, the convergent and discriminant validity was adequate. These findings showed that the questionnaires items used to measure beliefs about mathematical ability, goal orientations, and

learning strategies were reliable and valid instruments, and therefore thus, appropriate for use in the present study. However, deleting the items in general and deleting the items specifically with factor loading closer to the acceptable factor loading (.6) could have eliminated useful items from the analysis. This deletion in particular has changed deep-learning into practice strategies, and surface-learning strategies into memorisation technique. However, to maintain the consistency of the terms used in the discussion, surface and deep strategies have been used in general, although 'practice' and 'memorisation' have also been used in certain places for further explanations of the strategies.

When examining the mediational relationships among the variables in the model (i.e., beliefs -> goals -> strategies -> achievement) this study initially tested the direct relationships between variables. The first relationship tested in the mediational model was the relationship between beliefs about mathematical ability and achievement goals (beliefs -> goals). Incremental beliefs were positively related to both mastery and performance-approach goals, while entity beliefs were positively related to predicted performance-avoidance goals. These findings generally supported Dweck's (1986; Dweck & Leggett, 1988) motivation model, in which implicit theories of intelligence and goal orientations are related. These findings are also consistent with research that has been conducted in a performance-oriented learning environment (e.g., Shih, 2007) about the relationship between implicit theories of intelligence and achievement goals.

The second relationship tested in the mediational model was the relationship between goals and learning strategies (goals -> strategies). Findings were consistent with previous research. For example, the relationship between mastery goals and deep-learning strategies was positive and consistent with findings from a number of studies (e.g., Al-Emadi, 2001; Chan & Lai, 2006; Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008). Similarly, the relationship between performance-approach goals and surface-learning strategies was positive and consistent with finding from these same studies, with the exception of Liem et al. (2008) and Al-Emadi(2001). The present study did not show a significant relationship between performance-approach goals and deep-learning strategies, a finding which is inconsistent with Liem et al. (2008), which was on 9th grade students while the present study focussed on 12th graders. This indicates that Maldivian higher secondary students who compete to outperform their peers do not

necessarily use deep-learning strategies; instead they use surface-learning strategies in mathematics. Additionally, as expected, the results showed that performance-avoidance goals positively predicted surface-learning strategies. This is consistent with the same studies mentioned above with the exception Vrugt and Oort (2008), who found no relationship between performance-avoidance goals and either deep or surface-learning strategies.

The third relationship tested in the mediational model was between learning strategies and mathematics achievement (strategies → achievement). The present findings were consistent with previous research (Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008). As predicted, deep-learning strategies positively predicted mathematics achievement, a finding that was consistent with Liem et al. (2008) and Simons et al. (2004), while surface processing negatively predicted achievement, a finding that was consistent with Liem et al. (2008), Simons et al. (2004), and Vrugt and Oort (2008). In contrast, this finding was inconsistent with Al-Emadi (2001), who found that surface processing had a positive effect on mathematics achievement, while deep processing had no effect.

The present study failed to replicate three findings from previous research. First, the relationship between entity beliefs and performance-approach goals was not significant. This indicated that students who viewed their mathematical ability as fixed and stable did not seek to demonstrate their competence or compete with their peers. Second, the relationship between mastery goals and surface-learning strategies was non-significant, and third, the relationship between performance-approach goals and deep-learning strategies was also non-significant. This indicated that students who competed with their friends did not report using deep-learning strategies when they learned mathematics. Instead, they used surface-learning strategies, which had a negative effect on their achievement. Furthermore, students who were mastery-oriented tended not to use surface-learning strategies, but instead reported using deep-learning strategies.

Moreover, memorisation and repetitive learning technique used in the Maldivian culture did not have a beneficial outcome for higher secondary students in learning mathematics. However, Marton, Alba and Kun (1996) indicated that there are two types of memorisation: memorisation with understanding and mechanical memorisation. They emphasized that students could perform well by using memorisation with

understanding. While Maldivian students have been widely using memorisation technique in learning the Quran and other text related materials, and as a form of learning approach, it is essential to extend the use of memorisation technique to memorisation with understanding. Thus, emphasizing memorisation with understanding and practice-oriented learning could further potentially improve the achievement of students. In the performance-oriented and high-stakes testing environment, the students used both deep and surface-learning to prepare for examinations, when performance-approach orientations showed positive relation with surface-learning strategies (i.e., memorisation). However, the results indicated that in a performance-oriented learning environment such as the Maldives, no relation between performance-approach orientations and deep-learning strategies (i.e., practice-oriented learning) was found. Thus, to further improve students' achievement in a performance-oriented environment, the study highlights the importance, albeit indirect, of establishing a positive relation between performance-approach goals and deep-learning (e.g., Liem et al., 2008), and between surface-learning (i.e., memorisation) and achievement. It is also believed that by identifying performance-approach oriented students and teaching them how to use deep-learning and use memorisation with understanding would help these students to perform well in their subjects. Marton et al. (1996) highlighted those students who use memorisation technique could perform better in their level of achievement than students who do not, if they could use memorisation with understanding.

Additionally, Cohen (1992) effect sizes calculated for the endogenous variables in the present study indicated a large effect size for deep learning strategies (.56), and a medium effect size for mastery goals (.23), for the achievement (.19), and for surface-learning strategies (.19). However, the model indicated a small effect size for performance-approach goals (.06) and performance-avoidance goals (.06). According to Cohen (1992) an effect size more than .15 indicates medium effect size. The relatively small effect size for the performance-approach and performance-avoidance indicated large variance that had not been explained in the model, which indicates that there are other variables not included in the model that could explain performance-approach and performance-avoidance goals. Similarly, the effect sizes for mastery goals, surface learning strategies, and achievement were not large enough. As the effect size indicates the amount of variance over the unexpected variance, the whole mediational model of

the present study indicated 19% of the variance in the achievement over the variance that had not been explained by the model.

Alternatively, only 16% of the variance (i.e., R^2 values) in achievement was explained by the model and 84% was not explained by the model. This indicated that there were other variables which were not in the model that could explain mathematics achievement for higher secondary students in the Maldives.

7.3 Hypotheses Testing

In this section, I restate research questions and briefly address each question. Then I restate each hypothesis, indicate whether it was supported, and provide data from the analyses to justify the conclusion drawn about the respective hypotheses.

The first research question was: Are higher secondary students' beliefs about mathematical ability related to their mathematics achievement as mediated through achievement goals and learning strategies? Hypotheses 1.1 to 1.5 and 2.1 to 2.4 (see below) pertained to research question 1. In short, the answer was yes. The results indicated that higher secondary students' beliefs about mathematical ability were related to their mathematics achievement, mediated through achievement goals and learning strategies.

The second research question was: What are the beneficial and non-beneficial pathways in the mediational model? Hypotheses 1.1 to 1.5 and 2.1 to 2.4 also pertained to this question. One beneficial and two non-beneficial pathways were identified. The INCR->MASTERY->DEEP->RESULT pathway was beneficial effects for students, whereas the INCR->APPROACH->SURFACE->RESULT and the ENITITY->AVOID->SURFACE->RESULT pathways were non-beneficial. No other pathways in the mediational model showed significant three-path relationships.

The third research question was: What are the possible alternative models for the sample studied? Two alternative models were identified: one that showed the direct relation of the constructs with the achievement variable, and the other one showed the best three-path alternative model indicating that the relationships among higher secondary students' beliefs about mathematical ability achievement goals, learning strategies, and achievement.

7.3.1 Hypothesis 1.1

According to this hypothesis, incremental beliefs about mathematical ability have an indirect positive relation with mathematics achievement, mediated via mastery goals and deep processing strategies (i.e., INCR->MASTERY->DEEP->RESULT). This hypothesis was supported. The data indicated that when the students had incremental beliefs, endorsed a mastery goal orientation, and used deep-learning strategies, there was a positive effect on their mathematics achievement. Specifically, when students' believed that their mathematical ability could be developed with effort and hard work, they were motivated to learn mathematics, and indicated that they used deep-learning strategies, which in turn had a positive association with mathematics achievement. Previous research has shown that incremental beliefs predict mastery goals (Shih, 2007; Was, 2003), mastery goals were related to deep-learning strategies (Al-Emadi, 2001; Chan & Lai, 2006; Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008), and deep-learning strategies were related to achievement (Liem et al., 2008; Simons et al., 2004). Consistent with previous research on direct relationships, the present study supported the three-path mediational relationship, INCR->MASTERY->DEEP->RESULT for higher secondary mathematics students in the Maldives. Of all the specific mediations, this mediation, the relationship between incremental beliefs and mastery goals ($\beta = .43, p < .001$), and the relationship between mastery goals and deep-learning strategies ($\beta = .67, p < .001$), provided the strongest support for Dweck's (1986) model. Thus, despite the prevailing performance-oriented environment in educational settings in the Maldives, these higher secondary students focused on developing their competence with task mastery of the subject, which had a positive effect on their mathematics achievement.

7.3.2 Hypothesis 1.2

According to this hypothesis, incremental beliefs about mathematical ability have an indirect positive relation with mathematics achievement, mediated via mastery goals and surface-processing strategies (i.e., INCR->MASTERY->SURFACE->RESULT). This hypothesis was not supported. Research indicated that incremental beliefs were positively related to mastery goals (Shih, 2007; Was, 2003), mastery goals were negatively related to surface processing strategies (Chan & Lai, 2006; Simons et al.,

2004), and surface-learning strategies were negatively related to achievement (Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008). The hypothesis was not supported even though the above-mentioned direct relationships identified in previous research indicated the possibility of three-path mediated effects. One of the reasons could be that the direct relation of mastery goals with surface-learning strategies for the present study was not statistically significant ($\beta = -.03$, $p > .05$). This was inconsistent with Chan and Lai (2006) and Simons et al. (2004), who found that mastery goals were negatively related to surface-processing strategies. However, the relationship between incremental beliefs and mastery goals ($\beta = .43$, $p < .001$) was consistent with Shih (2007) and the relationship between surface-processing strategies and mathematics achievement was consistent with Liem et al. (2008), Simons et al. (2004), and Vrugt and Oort (2008) ($\beta = -.31$, $p < .001$), although inconsistent with Al-Emadi (2001). The result suggests that the indirect relation of incremental beliefs with higher secondary mathematics achievement, mediated through mastery goals and surface-learning strategies, was not significant. Thus, students' beliefs that their mathematical ability is incremental were not associated with their mathematics achievement when they adopted mastery goals along and surface-learning strategies when they studied mathematics. Therefore, there is no indication that by adopting mastery goals and surface-learning strategies would improve mathematics results, even if beliefs about mathematical ability are incremental.

7.3.3 Hypothesis 1.3

According to this hypothesis, incremental beliefs about mathematical ability have an indirect positive relation with mathematics achievement, mediated via performance-approach goals and deep learning strategies (i.e., INCR → APPROACH → DEEP → RESULT). This hypothesis was not supported. Previous research on the direct relationships in this pathway suggested that incremental beliefs were positively related to performance-approach goals (Shih, 2007), performance-approach goals were positively related to deep-learning strategies (Liem et al., 2008), and deep-learning strategies were positively related to achievement (Liem et al., 2008; Simons et al., 2004). However, the data from the present study did not support these relationships.

Additionally, the results of the direct effects for the present study showed that incremental beliefs had a direct positive relation with performance-approach goals ($\beta = .26, p < .001$), which was consistent with Shih (2007), and deep-learning strategies had a direct positive effect on mathematics achievement ($\beta = .27, p < .001$), consistent with Liem et al. (2008) and Simons et al. (2004). However, the direct relation with performance-approach goals on deep-learning strategies was not statistically significant. This finding is inconsistent with Liem et al. (2008), who found a direct relation of performance-approach goals with deep-learning strategies for students from non-western culture, studying English. I was unable to find a study that reported a significant direct relation with performance-approach goals and deep-learning strategies for students studying higher secondary mathematics.

These results indicated that students' incremental beliefs were not related to mathematics achievement if they adopted performance-approach goals and reported using deep-learning strategies in learning mathematics. Furthermore, despite the prevailing performance-oriented environment in educational settings in the Maldives, adoption of performance-approach goals did not were not associated with the use of deep-learning strategies in learning mathematics for higher secondary students. Thus, incremental beliefs did not benefit mathematics achievement when students chose to compete in the classroom and use deep-learning strategies in learning mathematics.

7.3.4 Hypothesis 1.4

According to this hypothesis, incremental beliefs about mathematical ability have a negative indirect relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., INCR->APPROACH->SURFACE->RESULT). This hypothesis was supported. When the students reported incremental beliefs, they also endorsed performance-approach goals, and used surface-learning strategies, which had a negative association with their mathematics achievement. Specifically, when students believed that their mathematical ability could be developed with effort and hard work, they were also motivated to compete among their peers and to use surface-learning strategies in mathematics, which in turn had a negative effect on their mathematics achievement.

Previous research has shown that incremental beliefs were positively related to performance-approach goals (e.g., Shih, 2007), performance-approach goals were positively related to surface-learning strategies (e.g., Al-Emadi, 2001; Chan & Lai, 2006; Simons et al., 2004; Vrugt & Oort, 2008), and surface-learning strategies negatively related to predict achievement (e.g., Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008). Consistent with previous research on direct relationships, the present study supported the three-path mediational relationship, INCR->APPROACH->SURFACE->RESULT for higher secondary mathematics students in the Maldives. However, in this mediation, the relationship between incremental beliefs and performance-approach goals ($\beta = .29, p < .001$) was inconsistent with Dweck's (1986) model.

The results of this analysis indicated that student who believed that their mathematical ability is incremental adopted performance-approach goals, and that performance-approach goals had a negative association with their mathematics' achievement when they chose a surface-learning approach in learning mathematics. Thus, despite holding incremental beliefs, these students adopted performance-approach goals, which could be related to the prevailing performance-oriented environment in educational settings in the Maldives, and they reported using surface-learning strategies, which did not promote mathematics achievement.

7.3.5 Hypothesis 1.5

According to this hypothesis, incremental beliefs about mathematical ability have an overall positive relationship with mathematics achievement. This hypothesis was supported. According to the mediational model, the overall relationship was mediated through, mastery goals, performance-approach goals, deep-learning strategies, and surface-learning strategies. It was found from that the specific relation between incremental beliefs and mathematics achievement mediated through mastery goals and deep-learning strategies was positive (see H 1.1), and the relation between incremental beliefs and mathematics achievement, mediated through performance-approach goals and surface-learning strategies was negative (see H 1.4). However, this hypothesis indicates that the overall indirect relation of incremental beliefs with mathematics achievement is positive. Thus, when students develop their incremental view of intelligence in mathematics context, indirectly, their mathematics results improve.

7.3.6 Summary

These results indicated that incremental beliefs had a positive relation with mathematics achievement, mediated through mastery goals and deep-learning strategies, whereas incremental beliefs had a negative effect on mathematics achievement, mediated through performance-approach goals and surface-learning strategies. These results also indicated that incremental beliefs had an overall positive relation with mathematics achievement. When students believed that mathematical ability is incremental, this belief had a positive and beneficial effect on their mathematics achievement. This relationship remained even when students adopted performance-approach goals and used surface-learning strategies, when they adopted mastery goals and used deep-learning strategies, or both. Thus, incremental beliefs had a positive and beneficial effect on mathematics achievement for higher secondary students in the Maldives.

7.3.7 Hypothesis 2.1

According to this hypothesis, entity beliefs about mathematical ability have an indirect negative relation with achievement, mediated via performance-approach goals and deep-learning strategies (i.e., ENTITY->APPROACH->DEEP->RESULT). This hypothesis was not supported. Previous research on the direct relationships in this pathway indicated that entity beliefs were positively related to performance-approach goals (Cury et al., 2006), performance-approach goals were positively related to deep learning (Liem et al., 2008), and deep-learning strategies were positively related to achievement (Liem et al., 2008; Simons et al., 2004). One of the reasons this hypothesis was posited for the present study is to the fact that Maldives learning environment is highly performance-oriented, and the students at the same time put lot of effort to pass and score good marks from the high-stake-testing environment. Therefore, it was believed that students who competed to outperform others would also put effort in their studies and learn deeply to score good marks in the examinations. However, in the present study, neither the direct relationship between performance-approach goals and deep-learning strategies ($\beta = .08$, $p > .05$), nor the indirect relationship between entity beliefs and mathematics achievement, mediated through performance-approach goals and deep-learning strategies was statistically significant.

The results of this analysis indicated that performance-approach goals and deep-learning strategies did not mediate the relationship between entity beliefs about mathematical ability and mathematics achievement for higher secondary students in the Maldives. Thus, entity beliefs had neither a beneficial nor detrimental effect on mathematics achievement when students adopted performance-approach goals and used deep-learning strategies in mathematics.

7.3.8 Hypothesis 2.2

According to this hypothesis, entity beliefs about mathematical ability have an indirect negative relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., ENTITY->APPROACH->SURFACE->RESULT). This hypothesis was not supported. Previous research on the direct relationships among these variables indicated that entity beliefs were positively predict performance-approach goals (Cury et al., 2006), performance-approach goals were positively related to surface-learning strategies (Al-Emadi, 2001; Chan & Lai, 2006; Simons et al., 2004; Vrugt & Oort, 2008), and surface-learning strategies were negatively related to achievement (Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008). However, the relationship between entity beliefs and performance-approach goals was not significant in the present study ($\beta = .09$, $p > .05$), and inconsistent with Dweck's (1986) postulates on the relation between theories of intelligence and goal orientations. Cury et al. (2006) who found consistency with Dweck's model was on lower secondary grade students between the of 12-14 years, while the present study focussed on students of higher secondary education at an average age of 19.0 years. While the relation between performance-approach goals and achievement was statistically significant, mediated through surface-learning strategies, this hypothesis would have supported had the relation between entity beliefs and performance-approach goals was significant.

The results of this analysis indicated that performance-approach goals and surface-learning strategies did not mediate the relationship between entity beliefs about mathematical ability and mathematics achievement for higher secondary students in the Maldives. Thus, entity beliefs had neither detrimental nor beneficial association with the achievement when students competed with their peers and chose surface-learning strategies in learning mathematics.

7.3.9 Hypothesis 2.3

According to this hypothesis, entity beliefs about mathematical ability have an indirect negative relation with mathematics achievement, mediated via performance-approach goals and surface-learning strategies (i.e., ENTITY->AVOID->SURFACE->RESULT). This hypothesis was supported. When the students had entity beliefs, endorsed a performance-avoidance goal orientation, and used surface-learning strategies were negatively related to their mathematics achievement. Specifically, when students' believed that their mathematical ability was fixed, they aimed to avoid looking incompetent among their peers, and used surface-learning strategies, which in turn had a negative association with mathematics achievement. This is consistent with previous research on the direct relationships among these variables which has shown relationships between entity beliefs and performance-avoidance goals (Cury et al., 2006; Shih, 2007), performance-avoidance goals and surface-learning strategies (Al-Emadi, 2001; Chan & Lai, 2006; Liem et al., 2008; Simons et al., 2004), and surface-learning strategies and achievement (Liem et al., 2008; Simons et al., 2004; Vrugt & Oort, 2008). Furthermore, these findings were consistent with Dweck's (1986) model. Thus, students' beliefs that mathematical ability is fixed had a non-beneficial association with higher secondary students' mathematics achievement in the Maldives, when they tried to avoid being viewed as less competent among their peers and used surface-learning strategies in learning mathematics.

7.3.10 Hypothesis 2.4

According to this hypothesis, entity beliefs about mathematical ability have an overall indirect negative relation with mathematics achievement. It was found that from the hypothesis 2.3 that the relation of entity beliefs with the achievement was negative, and no other specific pathway that showed the relation between entity beliefs and achievement showed positive or negative statistical significance. Thus, while incremental beliefs had overall negative association with achievement, entity beliefs about mathematical ability had overall negative association with the achievement. In other words, when a student believed that mathematical ability was fixed, he/she tried to avoid looking less competent than their peers, and used surface-learning approaches,

which in turn had a negative association with the results. Thus, entity beliefs provided negative and non-beneficial outcomes for higher secondary students in the Maldives.

7.3.11 Summary

These data addressed research questions 1 and 2. In general, these results showed that the higher secondary students' beliefs about mathematical ability were related to their mathematics achievement, as mediated through achievement goals and learning strategies. The data also showed the mediational pathways through which students' beliefs about their mathematical ability effected their achievement. In addition, they showed the mediational pathways that were adaptive and beneficial for students' achievement, as well as pathways that were detrimental or had no association with the achievement.

7.4 Discussion on the Results of Alternative models

The third research question was: What are the possible alternative models for the sample studied? Two alternative models were identified and tested along with the original mediational model for of the present study. First alternative model (alternative model 1) was identified by regressing all the 7 latent constructs on to mathematics achievement. This model was tested to see the direct relations of the 7 constructs with the achievement variable without having any other links in the model. The results of the alternative model 1 indicated that there was a need for mediational mode tested in the present study. For instance, in the alternative model 1 the direct relation between incremental beliefs and achievement ($\beta = -.07, p > .05$), entity beliefs and achievement ($\beta = -.07, p > .05$), were non-significant, indicating that there could have had indirect relations in the model. Furthermore, the direct relation between performance-approach goals and achievement ($\beta = -.05, p > .05$), performance-avoidance goals and achievement ($\beta = -.07, p < .05$), were non-significant too. This is an indication that these goals could have had indirect relations with the achievement mediated through learning strategies, and the original model tested indicated such mediations. However, there was a significant direct relation demonstrated between mastery goals and achievement ($\beta = .29, p < .05$), while the relation between deep-learning strategies and achievement ($\beta = .10, p > .05$) was non-significant. This in turn questions the indirect relation between incremental beliefs and the achievement in the original model, which was mediated

through mastery goals and deep-learning strategies. Somehow, the fit of the alternative model was very poor and the modification indices suggested that adding many paths in the model would improve the fit. Most of these paths (e.g., INCR->MASTERY, INCR->APPROACH, ENTITIY->AVOID, MASTERY->DEEP, APPROACH->SURFACE, and AVOID->SURFACE) suggested by MI were hypothesised paths that were tested in the original model. This indicates that there was a desperate need to have the above-mentioned paths in the model and a mediational model constituting mediational relationships among the variables studied.

The second alternative model (alternative model 2) was identified by doing post-hoc modifications to the original model. Based on the MI reported from the original model, two new significant relationships emerged: the direct positive relation between incremental beliefs and deep-learning strategies ($\beta = .08, p > .05$), and the direct positive relation between mastery goals and achievement ($\beta = .08, p > .05$). However, establishing these relationships in the model suppressed the direct relationship between deep-learning strategies and achievement ($\beta = .08, p > .05$). Elliot et al. (1999) found a significant positive relation between deep strategies and achievement, while Bandalos et al (2003) did not find a significant positive relation between them. A possible explanation for the non-significant relation between deep learning strategies and achievement in the alternative model 2 could be the way the strategies items had been measured or interpreted by the respondents. On the other hand, Mittal (2011) who did a study with high school students found that mastery goals were directly related to academic achievement, while performance-approach and performance-avoidance goals were not directly related to the achievement. On the other hand, Chan and Lai (2006) did not find a significant relation between deep-learning strategies and achievement.

For the alternative model 2, the direct relation between mastery goals and achievement is significant and stronger than the direct non-significant relation between deep-learning strategies and mathematics achievement. Hence, the relation between incremental beliefs and achievement was not mediated through mastery goal and deep-learning strategies. However, the post-hoc modifications did not affect two specific mediations: (1) the negative relation between incremental beliefs achievement via performance-approach goals and surface-learning strategies; and (2) the negative relation between entity beliefs and achievement via performance-avoidance goals and

surface-learning strategies. The alternative model 2 seemed to suggest that on the incremental side there was no full support, but a partial support for three-path mediation, and on the entity side there was support for three-path mediation

Furthermore, the significant direct relation between incremental beliefs about mathematical ability and deep-learning strategies was an interesting relation emerged. The former relation for the Alternative model 2, extends Dweck's (1986) model, to indicate the direct relation of the theories of intelligence with learning strategies, along with postulated relation between theories of intelligence and goal orientations. Additionally, both the original model and the alternative model 2 indicated a significant relation between incremental beliefs and performance-approach, which further built-up the Dweck's (1986) model. The results of the alternative model 2 indicated that it was a better model than the original one in term of the model fit. Therefore, for the context of Maldives, the alternative model 2 is a better representation of the relationships among the variables studied. Furthermore, the results of the original model and the alternative model 2 showed some differences in the relations among variables, and differences in significance of the pathways demonstrated in the two models, which could be attended to in future research to find possible explanations for these differences.

7.5 Limitations of the Study

There were several limitations to the present study. First, this study was based on self-report data that were collected with questionnaires, which are open to measurement error. Students interpreted the questionnaire items and responded to the respective items. It is possible that students did not interpret the items in the way the researcher intended (Urdan & Mestas, 2006). Also, classroom teaching practices differ for each classroom and so do students' social interactions, which in turn affect students' beliefs, achievement goals and their choice of learning. Furthermore, it is possible that there were inconsistencies between what the students reported and what they actually believed. Nonetheless, the possibility of measurement error exists whenever researchers use questionnaires to collect data, and can be caused by response styles, specifically acquiescence, disacquiescence, extreme response, response range, midpoint responding, and noncontingent responding (Baumgartner & Steenkamp, 2001; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). SEM techniques account for

measurement errors when measuring the construct, but the technique cannot completely eliminate them.

Second, the study was conducted in a single school that accounted for less than 52% of higher secondary population in the Maldives (Ministry of Education, 2009). Thus, it is not possible to generalise these findings to all students in the Maldives, or to students in general. However, given that this was the first study of this nature conducted in the Maldives, it provides a basis for conducting future research.

Third, much like other statistical methods, SEM is not without criticism. It is a model-testing procedure rather than model-building one, and hence the results of the analysis can only support or refute the hypothesised model (Stage et al., 2004). Furthermore, structural model of the SEM technique can only show certain relationships, but it cannot prove causality nor can it establish the absolute direction of the relationships (Stage et al., 2004). Therefore, any causal inference made in any section in the thesis was done to elaborate on the links justified in the theoretical model, and it is highly possible to have reciprocal effects on the relations tested in the study.

Fourth, in the preliminary analyses of the investigation, the items with weak factor loadings (loadings < .60) were removed on one hand to give adequate convergent validity for all of the constructs. However, removing some useful items on the other hand might have had eliminated some valuable responses provided by the students, which in turn could have changed the nature of the latent variable and possibly had affected the relations among the variables measured. Consequently, the deep-learning construct was found to be measuring practice-oriented learning, and the surface-learning construct was found to be measuring memorisation technique.

Fifth, a product coefficient approach (e.g., multivariate delta variance estimator) was used to test the specific mediations hypothesised in the present study. The decision to use this approach was made because it was feasible to learn these advanced statistical procedures. Alternatively, a bootstrapping approach, with the help of the appropriate software with built-in SEM (e.g., Mplus) would have been a more effective approach for testing the specific mediations hypothesised in the present study, had this been available.

7.6 Theoretical and Practical Contributions

This study makes three theoretical contributions. First, this study provided qualified support for Dweck's model on the patterns of relationships among beliefs about mathematical ability and goal orientations, and support for achievement goal theory on the relation among goals, learning strategies, and achievement. Along with the support provided to Dweck's model and the achievement goal theory, this study specifically indicated the importance of investigating the relation among beliefs about mathematical ability, achievement goals, learning strategies, and achievement in single study. The literature review of the present study indicated most of the studies looked at the relationships among goals, strategies, and achievement, while other studies looked at the relation between implicit theories of intelligence and achievement goals, and only limited studies looked at the four constructs in one study. Additionally, to look at the relations among beliefs, goals, strategies, and achievement, the present study used actual achievement data from standardised tests, from more than a half of the higher secondary population of the country which was reliable and valid to use in the study, while most of the studies had achievement data from the coursework programs of university students.

Second, the present study indicated that Maldivian higher secondary students' beliefs about mathematical ability are associated with their mathematics performance, mediated through achievement goals, and their choice of learning strategies. Alternatively, this study has identified and explored the individual three-path mediational pathways that came from the idea that beliefs about mathematical ability are incremental or fixed, and found that these different beliefs were indirectly related to mathematical achievement for Maldivian students, mediated through specific goals and learning strategies. The study showed that when higher secondary students in the Maldives believed that mathematical ability could be developed with effort, these beliefs had an indirect, beneficial association with students' mathematical achievement. In contrast, when the students believed their mathematical ability was fixed, it had an indirect, non-beneficial association with the achievement. This study indicated that holding entity beliefs about mathematical ability and adopting performance-avoidance goals has a detrimental association with mathematics achievement, as the students in this situation used less effective approaches, such as surface-learning strategies (e.g., Chan & Lai, 2006; Simons et al., 2004; Vrugt & Oort, 2008). However, the results showed

that only one pathway was beneficial for these students in the Maldives. When these students believed that their mathematical ability could be developed with effort, adopted mastery goals, and used deep-learning strategies, it was positively associated with mathematics achievement.

Third, despite the prevailing performance-oriented environment in educational settings in the Maldives, this study showed that competition in academic environments is not beneficial for promoting students' motivation, or their performance in the subject. Rather, it would be more beneficial to develop the competence with mastery-oriented tasks and to promote deep-learning strategies to improve students' achievement.

The study also makes three main practical contributions. First, it has provided reliable and valid instruments in the context of the Maldives with the translation to the Maldivian local language, to measure implicit theories of mathematical ability, trichotomous goals, and learning strategies in the mathematical domain. These instruments could be used to conduct similar studies in mathematics, and could be easily adapted for studies in disciplines other than mathematics education. Second, programs or workshops could be conducted for higher secondary students to cultivate an incremental view of intelligence and ability. One such possibility would be to implement 'Brainology®', a computer program that helps students build growth mind-sets and motivation to learn, and produces significant results in their achievement (e.g., Blackwell et al., 2007; Ramsden et al., 2011). Similarly, praising and rewarding students' hard work, effort, or the effectiveness of the tasks they do rather than their ability or intelligence when they have performed well in an examination (Kamins & Dweck, 1999) can help them to cultivate a growth-mind-set. Finally, teachers and educators should refrain from comparing and favouring students' based on their grades, instead, they could place emphasis on increasing knowledge and improving skills in the subject, and encourage them to work hard and use effective strategies such as deep-learning strategies.

7.7 Directions for Future Research

Future research can build upon this study by addressing its limitations. The questionnaire items, which were used to measure beliefs about mathematical ability, goal orientations, and learning strategies in mathematics, could be used to conduct similar studies in other disciplines. Future research could also include qualitative data

to investigate students' perceptions of their beliefs' about intelligence, achievement goals, and learning strategies. These data could expand our understanding of students' perspectives and could minimise variability in students' interpretations of questionnaire items. Future research could also use quasi-experimental design with intervention studies in which students receive instruction that is focused on beliefs about intelligence, and learning strategies to help them identify paths that are beneficial to them, and investigate the effect of such interventions to students' performances in academic settings. Lastly, future studies could use mediational analyses to investigate relationships, such as those in the present study, for different groups of students (e.g., lower and higher aptitudes, males and females). Such research could help teachers and educators to help create a better learning environment to meet the needs of a variety of students.

7.8 Conclusion

This study, which was conducted in the Maldives, addressed two major components of Dweck's (1986) motivation model and explanation of achievement goal theory. It investigated the relationship between higher secondary students' beliefs about mathematical ability and mathematics achievement in the Maldives, and found that their relationship was mediated through achievement goals and learning strategies. The instruments, which were specific to mathematics and were translated into the local Maldivian language, were reliable and valid, and could be used in future research in the country. SEM techniques, along with mediational tests, provided the means to examine the three-path mediational model for mathematics achievement. The nine hypotheses developed for the present study addressed the research questions and provided comprehensive answers for addressing relationships among the measured variables. The study highlighted that a growth mind-set, focused on developing one's competence with task mastery and the use of deep-learning strategies, was positively related to mathematics achievement, while a growth mind-set focused on competitions, and use of surface-learning was negatively related to mathematics achievement. In closing, it is believed that this study could help teachers and educators to create a better learning environment for students in general, and for students in the Maldives in particular, and could improve the quality of mathematics education in the country.

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APPENDIX A

Table 13: *Methods of testing three-path mediated effect*

Method	Test ($\alpha = .05$)
Joint significance	Reject Hypothesis ₀ if $|b_1|/s_{b1} > t_{.975(n-2)}$ and $|b_2|/s_{b2} > t_{.975(n-3)}$ and $|b_3|/s_{b3} > t_{.975(n-4)}$, where $t_{.975(df)}$ is the critical t value for a two-tailed test given the df . For example, $t_{.975(100)} = 1.98$.
Multivariate delta standard error	Reject Hypothesis ₀ if 95% confidence interval $= b_1b_2b_3 \pm z_{.975}(s_{\text{multivariate delta}}^2)^{1/2}$ does not include zero, where $s_{\text{multivariate delta}}^2 = b_1^2b_2^2s_{b3}^2 + b_1^2b_3^2s_{b2}^2 + b_2^2b_3^2s_{b1}^2$ and $z_{.975} = 1.96$.
Unbiased standard error	Reject Hypothesis ₀ if 95% confidence interval $= b_1b_2b_3 \pm z_{.975}(s_{\text{unbiased}}^2)^{1/2}$ does not include zero, where $s_{\text{unbiased}}^2 = b_1^2b_2^2s_{b3}^2 + b_1^2b_3^2s_{b2}^2 + b_2^2b_3^2s_{b1}^2 - b_1^2s_{b2}^2s_{b3}^2 - b_2^2s_{b1}^2s_{b3}^2 - b_3^2s_{b1}^2s_{b2}^2 + s_{b1}^2s_{b2}^2s_{b3}^2$.
Exact standard error	Reject Hypothesis ₀ if 95% confidence interval $= b_1b_2b_3 \pm z_{.975}(s_{\text{exact}}^2)^{1/2}$ does not include zero, where $s_{\text{exact}}^2 = b_1^2b_2^2s_{b3}^2 + b_1^2b_3^2s_{b2}^2 + b_2^2b_3^2s_{b1}^2 + b_1^2s_{b2}^2s_{b3}^2 + b_2^2s_{b1}^2s_{b3}^2 + b_3^2s_{b1}^2s_{b2}^2 + b_1^2s_{b2}^2s_{b3}^2$.
Percentile bootstrap	Draw a large number of bootstrap samples and estimate $b_1b_2b_3$ in each to form bootstrap distribution. Endpoints of a 95% confidence interval are 2.5th and 97.5th percentiles of distribution. Reject Hypothesis ₀ if confidence interval does not include zero.
Bias-corrected bootstrap	Form bootstrap distribution as above. Find p , proportion of the distribution greater than original sample $b_1b_2b_3$. Calculate $z_{\text{lower}} = -1.96 + 2z_0$ and $z_{\text{upper}} = 1.96 + 2z_0$, where z_0 is the z score corresponding to probability p . For example, for $p = .55$, $z_0 = 0.13$. End points of a 95% confidence interval are percentile ranks from the bootstrap distribution corresponding to normal percentiles for z_{lower} and z_{upper} . Reject Hypothesis ₀ if confidence interval does not include zero.

Source: Taylor et al. (2008, p. 245)

APPENDIX B

VICTORIA UNIVERSITY OF WELLINGTON

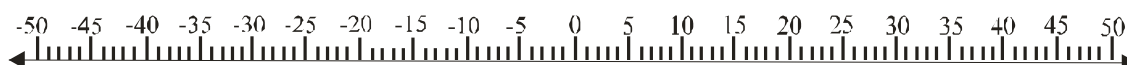
Te Whare Wananga o te Upoko o te Ika a Maui



MATHEMATICAL BELIEFS

Read the following questions carefully and place "X" on the number line from 0 to -50 (Strongly Disagree) to 0 to 50 (Strongly Agree). Please give your honest responses.

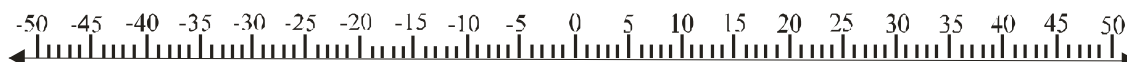
1) You have a fixed amount of maths ability.

[illegible]

Strongly Disagree

Strongly Agree

2) High performance in maths is a result of your high maths ability.

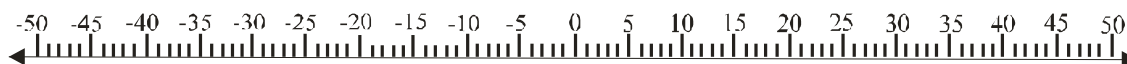
[illegible]

Strongly Disagree

Strongly Agree

3) Maths ability cannot be changed.

(3) ಸ್ವರೈಶ್ವರ್ಯಾನ್ಮುಕ್ತಾಯಾಃ ಪೂಜ್ಯಾಪೂಜ್ಯಾಃ



Strongly Disagree

Strongly Agree

4) No amount of hard work in learning maths can change your ability.

(4) *ရန်သူ့ကိစ္စမှာ အားနည်းမှုကို ပြောင်းလဲနိုင်ရန် အားထုတ်ပေးသော်လည်း အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။*

အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။



Strongly Disagree

Strongly Agree

5) You can develop your maths ability a great deal.

(5) *ရန်သူ့ကိစ္စမှာ အားနည်းမှုကို ပြောင်းလဲနိုင်ရန် အားထုတ်ပေးသော်လည်း အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။*



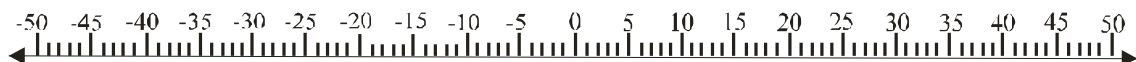
Strongly Disagree

Strongly Agree

6) If you fail in a maths task, you question your in-born ability.

(6) *ရန်သူ့ကိစ္စမှာ အားနည်းမှုကို ပြောင်းလဲနိုင်ရန် အားထုတ်ပေးသော်လည်း အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။*

အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။



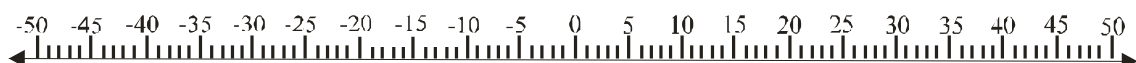
Strongly Disagree

Strongly Agree

7) Difficulties and challenges in solving maths problems prevent you from developing your ability.

(7) *ရန်သူ့ကိစ္စမှာ အားနည်းမှုကို ပြောင်းလဲနိုင်ရန် အားထုတ်ပေးသော်လည်း အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။*

အားနည်းမှုကို ပြောင်းလဲနိုင်ခြင်း မရှိပါ။



Strongly Disagree

Strongly Agree

8) If you fail in a maths task, you still trust your ability in maths.

(8) ሪፍኤፍ ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ

ፍጥነት ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ



Strongly Disagree

Strongly Agree

9) Learning new concepts does not affect your basic level of maths ability.

(9) ሪፍኤፍ ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ



Strongly Disagree

Strongly Agree

10) Encouragement from others does not help to improve my maths ability.

(10) ሪፍኤፍ ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ



Strongly Disagree

Strongly Agree

11) When you learn new things in maths, your basic maths knowledge improves.

(11) ሪፍኤፍ ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ

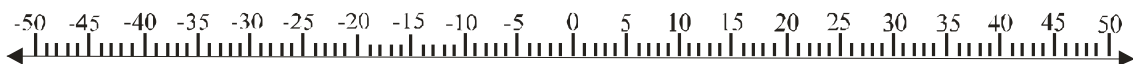


Strongly Disagree

Strongly Agree

12) Good preparation before performing a maths task is a way to develop your maths ability.

(12) ሪፍኤፍ ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ ለሌሎች ስራዎን ለማግኘት ሲፈቀድ



Strongly Disagree

Strongly Agree

(13) ስላግባኝ ነው ብለን መናገር ይቻላል

-50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50

Strongly Disagree Strongly Agree

(14) ሥጋው ለሌሎች ለመባዛት ሊያገለግል ይችላል

← -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 →

Strongly Disagree *Strongly Agree*

(15) رِسْوَت، جَزْوَءُ الْحَقِّ زَنْتَرَدِي اِهْ مَعْرَسُوں دَ سَوَّ کِ تَجْدُسُوں اِدْعَاؤُنْوَنُورَانُو:

-50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50

Strongly Disagree **Strongly Agree**

(16) ለጥያቄዎቼ ምክር ቤቱ ማቅረብ ይቻላል (16)

-50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50

Strongly Disagree Strongly Agree

APPENDIX C

VICTORIA UNIVERSITY OF WELLINGTON

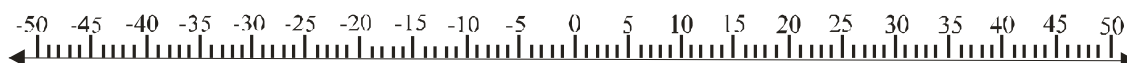
Te Whare Wananga o te Upoko o te Ika a Maui



ACHIEVEMENT GOALS

Read the following questions carefully and place "X" on the number line from (0 to -50) Strongly Disagree to (0 to 50) Strongly Agree. Please give your honest responses.

1) Doing better than other students in my maths class is important to me.

[illegible]

Strongly Disagree

Strongly Agree

2) I do my mathematics work because I am interested in it.

(2) اِرْعَسْ رِسَدَّ دَرَمَرَدَرْ دَسَمَدَنِيْعَسْ اِنْدَرْ اِرْعَسْ شَدَرْتِيْ وَمَرْوِيْوْ.

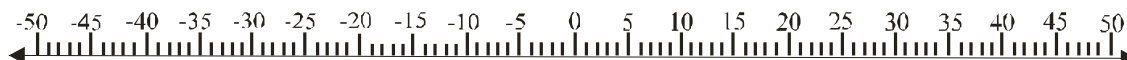


Strongly Disagree

Strongly Agree

3) I like maths work best when it really makes me think.

(3) رَسَدٌ مَّزْزُوعٌ لِمَا اسْتَرْزَقَ رَمُوسٌ اِنْدَاسَ اِرْعَسَ وَسُوسَ رَعِ رَمُوسٌ

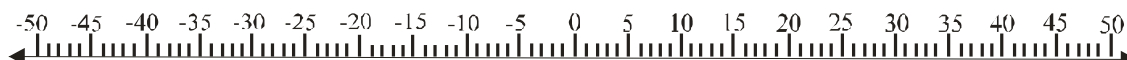


Strongly Disagree

Strongly Agree

4) I do my work in maths class because I want to get better at it.

(4) رَسُوْهُنَّ لَمْ يَكُنْ لَهُنَّ كُفْرٌ وَلَا فَرْقٌ وَهِيَ الْمَلَائِكَةُ الْمُطَهَّرَاتُ

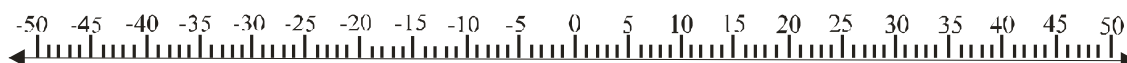


Strongly Disagree

Strongly Agree

5) I like maths work that I learn from, even if I make a lot of mistakes.

(5) *أنا أحب العمل الرياضي الذي أتعلم منه، حتى لو أخطأت الكثير.*

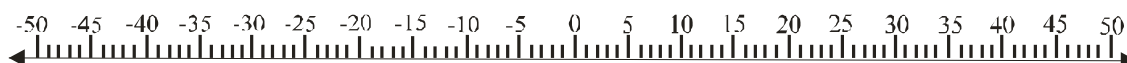


Strongly Disagree

Strongly Agree

6) One of my main goals is to avoid looking like I can't do maths.

(6) *أحد أهدافي الرئيسية هو تجنب أن أبدو وكأنني لا أفهم الرياضيات.*



Strongly Disagree

Strongly Agree

7) I do my maths work so others won't think I am dumb.

(7) *أفعل العمل الرياضي حتى لا يعتقد الآخرون أنني أحمق.*

أفعل العمل الرياضي حتى لا يعتقد الآخرون أنني أحمق.



Strongly Disagree

Strongly Agree

8) I do my maths sums because I like to learn new things.

(8) *أفعل العمل الرياضي لأنني أحب أن أتعلم أشياء جديدة.*



Strongly Disagree

Strongly Agree

9) I would like to show my maths teachers that I am smarter than other students in my class.

(9) *أريد أن أظهر لمدربي الرياضيات أنني أذكى من الطلاب الآخرين في صفي.*

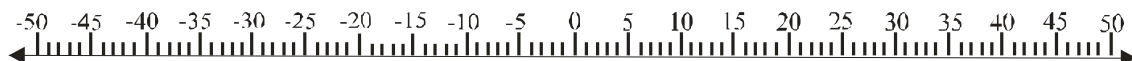


Strongly Disagree

Strongly Agree

10) I would feel successful in maths class if I did better than most of the other students.

(10) رِسْوَ نَظَرِي يَسَر نَقِسْ سَرَسَر سَرَوَعَر دِيَسَر دَمَر نَسَر رَكِرَافَ سَرَر اِيَر رِسْوَ سَر نَدَر نَوِي نَدِيَر
رِئَمَر دَو.

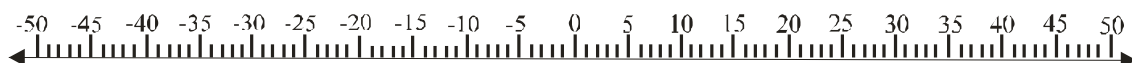


Strongly Disagree

Strongly Agree

11) I want to do better than the other students in my maths class.

(12) اَرَمَسَر نَظَرِي اَرَسَر نَقِسْ سَرَسَر سَرَوَعَر دِيَسَر دَمَر دَو سَرَوَعَر

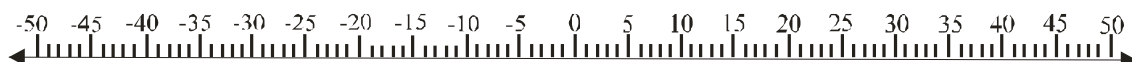


Strongly Disagree

Strongly Agree

12) I would feel really good if I were the only one who could answer the teacher's questions in my maths class.

(12) نَظَرِي رِسْوَ دَمَر سَرَوَعَر سَرَر رَكِرَافَ سَر نَقِسْ سَرَسَر اَسَرِي دَرِي اَرَمَسَر نَدِيَر وَدِيَر
اَرَمَسَر وَمَرَسَر رِئَمَر دَو سَر نَدِيَر.

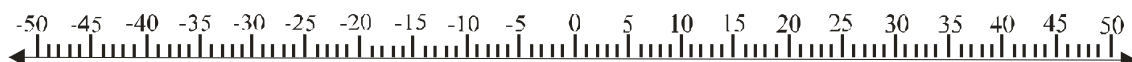


Strongly Disagree

Strongly Agree

13) It is very important to me that I don't look stupid in my maths class.

(13) رِسْوَ نَظَرِي اَرَمَسَر سَرِي نَدِيَر نَدِيَر سَرَر اَرَمَسَر سَرَسَر وَمَرَسَر دَرِي دَو.

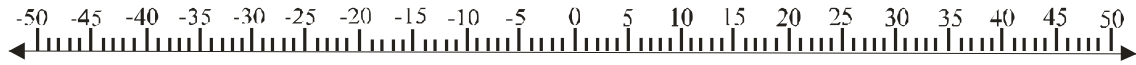


Strongly Disagree

Strongly Agree

14) I do my maths work so I don't embarrass myself.

(14) اَرْمَعْسَر رِسَدَو مَزْوَوَقْوَإَر رَقْرَقِر اَرْمَعْسَر اَجْوَإَر اَرْمَعْسَر مَزْمَرِيْوَإَر



Strongly Disagree

Strongly Agree

15) I do my work so my maths teachers don't think I know less than others.

(15) اَرْمَعْسَر رِسَدَو مَزْوَوَقْوَإَر رَقْرَقِر اِيْ اَرْمَعْسَر اَرْمَعْسَر رِسَدَو اَرْمَعْسَر اَرْمَعْسَر مَزْمَرِيْوَإَر

مَزْمَرِيْوَإَر رِسَدَو مَزْمَرِيْوَإَر مَزْمَرِيْوَإَر



Strongly Disagree

Strongly Agree

APPENDIX D

VICTORIA UNIVERSITY OF WELLINGTON

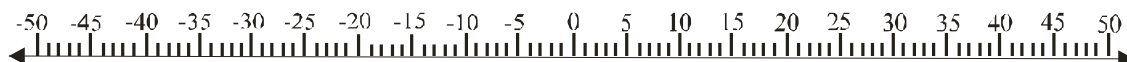
Te Whare Wananga o te Upoko o te Ika a Maui



LEARNING STRATEGIES

Read the following questions carefully and place "X" on the number line from (0 to -50) Strongly Disagree to (0 to 50) Strongly Agree. Please give your honest responses.

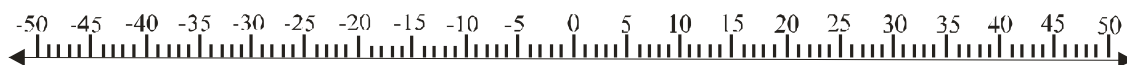
1. When studying, I try to combine different pieces of information from course material in new ways.

[illegible]

Strongly Disagree

Strongly Agree

2. I draw pictures or diagrams to help me solve some problems.

[illegible]

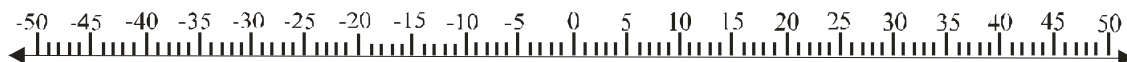
Strongly Disagree

Strongly Agree

3. I work several examples of the same type of problem when studying mathematics so I can understand the problems better.

[illegible]

دستور و رکر و

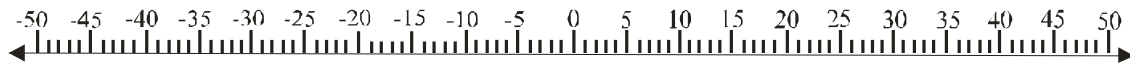


Strongly Disagree

Strongly Agree

4. I work practice problems to check my understanding of new concepts or rules.

(4) رښته دې رڼا ، نښته دې څو ، څرنگه دې څو ، څرنگه دې څو ، څرنگه دې څو .



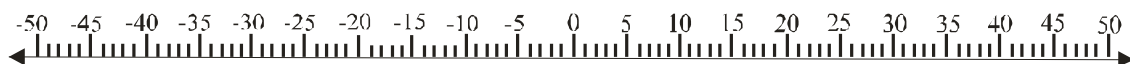
Strongly Disagree

Strongly Agree

5. I examine example problems that have already been worked to help me figure out how to do similar problems on my own.

(5) دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو .

دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو .



Strongly Disagree

Strongly Agree

6. I classify problems into categories before I begin to practise for an exam.

(6) دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو .

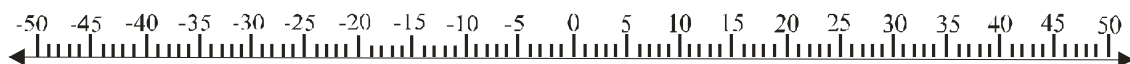


Strongly Disagree

Strongly Agree

7. When I work a maths problem, I analyse it to see if there is more than one way to get the right answer.

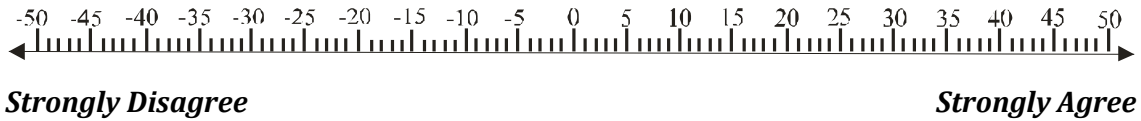
(7) دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو ، دې څو .



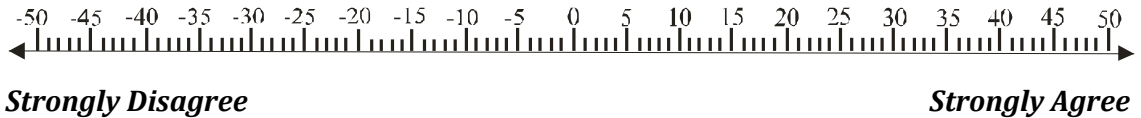
Strongly Disagree

Strongly Agree

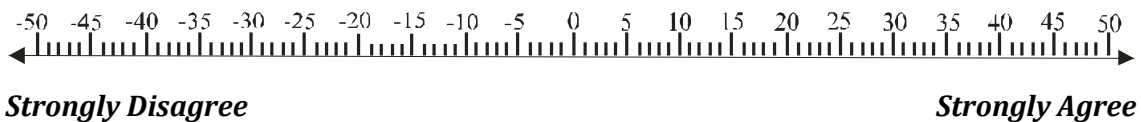
8. I try to memorise the steps for solving problems presented in the text or in maths class.

[illegible]

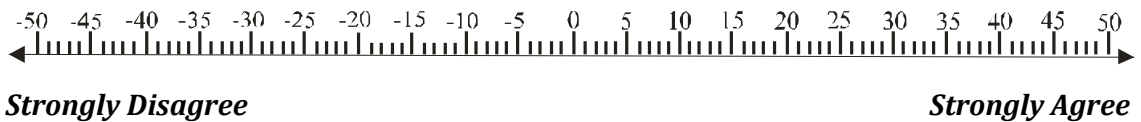
9. When I study for maths tests I review my class notes and look at solved problems.

[illegible]

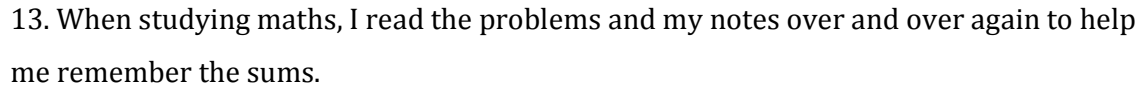
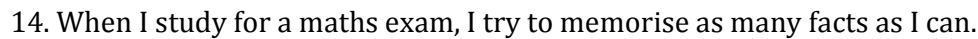
10. When I study for a maths tests I use solved problems in my maths notes or in the book to help me memorise the steps involved.

[illegible]

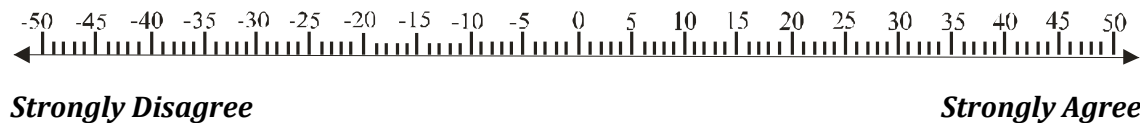
11. I find reviewing previously solved problems to be a good way to study for a maths test.

[illegible]

(12) $\text{بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ} \text{بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ}$

[illegible]

(14) رَسَدُ كَرَسَمَرَزِي، رَسَدِي 'كَرْسَمَرَزِي' وَرَوُتْ يَسْرِي سُرْ رِي كَرَسَمَرَزُو.



APPENDIX E

Table 13: *Standardised direct effects*

	ENTITY	INCR	APPROACH	MASTERY	AVOID	DEEP	SURFACE
APPROACH	0.092	0.285	0	0	0	0	0
MASTERY	0	0.435	0	0	0	0	0
AVOID	0.252	0	0	0	0	0	0
DEEP	0	0	0.080	0.578	0	0	0
SURFACE	0	0	0.253	-0.033	0.308	0	0
RESULT	0	0	0	0	0	0.260	-0.305

Table 14: *Standardised direct effects – Two-tailed significance*

	ENTITY	INCR	APPROACH	MASTERY	AVOID	DEEP	SURFACE
APPROACH	0.299	0.000	...	...	...	...	...
MASTERY	...	0.001	...	...	...	...	...
AVOID	0.000	...	...	...	...	...	...
DEEP	...	...	0.266	0.000	...	...	...
SURFACE	...	...	0.002	0.567	0.000	...	...
RESULT	...	...	...	...	...	0.000	0.000

Note: INCR=Incremental beliefs; Entity=Entity beliefs; MASTERY=Mastery goals; APPROACH=Performance-approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies.

APPENDIX F

Table 15: *Standardised indirect effects*

	ENTITY	INCR	APPROACH	MASTERY	AVOID	DEEP	SURFACE
APPROACH	0	0	0	0	0	0	0
MASTERY	0	0	0	0	0	0	0
AVOID	0	0	0	0	0	0	0
DEEP	0.007	0.274	0	0	0	0	0
SURFACE	0.101	0.058	0	0	0	0	0
RESULT	-0.029	0.054	-0.056	0.160	-0.094	0	0

Table 16: *Standardised indirect effects – Two-tailed significance*

	ENTITY	INCR	APPROACH	MASTERY	AVOID	DEEP	SURFACE
APPROACH	...	...	...	...	...	...	...
MASTERY	...	...	...	...	...	...	...
AVOID	...	...	...	...	...	...	...
DEEP	0.229	0.000	...	...	...	...	...
SURFACE	0.010	0.069	...	...	...	...	...
RESULT	0.003	0.042	0.065	0.001	0.000	...	...

Note: INCR=Incremental beliefs; Entity=Entity beliefs; MASTERY=Mastery goals; APPROACH=Performance-approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies.

APPENDIX G

Table 17: *Standardised indirect effects - Lower bounds*

	ENTITY	INCR	APPROACH	MASTERY	AVOID	DEEP	SURFACE
APPROACH	0	0	0	0	0	0	0
MASTERY	0	0	0	0	0	0	0
AVOID	0	0	0	0	0	0	0
DEEP	-0.006	0.148	0	0	0	0	0
SURFACE	0.027	-0.005	0	0	0	0	0
RESULT	-0.064	0.002	-0.125	0.063	-0.156	0	0

Table 18: *Standardised indirect effects - Upper bounds*

	ENTITY	INCR	APPROACH	MASTERY	AVOID	DEEP	SURFACE
APPROACH	0	0	0	0	0	0	0
MASTERY	0	0	0	0	0	0	0
AVOID	0	0	0	0	0	0	0
DEEP	0.044	0.409	0	0	0	0	0
SURFACE	0.196	0.125	0	0	0	0	0
RESULT	-0.009	0.125	0.004	0.275	-0.048	0	0

Note: INCR=Incremental beliefs; Entity=Entity beliefs; MASTERY=Mastery goals; APPROACH=Performance-approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface learning strategies.

APPENDIX H

Table 19: Sobel's test- Beliefs, goals, and learning strategies

Specific indirect paths	z- value	p-value
INCR->MASTERY->DEEP	5.38	0.00
INCR->MASTERY->SURFACE	-0.51	0.61
INCR->APPROACH->DEEP	1.21	0.23
INCR-> APPROACH->SURFACE	2.44	0.00
ENTITY->APPROACH->DEEP	0.84	0.40
ENTITY->APPROACH->SURFACE	1.62	0.29
ENTITY->AVOID->SURFACE	2.95	0.00

Note: INCR=Incremental beliefs; ENTITY=Entity beliefs; MASTERY=Mastery goals; APPROACH=Performance approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies

$$z\text{-value} = a*b/\text{SQRT}(b^2*s_a^2 + a^2*s_b^2);$$

Where, a = regression weights of the first path(given in Appendix I)

b = regression weights of the first path;

s_a = Standard Error of a ;

s_b = Standard Error of b ;

The z-value and the p-value are calculated using an online Sobel Test calculator for the significance of the mediation (Soper, 2012).

APPENDIX I

Table 20: Sobel's test-Goals, learning strategies and achievement

Specific indirect paths	z- value	p-value
MASTERY->DEEP-> RESULT	3.80	0.00
MASTERY->SURFACE-> RESULT	0.51	0.61
APPROACH->DEEP->RESULT	1.25	0.21
APPROACH->SURFACE->RESULT	-3.02	0.00
AVOID->SURFACE->RESULT	-3.44	0.00

Note: MASTERY=Mastery goals; APPROACH=Performance- approach goals; AVOID=Performance-avoidance goals; DEEP=Deep-learning strategies; SURFACE=Surface-learning strategies; RESULT=Mathematics achievement.

$$z\text{-value} = a*b/\text{SQRT}(b^2*s_a^2 + a^2*s_b^2);$$

Where, a = regression weights of the first path(given in Appendix I)

b = regression weights of the first path;

s_a = Standard Error of a ;

s_b = Standard Error of b ;

The z-value and the p-value are calculated using an online Sobel Test calculator for the significance of the mediation (Soper, 2012).

APPENDIX J

Table 21: *Regression weights*

			Estimate	S.E.	C.R.	P
AVOID	<---	ENTITY	5.05	1.29	3.93	***
MASTERY	<---	INCR	9.06	1.29	7.01	***
APPROACH	<---	INCR	5.82	1.76	3.31	***
APPROACH	<---	ENTITY	1.88	1.69	1.11	0.27
SURFACE	<---	AVOID	0.42	0.09	4.47	***
DEEP	<---	MASTERY	0.37	0.0	8.28	***
SURFACE	<---	APPROACH	0.34	0.09	3.60	***
DEEP	<---	APPROACH	0.05	0.04	1.29	0.20
SURFACE	<---	MASTERY	-0.04	0.08	-0.52	0.60
RESULT	<---	DEEP	0.41	0.09	4.33	***
RESULT	<---	SURFACE	-0.23	0.04	-5.51	***

Note: INCR = Incremental beliefs; Entity = Entity beliefs; MASTERY = Mastery goals; APPROACH = Performance-approach goals; AVOID = Performance-avoidance goals; DEEP = Deep-learning strategies; SURFACE = Surface-learning strategies;
 Estimate = Unstandardised regression coefficient
 S.E = Standard error
 C.R. = Critical Ratio
 *** = significant at $p < .0001$

APPENDIX K

Table 22: Testing 3-path mediation-(INCR->MASTERY->DEEP->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
INCR->APPROACH ($path_1$)	$\beta_1 = 9.058$	$SE_1 = 1.924$
APPROACH->SURFACE ($path_2$)	$\beta_2 = 0.369$	$SE_2 = 0.064$
SURFACE ->RESULT ($path_3$)	$\beta_3 = 0.405$	$SE_3 = 0.127$
$(\beta_1 * \beta_2 * SE_3)^2$		0.180
$(SE_1 * \beta_2 * \beta_3)^2$		0.083
$(\beta_1 * SE_2 * \beta_3)^2$		0.055
$S^2_{\text{multivariate delta}}$		0.318
Multivariate Delta		0.564
$\beta_1 \beta_2 \beta_3$		1.354
95 % LO= $\beta_1 \beta_2 \beta_3 - 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		0.248
95 % HI= $\beta_1 \beta_2 \beta_3 + 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		2.459

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.975 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero,
 where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.975 = 1.96$ (e.g.,
 Taylor et al. (2008).

APPENDIX L

Table 23: Testing 3-path mediation (INCR->MASTERY->SURFACE->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
INCR->MASTERY ($path_1$)	$\beta_1 = 9.058$	$SE_1 = 1.924$
MASTERY->SURFACE ($path_2$)	$\beta_2 = -0.043$	$SE_2 = 0.081$
SURFACE->RESULT ($path_3$)	$\beta_3 = -0.233$	$SE_3 = 0.043$
$(\beta_1 * \beta_2 * SE_3)^2$		0.0003
$(SE_1 * \beta_2 * \beta_3)^2$		0.0004
$(\beta_1 * SE_2 * \beta_3)^2$		0.0292
$S^2_{\text{multivariate delta}}$		0.0299
Multivariate Delta		0.1729
$\beta_1 \beta_2 \beta_3$		0.0908
95 % LO = $\beta_1 \beta_2 \beta_3 - 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		-0.2480
95 % HI = $\beta_1 \beta_2 \beta_3 + 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		0.4295

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.975 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.975 = 1.96$ (e.g., Taylor et al. (2008)).

APPENDIX M

Table 24: Testing 3-path mediation (INCR->APPROACH->DEEP->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
INCR->APPROACH ($path_1$)	$\beta_1 = 5.823$	$SE_1 = 1.690$
APPROACH->DEEP ($path_2$)	$\beta_2 = 0.052$	$SE_2 = 0.047$
DEEP->RESULT ($path_3$)	$\beta_3 = 0.405$	$SE_3 = 0.127$
$(\beta_1 * \beta_2 * SE_3)^2$		0.002
$(SE_1 * \beta_2 * \beta_3)^2$		0.001
$(\beta_1 * SE_2 * \beta_3)^2$		0.012
$S^2_{\text{multivariate delta}}$		0.015
Multivariate Delta		0.123
$\beta_1 \beta_2 \beta_3$		0.123
95 % LO = $\beta_1 \beta_2 \beta_3 - 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		-0.118
95 % HI = $\beta_1 \beta_2 \beta_3 + 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		0.363

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.975 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.975 = 1.96$ (e.g., Taylor et al. (2008)).

APPENDIX N

Table 25: Testing 3-path mediation-(INCR->APPROACH->SURFACE->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
INCR->APPROACH ($path_1$)	$\beta_1 = 5.823$	$SE_1 = 1.690$
APPROACH->SURFACE ($path_2$)	$\beta_2 = 0.335$	$SE_2 = 0.099$
SURFACE->RESULT ($path_3$)	$\beta_3 = -0.233$	$SE_3 = 0.043$
$(\beta_1 * \beta_2 * SE_3)^2$		0.007
$(SE_1 * \beta_2 * \beta_3)^2$		0.017
$(\beta_1 * SE_2 * \beta_3)^2$		0.018
$S^2_{\text{multivariate delta}}$		0.042
Multivariate Delta		0.206
$\beta_1 \beta_2 \beta_3$		-0.454
95 % LO = $\beta_1 \beta_2 \beta_3 - 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		-0.858
95 % HI = $\beta_1 \beta_2 \beta_3 + 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		-0.051

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.975 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.975 = 1.96$ (e.g., Taylor et al. (2008)).

APPENDIX O

Table 26: Testing 3-path mediation (ENTITY->APPROACH->DEEP->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
ENTITY->APPROACH ($path_1$)	$\beta_1 = 1.878$	$SE_1 = 1.856$
APPROACH->DEEP ($path_2$)	$\beta_2 = 0.052$	$SE_2 = 0.047$
DEEP->RESULT ($path_3$)	$\beta_3 = 0.405$	$SE_3 = 0.127$
$(\beta_1 * \beta_2 * SE_3)^2$		0.0002
$(SE_1 * \beta_2 * \beta_3)^2$		0.0015
$(\beta_1 * SE_2 * \beta_3)^2$		0.0013
$S^2_{\text{multivariate delta}}$		0.0030
Multivariate Delta		0.0544
$\beta_1 \beta_2 \beta_3$		0.0396
95 % LO = $\beta_1 \beta_2 \beta_3 - 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		-0.0671
95 % HI = $\beta_1 \beta_2 \beta_3 + 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		0.1462

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.975 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.975 = 1.96$ (e.g., Taylor et al. (2008)).

APPENDIX P

Table 27: Testing 3-path mediation (ENTITY->APPROACH->SURFACE->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
ENTITY->APPROACH ($path_1$)	$\beta_1 = 1.878$	$SE_1 = 1.856$
APPROACH->SURFACE ($path_2$)	$\beta_2 = 0.335$	$SE_2 = 0.099$
SURFACE->RESULT ($path_3$)	$\beta_3 = -0.233$	$SE_3 = 0.043$
$(\beta_1 * \beta_2 * SE_3)^2$		0.0007
$(SE_1 * \beta_2 * \beta_3)^2$		0.0210
$(\beta_1 * SE_2 * \beta_3)^2$		0.0019
$S^2_{\text{multivariate delta}}$		0.0236
Multivariate Delta		0.1536
$\beta_1 \beta_2 \beta_3$		-0.1466
95 % LO = $\beta_1 \beta_2 \beta_3 - 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		-0.4476
95 % HI = $\beta_1 \beta_2 \beta_3 + 1.975 (S^2_{\text{multivariate delta}})^{1/2}$		0.1545

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.975 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.975 = 1.96$ (e.g., Taylor et al. (2008)).

APPENDIX Q

Table 28: Testing 3-path mediation-(ENTITY->AVOID->SURFACE->RESULT)

	Regression Coefficient (β)	Standard Error (SE)
ENTITY->AVOID ($path_1$)	$\beta_1 = 5.052$	$SE_1 = 1.512$
AVOID->SURFACE ($path_2$)	$\beta_2 = 0.415$	$SE_2 = 0.103$
SURFACE ->RESULT ($path_3$)	$\beta_3 = -0.233$	$SE_3 = 0.043$
$(\beta_1 * \beta_2 * SE_3)^2$		0.008
$(SE_1 * \beta_2 * \beta_3)^2$		0.021
$(\beta_1 * SE_2 * \beta_3)^2$		0.015
$S^2_{\text{multivariate delta}}$		0.044
Multivariate Delta		0.210
$\beta_1 \beta_2 \beta_3$		-0.486
95 % LO = $\beta_1 \beta_2 \beta_3 - 1.96 (S^2_{\text{multivariate delta}})^{1/2}$		-0.901
95 % HI = $\beta_1 \beta_2 \beta_3 + 1.96 (S^2_{\text{multivariate delta}})^{1/2}$		-0.076

Note: Reject the Hypothesis₀ if 95% CI = $\beta_1 * \beta_2 * \beta_3 \pm 1.96 (S^2_{\text{multivariate delta}})^{1/2}$ does not include zero, where $S^2_{\text{multivariate delta}} = (\beta_1 * \beta_2 * SE_3)^2 + (SE_1 * \beta_2 * \beta_3)^2 + (\beta_1 * SE_2 * \beta_3)^2$, and $1.96 = 1.96$ (e.g., Taylor et al. (2008)).

APPENDIX R

Table 29: *Correlation matrix for the observed variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1. I1	1																										
2. I3	0.61	1																									
3. I4	0.50	0.49	1																								
4. I7	0.49	0.44	0.50	1																							
5. ENT3	-0.32	-0.24	-0.35	-0.35	1																						
6. ENT4	-0.32	-0.30	-0.39	-0.36	0.68	1																					
7. ENT7	-0.32	-0.33	-0.42	-0.30	0.58	0.64	1																				
8. M1	0.27	0.25	0.19	0.17	-0.11	-0.12	-0.18	1																			
9. M2	0.24	0.23	0.12	0.10	0.01	0.01	-0.05	0.61	1																		
10. M3	0.32	0.24	0.22	0.25	-0.10	-0.13	-0.18	0.61	0.46	1																	
11. M4	0.32	0.31	0.20	0.25	-0.08	-0.07	-0.14	0.54	0.45	0.48	1																
12. M5	0.22	0.28	0.12	0.17	-0.10	-0.06	-0.17	0.65	0.51	0.53	0.41	1															
13. PAP1	0.12	0.11	0.13	0.17	-0.02	-0.03	0.01	0.27	0.25	0.27	0.21	0.24	1														
14. PAP2	0.10	0.08	0.06	0.14	-0.08	-0.05	-0.09	0.13	0.17	0.15	0.12	0.19	0.56	1													
15. PAP3	0.00	0.00	-0.01	0.09	0.02	0.03	0.08	0.02	0.01	0.12	0.04	0.06	0.44	0.52	1												
16. PAP4	0.13	0.13	0.14	0.22	-0.11	-0.10	-0.06	0.22	0.15	0.22	0.15	0.26	0.68	0.63	0.53	1											
17. PAV2	-0.11	-0.12	-0.13	-0.07	0.12	0.15	0.09	-0.15	-0.06	-0.05	-0.14	-0.07	0.10	0.26	0.25	0.12	1										
18. PAV3	-0.03	0.01	0.03	0.01	0.05	0.10	0.07	0.01	0.00	0.03	0.03	0.03	0.34	0.43	0.45	0.34	0.44	1									
19. PAV4	-0.12	-0.14	-0.18	-0.14	0.15	0.19	0.19	-0.16	-0.12	-0.11	-0.14	-0.08	0.16	0.36	0.31	0.20	0.56	0.56	1								
20. PAV5	-0.13	-0.13	-0.19	-0.13	0.17	0.17	0.15	-0.12	-0.06	-0.05	-0.12	-0.02	0.14	0.31	0.27	0.17	0.55	0.50	0.74	1							
21. DP3	0.26	0.21	0.20	0.16	-0.06	-0.05	-0.09	0.33	0.23	0.31	0.37	0.24	0.13	-0.02	0.03	0.11	-0.12	0.01	-0.13	-0.10	1						
22. DP4	0.22	0.18	0.22	0.22	-0.13	-0.11	-0.19	0.40	0.27	0.37	0.34	0.37	0.15	0.10	0.14	0.24	-0.06	0.04	-0.09	-0.09	0.55	1					
23. DP5	0.19	0.25	0.23	0.28	-0.10	-0.09	-0.16	0.29	0.20	0.32	0.26	0.25	0.15	0.09	0.10	0.19	-0.01	0.02	-0.06	-0.09	0.54	0.46	1				
24. SP1	0.02	0.02	0.01	-0.01	0.06	0.07	-0.01	0.01	-0.04	0.08	0.00	0.05	0.25	0.24	0.26	0.27	0.16	0.28	0.26	0.28	0.02	0.07	0.04	1			
25. SP3	-0.02	0.06	0.02	0.03	0.05	0.05	-0.03	-0.05	-0.10	0.02	-0.05	0.04	0.14	0.20	0.27	0.23	0.11	0.25	0.24	0.27	-0.04	0.06	-0.01	0.66	1		
26. SP5	-0.06	-0.03	-0.07	-0.09	0.11	0.11	0.06	0.01	0.01	0.03	0.02	0.02	0.16	0.18	0.17	0.18	0.15	0.24	0.23	0.32	0.00	0.05	-0.04	0.67	0.66	1	
27. RESULT	0.15	0.07	0.03	-0.01	-0.05	-0.14	-0.05	0.31	0.29	0.14	0.19	0.13	0.02	-0.02	-0.13	-0.07	-0.16	-0.20	-0.17	-0.19	0.15	0.19	0.14	-0.22	-0.29	-0.21	1

Note: Figures in bold are significant at $p < .05$

APPENDIX S

School Information Sheet

VICTORIA UNIVERSITY OF WELLINGTON

Te Whare Wananga o te Upoko o te Ika a Maui



Project Title: Relationships among beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement of higher secondary students in the Maldives.

Ethics Application SEPP/2010/01: RM 17255

I am a PhD student at Victoria University of Wellington and I would like to invite your students to be part of my research. The aim of this study is to examine how the way that students think about mathematics affects how well they achieve in mathematics in Maldivian context. This study will help students to relate their beliefs to their goals in academic settings and choose effective learning strategies for learning mathematics. I hope that the results of this study will help us improve mathematics education in the country. This project is being conducted with the supervision of experienced researchers in the School of Educational Psychology and Pedagogy at Victoria University of Wellington in New Zealand.

Participation: Please note that your school is under no obligation to participate in the study. If you decide to participate, you have the right to withdraw your consent up to the end of data collection and discontinue your school's participation. Your decision to discontinue participation will not affect your present or future relationship with Victoria University of Wellington.

If you allow your students to participate in this study, Grade 12 students in your school will complete a 47-item questionnaire that will measure their perceptions about their beliefs, goals and learning strategies. This activity will be conducted in their regular class times. The questionnaire will take approximately 30 minutes to complete. Along with the questionnaire data, students' mathematics results will be collected from school. A small group of students will be asked to participate in a subsequent interview lasting approximately 15 minutes.

Confidentiality: Any information that is obtained in connection with this study and that can be identified with your school will remain confidential. The results of this project will be presented in written and oral reports, but we will not use names of the students in any written or oral reports. We will not provide any personal information that would enable anyone to identify your students in any reports. In case a research assistant is hired to help the data collection, he/she would be required to keep the data collected for this research strictly confidential.

Ethics: The project has received approval from the Victoria University Faculty of Education Ethics Committee. If at any time you have any questions or concerns about your treatment as a research participant in this study, contact Dr Judith Loveridge, who is current Chair of this ethics committee (telephone: +64 4 463 6028), judith.loveridge@vuw.ac.nz.

Data Storage and Deletion: The information collected in the study will be entered into a computer belonging to the investigator for this project. These data will not be identifiable in any way. The data will be stored in a locked office in the Faculty of Education building for 3 years after the completion of the study and will then be destroyed.

Reporting/Dissemination: The results of this study will be used for a PhD thesis publication and the summarised findings may be presented at a conference.

If you have any questions about the study now or at any time in the future, please feel free to contact the primary researcher using the following contact information: Ahmed Riyaz, PhD Student, School of Educational Psychology and Pedagogy, Faculty of Education, Victoria University of Wellington, PO Box 17-310, Karori, Wellington, NZ, +64 4 463 9852, or (+960) 7733234, ahmed.riyaz@vuw.ac.nz , or Dr Matt McCrudden, Senior Lecturer, School of Educational Psychology and Pedagogy, Faculty of Education, Victoria University of Wellington, PO Box 17-310, Karori, Wellington, NZ, +64 4 463 5179, matt.mccrudden@vuw.ac.nz.

Sincerely,

Ahmed Riyaz
PhD Student
Victoria University of Wellington

APPENDIX T

Students' Information Sheet

VICTORIA UNIVERSITY OF WELLINGTON

Te Whare Wananga o te Upoko o te Ika a Maui



Project Title: Relationships among beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement of higher secondary students in the Maldives.

Ethics Application SEPP/2010/01: RM 17255

I am a PhD student at Victoria University of Wellington and I would like to invite you to be part of my research. The aim of this study is to examine how the way that students think about mathematics affects how well they achieve in mathematics in Maldivian context. This study will help students to relate their beliefs to their goals in academic settings and choose effective learning strategies for learning mathematics. I hope that the results of this study will help us improve mathematics education in the country. This project is being conducted with the supervision of experienced researchers in the School of Educational Psychology and Pedagogy at Victoria University of Wellington in New Zealand.

Participation: Please note that you are under no obligation to participate in the study. If you decide to participate, you also have the right to withdraw your consent within a week time after data collection and discontinue your participation. Your decision to discontinue participation will not affect your present or future relationship with your school or with Victoria University of Wellington.

If you choose to participate in this study, you will complete a 47-item questionnaire that will measure your perceptions about your beliefs, goals and learning strategies. This activity will be conducted in your regular class timings. The questionnaire will take approximately 30 minutes to complete. Along with the questionnaire data, your mathematics results will be collected from school. A small group of students will be asked to participate in a subsequent interview lasting approximately 15 minutes.

Confidentiality: Any information that is obtained in connection with this study and that can be identified with you will remain confidential. The results of this project will be presented in written and oral reports, but we will not use your name in any written or oral reports. We will not provide any personal information that would enable anyone to identify you in any reports. In case a research assistant is hired to help the data collection, he/she would be required to keep the data collected for this research strictly confidential.

Ethics: The project has received approval from the Victoria University Faculty of Education Ethics Committee. If at any time you have any concerns about your treatment as a research participant in this study, contact Dr Judith Loveridge, who is current Chair of this ethics committee (telephone: +64 4 463 6028), judith.loveridge@vuw.ac.nz.

Data Storage and Deletion: The information collected in the study will be entered into a computer belonging to the investigator for this project. These data will not be identifiable in any way. The data will be stored in a locked office in the Faculty of Education building for 3 years after the completion of the study and will then be destroyed.

Reporting/Dissemination: The results of this study will be used for a PhD thesis publication and the summarised findings may be presented at a conference.

If you have any questions about the study now or at any time in the future, please feel free to contact the primary researcher using the following contact information: Ahmed Riyaz, PhD Student, School of Educational Psychology and Pedagogy, Faculty of Education, Victoria University of Wellington, PO Box 17-310, Karori, Wellington, NZ, +64 4 463 9852, ahmed.riyaz@vuw.ac.nz , or Dr Matt McCrudden, Senior Lecturer, School of Educational Psychology and Pedagogy, Faculty of Education, Victoria University of Wellington, PO Box 17-310, Karori, Wellington, NZ, +64 4 463 5179, matt.mccrudden@vuw.ac.nz.

Sincerely Yours

Ahmed Riyaz
PhD Student
Victoria University of Wellington

APPENDIX U

Parents' Information Sheet

VICTORIA UNIVERSITY OF WELLINGTON

Te Whare Wananga o te Upoko o te Ika a Maui



Project Title: Relationships among beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement of higher secondary students in the Maldives.

Ethics Application SEPP/2010/01: RM 17255

I am a PhD student at Victoria University of Wellington and I would like to invite your child to be part of my research. The aim of this study is to examine how the way that students think about mathematics affects how well they achieve in mathematics in Maldivian context. This study will help students to relate their beliefs to their goals in academic settings and choose effective learning strategies for learning mathematics. I hope that the results of this study will help us improve mathematics education in the country. This project is being conducted with the supervision of experienced researchers in the School of Educational Psychology and Pedagogy at Victoria University of Wellington in New Zealand.

Participation: Please note that your child is under no obligation to participate in this study. If you agree that your child can participate, you also have the right to withdraw your consent within a week time after data collection and discontinue your child's participation. Your decision to discontinue their participation will not affect your present or future relationship with your school or with Victoria University of Wellington.

If you allow your child to participate in this study, he/she will complete a 47-item questionnaire that will measure their perceptions about their beliefs, goals and learning strategies.. This activity will be conducted in their regular class times. The questionnaire will take approximately 30 minutes to complete. Along with the questionnaire data, your child's mathematics results will be collected from school. A small group of students will be asked to participate in a subsequent interview lasting approximately 15 minutes.

Confidentiality: Any information that is obtained in connection with this study and that can be identified with your child will remain confidential. The results of this project will be presented in written and oral reports, but we will not use your child's name in any written or oral reports. We will not provide any personal information that would enable anyone to identify your child in any reports. In case a research assistant is hired to help the data collection, he/she would be required to keep the data collected for this research strictly confidential.

Ethics: The project has received approval from the Victoria University Faculty of Education Ethics Committee. If at any time you have any questions or concerns about your treatment as a research participant in this study, contact Dr Judith Loveridge, who is current Chair of this ethics committee (telephone: +64 4 463 6028), judith.loveridge@vuw.ac.nz.

Data Storage and Deletion: The information collected in the study will be entered into a computer belonging to the investigator for this project. These data will not be identifiable in any way. The data will be stored in a locked office in the Faculty of Education building for 3 years after the completion of the study and will then be destroyed.

Reporting/Dissemination: The results of this study will be used for a PhD thesis publication and the summarised findings may be presented at a conference.

If you have any questions about the study now or at any time in the future, please feel free to contact the primary researcher using the following contact information: Ahmed Riyaz, PhD Student, School of Educational Psychology and Pedagogy, Faculty of Education, Victoria University of Wellington, PO Box 17-310, Karori, Wellington, NZ, +64 4 463 9852 or (+960) 7733234, ahmed.riyaz@vuw.ac.nz , or Dr Matt McCrudden, Senior Lecturer, School of Educational Psychology and Pedagogy, Faculty of Education, Victoria University of Wellington, PO Box 17-310, Karori, Wellington, NZ, +64 4 463 5179, matt.mccrudden@vuw.ac.nz.

Sincerely Yours

Ahmed Riyaz
PhD Student
Victoria University of Wellington

APPENDIX V

Principal's Consent Form

Project Title: Relationships among beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement of higher secondary students in the Maldives.

Ethics Application **SEPP/2010/01: RM 17255**

I agree to take part in the above research. I have had the project explained to me and I have had a chance to ask questions. I understand that agreeing to this means that I will be willing to do the following: (please tick each box)

- ☐ I agree that the students may participate in this study.
- ☐ I have had the project explained to me.
- ☐ I have had the chance to ask questions and these have been answered to my satisfaction.
- ☐ I agree to allowing mathematics teachers of this school to release students' results for this study.
- ☐ I understand that I do not have to agree to take part in the research and that I may withdraw the school from this project without having to give a reason.
- ☐ I understand that any information I provide will be kept confidential to the researcher and that neither I nor the students will be identified in the research or any reports on the project or to any party.
- ☐ I understand that any data gathered from this project will be destroyed after three years.

Name: _____

Date: _____

Signature: _____

APPENDIX W

Students' Consent Form

Project Title: Relationships among beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement of higher secondary students, in the Maldives.

Ethics Application SEPP/2010/01: RM 17255

I agree to take part in the above research. I have had the project explained to me and I have had a chance to ask questions. I understand that agreeing to this means that I will be willing to do the following: (please tick each box)

- ☐ I agree to take part in this research project and to allow my answers to be collected and analysed.
- ☐ I have had the project explained to me.
- ☐ I have had the chance to ask questions and these have been answered to my satisfaction.
- ☐ I have no objection to my mathematics results being used in this study.
- ☐ I understand that I don't have to take part in the research and that I may withdraw from this project without having to give a reason.
- ☐ I understand that any information I provide will be kept confidential to the researcher and that I will not be identified in the research or any reports on the project or to any party.
- ☐ I understand that any data gathered from this project will be destroyed after three years.

Name: _____

Date: _____

Signature: _____

APPENDIX X

Parental Consent Form

Project Title: Relationships among beliefs about mathematical ability, achievement goals, learning strategies and mathematics achievement of higher secondary students in the Maldives.

Ethics Application **SEPP/2010/01: RM 17255**

I agree that my child may take part in the above research. I have had the project explained to me and I have had a chance to ask questions. I understand that agreeing to this means that I will be willing to do the following: (please tick box)

- ☐ I agree that my child may take part in this research project and to allow my child's answers to be collected and analysed.

- ☐ I have had the project explained to me.

- ☐ I have had the chance to ask questions and these have been answered to my satisfaction.

- ☐ I agree to allow my child's mathematics results to be collected and analysed.

- ☐ I understand that my child does not have to take part in the research and that he or she may withdraw from this project without having to give a reason.

- ☐ I understand that any information my child provides will be kept confidential to the researcher and that he or she will not be identified in the research or any reports on the project or to any party.

- ☐ I understand that any information from this project will be destroyed after three years.

- ☐ I understand that this assessment is for research purposes only, and will not impact on my child's immediate classroom instruction.

Name: _____

Date: _____

Signature: _____

APPENDIX Y

VICTORIA UNIVERSITY OF WELLINGTON

Te Whare Wananga o te Upoko o te Ika a Maui



Relationships among students' beliefs about their mathematical ability, achievement goals, learning strategies, and mathematics achievement of higher secondary students in the Maldives

CONFIDENTIALITY AGREEMENT FOR TRANSCRIBERS

I, _____, (Transcriber) agree to keep all information derived from my participation in the study entitled "*Relationships among students' beliefs about mathematical ability, achievement goals, learning strategies, and mathematics achievement of higher secondary students in the Maldives*" confidential to myself and the Principal Researcher, Ahmed Riyaz. I also agree to take all possible precautions at every stage of research to guarantee the participant anonymity as indicated in their Consent Forms.

This undertaking includes all aspects of the gathering, handling, storage and publication of research materials during and subsequent to the research.

Ahmed Riyaz

Principal Researcher

Date:

Transcriber

Date