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Investigating the role of maths intelligence and failure mindsets and the responses of teachers and mothers to pupils' maths intelligence mindsets and/or achievement in Riyadh, Saudi Arabia.

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Alaa Saleh Alassaf

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Abstract

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Intelligence mindset refers to beliefs regarding the fixedness or malleability of intelligence and includes two types: growth and fixed (Haimovitz & Dweck, 2017). Previous research has confirmed the associations between students' intelligence mindsets and achievement. Additionally, recent studies have demonstrated the importance of adults' mindsets and practices on shaping children's intelligence mindsets and influencing their achievement. Accordingly, Haimovitz and Dweck (2017) developed a model suggesting that adults' intelligence and/or failure mindsets might impact their response toward their children's success and/or failure, thus influencing their children's intelligence mindsets. This thesis aimed to test this model in the subject of mathematics, to understand and to explain the role of adults' mindsets and responses in forming their children's intelligence mindsets. Additionally, this thesis sought to expand the literature by investigating the impact of mindsets in a Saudi Arabian context, as most studies into mindsets have been conducted in Western countries.

Firstly, a systematic review aiming to investigate the relationship between teacher intelligence mindset and pupils' maths achievement was conducted. The review included seven studies that reported mixed evidence. Secondly, a qualitative study exploring the role of 30 primary maths teachers' intelligence mindsets and practices in their pupils' maths success and failure was carried out. As a result of thematic analysis, five overarching themes emerged. Lastly, a quantitative study was also conducted. It explored the impact of maths teachers' and mothers' intelligence and failure mindsets on their response orientations to a pupil's/child's maths failure scenario and how these influenced their intelligence mindsets. The findings showed that across 56 pupils (aged 10 to 12 years old) and their mothers and maths teachers (one triad per school) only the mothers' mindset/practice was found to shape their child's intelligence mindset concerning their maths' ability. The implications, strengths, limitations and recommendations for future research were also provided.

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Declaration of Authorship

Print name: Alaa Saleh Alassaf

Title of thesis: Investigating the role of maths intelligence and failure mindsets and the responses of teachers and mothers to pupils' maths intelligence mindsets and/or achievement in Riyadh, Saudi Arabia.

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

Signature: ..... Date: 27/ 01/ 2023

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List of Abbreviations

ETEC	Education and Training Evaluation Commission
GASTAT	General Authority for Statistics
GPA	Grade point average
KSA	Kingdom of Saudi Arabia
MOE	Ministry of Education
MTMF	The Math Teaching for Mindset Framework
OECD	Organization for Economic Cooperation and Development
PISA	Programme for International Student Assessment
r	Pearson correlation coefficients
SES	Socioeconomic Status
STEM	Science, Technology, Engineering, and Mathematics
TIMSS	Trends of the International Mathematics and Science Studies
UK	United Kingdom
UNP	Unified National Platform
USA	United States of America

Chapter 1 A literature review of mindsets and response orientations

1.1 Introduction

This chapter begins by presenting the structure of the thesis. Following that, it provides a description of the concept of implicit theories of intelligence, and then presents the factors that may affect and shape an individual's intelligence mindset. In addition, it demonstrates how both types of intelligence mindset are associated with other motivational constructs. Subsequently, it describes the concepts of implicit theories of failure and response orientations. Lastly, the literature review, which aims to consider the role of students' mindsets on their academic achievement and the role of adults' mindsets and/or response orientations on their children's mindsets and/or achievement, is presented.

1.2 Structure of the thesis

This thesis overall aims to explore the role of maths teachers' and/or mothers' intelligence mindsets, failure mindsets and response orientation to their pupils'/children's maths intelligence mindsets and/or achievement. This is in order to investigate how adults' beliefs and practices might shape their children's intelligence mindsets and cause them to adopt more of growth or fixed mindset in relation to their abilities in maths. Therefore, three studies will be included in this thesis, each of which will use different methods to achieve the objectives of the current thesis. The three studies contained in this thesis will be a systematic review, a qualitative study and a quantitative study. The overall structure of the thesis takes the form of six chapters.

Chapter 1 began with an introduction. Following this section, it will provide a theoretical framework concerning three themes: the implicit theories of intelligence (i.e., intelligence mindsets), the implicit theories of failure (i.e., failure mindsets), and response orientations to failure in the context of mathematics. This theoretical framework will start by presenting a literature review about both growth and fixed maths intelligence mindsets and then describe the factors that might impact individual mindsets such as gender, age, experience and so on. Subsequently, it will identify the concepts related to intelligence mindsets. Following that, it will provide information about both types of failure mindsets: enhancing and debilitating. Then, the chapter will describe the concept of response orientations to failure and explain both types of orientations: performance orientation and learning orientation. Finally, it will demonstrate the role of teachers', mothers' and pupils' own mindsets on the motivation and achievement of maths pupils.

Chapter 2 will begin by presenting a literature review of the implicit theories of intelligence studies, which were conducted among teachers and students at different stages of their education in the Kingdom of Saudi Arabia (KSA). Then, it will provide a description of the education system in the KSA by first explaining the origins of the Ministry of Education (MOE), before moving on to describe the stages of education and the categories and types of schools in the country. Following that, the education development plan that has been implemented by the MOE in the KSA, in order to realize the "Saudi Vision 2030", will be detailed. Subsequently, the assessment systems that have been applied in primary schools since 2016/17 will be presented, followed by evidence related to Saudi students' performance in mathematics assessments. Then, the rationale, contributions and application of the research in Saudi education will be discussed. Finally, the research aims, design and questions will be described.

Chapter 3 will present the first study of this thesis. This study includes a systematic review of the relationship between maths teachers' intelligence mindsets and their pupils' maths achievements in primary and secondary schools from 1980 to 2020. In addition, it will present and discuss the results and implications of the study, as well as provide the strengths and limitations of this systematic review and suggestions for future research, as a result of conducting this review.

Chapter 4 will detail the second study of this thesis. Based on interviews, this study took a qualitative method approach, aiming to investigate and understand the role of 30 primary school maths teachers' intelligence mindset and their reactions to their pupils' (aged 10 and 11 years old) maths achievement and failure in Riyadh, Saudi Arabia. A thematic analysis will present the results that cover the five main themes. Then, the discussion, strengths and limitations, future direction of research and conclusion will be provided.

Chapter 5 will present the third and final empirical study of this thesis. This study utilised a quantitative method, in the form of online questionnaires that determined the intelligence and failure mindsets, as well as the response orientations of maths teachers, mothers and pupils (aged 10 and 11 years old) to a hypothetical scenario detailing their pupil's/child's own maths failure. The results of these relationships as suggested in the hypothesised model created by Haimovitz and Dweck (2017), will be presented. An expanded version of Haimovitz and Dweck's model (2017), including additional relationships related to children's beliefs, was also explored, in order to test these correlations, and thus improve upon our understanding of what promotes a growth or fixed mindset in children, beyond that obtained from only considering the relationships suggested by Haimovitz and Dweck (2017). Lastly, the discussion, strengths and limitations, future research recommendations and a conclusion will be given in detail.

Chapter 6, the final chapter of this thesis, will summarise the aims and key findings of the three studies contained in this current thesis and then provide a general discussion. The strengths and limitations of the thesis, along with the implications and suggestions for future directions of research will be presented. Finally, the conclusion will be provided.

1.3 Implicit theories of intelligence

Throughout the 19th century, many theories emerged regarding students' motivation to learn. Some of these explicit theories were put forward by experts in the domain, such as psychologists or other scientists, and were based on data gathered from participants' performance in tasks that were intended to measure psychological functioning (Sternberg, 1985; Zhang & Sternberg, 1998). On the contrary, implicit theories are defined as concepts held by both experts such as psychologists or lay people about phenomena and that already exist in their minds (Sternberg, 1985; Zhang & Sternberg, 1998). One set of these theories is the Implicit Theories of Intelligence, which was developed by Bandura and Dweck in 1981 (as cited in Dweck & Leggett, 1988; Dweck, 2000). Implicit theories of intelligence are defined as individuals' implicit perceptions regarding the nature of their capacities (Dweck & Leggett, 1988). The term 'implicit' was used because these assumptions are not often clear (Yeager & Dweck, 2012). Furthermore, the word 'theories' was used because they form a framework used to make predictions and judgements, similar to a scientific theory (Yeager & Dweck, 2012).

There are two types of implicit theories of intelligence: entity theory and incremental theory (Dweck & Leggett, 1988), both of which refer to a person's assumptions regarding the fixedness or malleability of human abilities (Dweck et al., 1995). Recently, however, Dweck and other researchers have begun to use another term in place of implicit theories of intelligence, namely intelligence mindsets. Moreover, they also introduced the terms 'fixed intelligence mindset' to replace entity theory and 'growth intelligence mindset' as a replacement of incremental theory.

To clarify, individuals who adopt a fixed mindset believe that an individual's capabilities and abilities such as their intelligence is unchangeable, limited and cannot improve (Dweck, 2006; Dweck & Leggett, 1988). This belief, it is argued, drives them to appear intelligent, steer clear of challenges or be more likely to admit defeat in the face of them, view effort as futile, disregard constructive criticism and feel threatened when other people succeed (Dweck, 2006). Consequently, their potential for growth may stagnate and the individual may never fulfil their potential (Dweck, 2006). Students who endorse a fixed intelligence mindset not only set the goal of appearing intelligent, even at the expense of learning, but also view failure and effort as reflecting low intelligence, devote

less effort when facing difficulties, demonstrate a high level of self-defeating defensive behaviour and deliver a poorer performance after a challenge (Dweck, 2002b).

Conversely, individuals who adopt a growth mindset are more likely to believe that capability and ability, as well as intelligence, can be improved over time (Dweck, 2006; Yeager & Dweck, 2012). Thus, this belief propels them to learn and participate in challenges, persevere in the face of failure, believe that proficiency can be achieved with effort, learn from valuable negative feedback and benefit from the success stories of other people (Dweck, 2006). Consequently, they are likely to reach a higher level of achievement than individuals who hold a fixed mindset (Dweck, 2006). Students who endorse a growth intelligence mindset not only identify their goal as learning new things, regardless of their difficulty or risk, but also view failure as an indicator of a feeble attempt and a poor strategy, view effort as activating intelligence, expend more effort after encountering difficulties, show low levels of self-defeating defensiveness and their performance after facing a difficulty is equal to that beforehand or improved (Dweck, 2002b).

However, it is worth mentioning that neither type of mindset is correct, since both (i.e., growth and fixed) have potential drawbacks and benefits (Dweck et al., 1995). Most people are classified into these two types of intelligence mindsets according to their beliefs. For example, Dweck (2008) stated that 40% of the students held a fixed mindset, while 40% of the students held a growth mindset, and around 20% did not make a clear choice, and therefore did not fall into either category. Claro et al. (2016) also showed that some individuals hold mixed intelligence mindsets, that is, that they do not strongly endorse either a fixed or growth intelligence mindset. This was evident in their academic results of their study (Claro et al., 2016), as the mixed mindset group usually scored between the growth and fixed mindset groups in maths and language performance tests.

Interestingly, it has also been noted that maths teachers who hold a growth mindset may send contradictory fixed mindset messages to their students through their instruction (Sun, 2019). Dweck (2016) indicated that there is a misunderstanding about the meaning of true growth mindset, which she referred to as a "False Growth Mindset". This concept means that teachers, for example, (1) praise and reward students' effort alone, rather than also praising their learning and improvement and emphasising the processes that lead to this outcome, (2) affirm students' ability to do anything without first receiving the skills, knowledge, strategies or resources, and (3) focus on blaming students' mindset when they fail rather than refocussing on instilling a growth mindset in students (Dweck, 2016). An example of this is seen in Buttrick's (2020) study, which analysed secondary data and included teachers and students aged 14 to 15 years old. The results

demonstrated that 22% of the teachers who participated had a fixed mindset, while 39% of the teachers held a true growth mindset. However, 38% of the teachers who participated had a false growth mindset. The results showed that students taught by teachers who held a false growth mindset were more likely to hold a fixed mindset and to believe that their teachers had a fixed mindset.

1.3.1 Factors that may affect and shape an individual's mindsets

Identity factors found to influence individuals' mindsets have been explored in several studies. For example, it has been argued in a number of studies that individuals' mindsets are affected by demographic factors such as culture and ethnicity, gender, age, socioeconomic status (SES), domain, years of experience and the school system. However, overall, the evidence from these studies has been mixed, with not clear evidence that any of these factors has a major influence on mindset.

1.3.1.1 Culture and ethnicity

Rattan, Savani, et al. (2012) pointed out that the belief that only a few people are highly intelligent is formed by culture. Accordingly, some researchers have investigated the role of culture and ethnicity in shaping individuals' mindsets. In terms of the role of culture, the results showed that individuals in the United Kingdom (UK) were more likely to hold more of a growth mindset than those in other countries. For example, Ilhan-Beyaztas and Dawson (2017) reported that a greater proportion of undergraduate students from England held a growth intelligence mindset (cf. fixed mindset) compared to Turkish students, who were found to hold a more fixed intelligence mindset (cf. growth mindset). Moreover, Asbury et al. (2016) found that British and East Asian students at British universities demonstrated a growth mindset, but those raised in the UK showed a more significant growth mindset than those raised in East Asian countries. Although the results regarding the role of British culture on individuals' mindsets were consistent, the results related to the effects of other cultures, such as American culture, were inconsistent and contradictory. For instance, across two studies, Sun et al. (2021) reported that Chinese students adopted a significantly more fixed intelligence mindsets compared to American students, who held more growth mindsets. In contrast, based on a series of studies, Rattan, Savani, et al. (2012) found that South Asian Indian believe that most people have the potential to become highly intelligent, while people in the United States of America (USA) were shown to hold the belief that only a few people can become highly intelligent.

Regarding the ethnicity factor, other studies aiming to investigate the role of ethnicity also found inconsistent and contradictory findings. For example, Chen (2012) found that Hispanic and African American students were more likely to hold a growth mindset regarding their capacity in science compared with White and Asian students, who were more likely to hold a fixed mindset. Hwang et al. (2019) also showed that White students were more likely to hold more of a fixed mindset in maths compared to African American and Hispanic students. On the contrary, Warren et al. (2019) and Jennings and Cuevas (2021) found that there were no differences in mindsets between students of any ethnicity. In addition, Canning et al. (2019) also found that instructors' race or ethnicity did not affect their mindset.

To summarise, the evidence regarding culture and ethnicity explored above indicates that individuals' mindsets about whether intelligence is changeable or not might be influenced by their culture and ethnicity.

1.3.1.2 Gender

Another factor that some studies have aimed to explore the impact of is an individual's beliefs about gender and its relationship with intelligence, however, the evidence has been mixed. That is, some studies have found significant differences in people's mindsets due to their gender, yet the findings of these studies have not agreed that a particular gender had a specific type of mindset. For example, Beyaztaş and Hymer (2018) found that the males who participated in the study tended to have a fixed mindset, while the females usually displayed a growth mindset. Diaconu-Gherasim et al. (2019) also demonstrated that although both girls and boys were found to believe that intelligence can be developed, the participating girls were shown to have higher mean scores regarding growth mindset than the boys. In contrast, Chen and Pajares (2010) and Su et al. (2021) reported that, on average, both the girls and the boys featured in their research held a growth mindset in term of their ability in science or general intelligence, however, the boys had a slightly higher growth mindset compared to the girls. In addition, Ibrahim and Ayoub (2011), Todor (2014), Ādamsone et al. (2020) and Ibrahim (2008) reported that boys/males included in their research tended to hold a growth mindset more often than girls/females. Another study revealed that the number of girls who held a fixed mindset related to their science capacity was higher than the number of boys (Chen, 2012). On the contrary, other studies did not find that participant's intelligence mindsets were affected by their gender (e.g., Ablard & Mills, 1996; Spinath & Stiensmeier-Pelster, 2001, in all the five studies; Leondari & Gialamas, 2002; Wynn, et al., 2012; Gutshall, 2013; Haimovitz & Dweck, 2016, in four studies 1, 2, 3a and 4; Macnamara & Rupani, 2017, through fixed-effect meta-analyses of their findings from three studies; Doedens-Plant, 2018;

Beyaztaş & Hymer, 2018, only in the children's sample; Hwang et al., 2019; Canning et al., 2019; Warren et al., 2019; Jennings & Cuevas, 2021). In a comprehensive survey of students around the world, the findings of the programme for international student assessment (PISA) in 2018 showed that girls aged 15 years old were more likely to hold a growth intelligence mindset compared to boys in 39 countries (including the KSA), while six countries showed the opposite (Organization for Economic Cooperation and Development [OECD], 2019a). However, the results of 32 countries showed no significant difference between boys and girls (OECD, 2019a). In summary, this review shows that there is no specific gender associated with a specific kind of mindset.

1.3.1.3 Age/grade

Studies have argued that mindsets might vary according to participants' age or school level. However, there has been no consensus concerning level differences in the participants' views about intelligence based on their age or school. For example, in several studies, it was found that older students held more fixed mindsets regarding capacity than their younger peers (Ablard & Mills, 1996; Leondari & Gialamas, 2002; Chen, 2012). Moreover, Robins and Pals (2002) reported that the intelligence mindsets of undergraduate students did not change from their senior year at high school to the end of college. Unlike previous findings, other studies did not find that participants' mindsets differed by age/grade (e.g., Wynn, et al., 2012; Haimovitz & Dweck, 2016, in three studies 1, 3a and 4; Doedens-Plant, 2018; Canning et al., 2019). The research explored illustrates that participants' age can be a factor that influences participants' mindset and their belief that intelligence can be improved or not.

1.3.1.4 Socioeconomic status (SES)

Researchers have argued whether or not an individual's SES affects their mindset. For instance, Claro et al. (2016) found that students from a low SES were more likely to have a fixed mindset than those from a high SES. Warren et al. (2019) also reported that pupils qualifying for free school meal status held a fixed intelligence mindset more strongly than pupils who did not qualify for free school meals. Moreover, Destin et al.'s (2019) results revealed that students with a higher SES believed less in a fixed mindset than students with a lower SES. In contrast, Hwang et al. (2019) found that students with a high SES tended to display more of a fixed mindset than individuals with a lower SES. However, other studies found that SES did not impact either an adult's or child's mindsets (Haimovitz & Dweck, 2016, in three studies 1, 2 and 4). The PISA 2018 findings demonstrated that socio-economically disadvantaged students from 68 countries (including the KSA) were more likely to hold a fixed intelligence mindset compared to advantaged students, while the results from B-S-J-Z

(China) showed the opposite (OECD, 2019a). However, eight countries/cities (Germany, Switzerland, Turkey, Czech Republic, Macao and Hong Kong in China, Greece and Albania) revealed no significant difference between them (OECD, 2019a). The evidence reviewed here seems to suggest that SES may impact an individual's mindset and their belief that intelligence is either malleable or fixed.

1.3.1.5 Domain-specific mindsets

Another theory to consider is that mindsets might also be domain specific. That is, people do not have a single mindset/theory that encompasses all human characteristics (Dweck et al.,1995; Dweck & Molden, 2005; Dweck, 2006). Indeed, it has been shown that individuals may hold various mindsets for different attributes (Dweck et al.,1995). For example, people may believe that their intelligence can be developed, while their artistic skills cannot (Dweck, 2006). People may also have different intelligence mindsets about different school subjects. Dweck (2008) pointed out that students are more likely to subscribe to the fixed mindset for maths compared to other academic skills. Indeed, one study showed that teachers of languages, social sciences and practical disciplines were more likely to have a growth intelligence mindset rather than a fixed intelligence mindset, while maths and science teachers did not differ significantly in their preferences for one of these two types of mindsets (Jonsson et al., 2012). Yet, Kraker-Pauw et al. (2017, study 2) claimed that science, technology, engineering, and mathematics (STEM) teachers are more likely to give more growth-oriented feedback than teachers of other subjects. It has also been argued in studies by Aljughaiman and Ayoub (2017) and Ibrahim and Ayoub (2011) that the teachers of gifted students tend to display a growth intelligence mindset, while teachers in standard classrooms are more likely to demonstrate a fixed intelligence mindset. Nevertheless, unlike previous findings, Gutshall (2013) reported that, no matter whether teaching special education or regular students, it does not affect teachers' mindsets. Therefore, it is clear that although there is no consistency in the results of these studies whether a particular subject or attribute is linked to a specific type of intelligence mindset, there is agreement that individuals may hold different types of mindsets in different domains.

1.3.1.6 Years of teaching experience

Teachers' years of experience is another factor that researchers have argued may influence mindsets. Yet again, studies have provided mixed evidence. Some studies have reported that there is no association between intelligence mindsets and years of experience (e.g., Jones et al., 2012; Gutshall, 2013; Patterson et al., 2016; Canning et al., 2019). However, one further study reported that no differences were found for growth mindset, but there was a difference for fixed mindset (Jonsson et al., 2012). That is, older teachers with more years of experience and younger teachers

with fewer years of experience were more likely to hold the view that intelligence is fixed and unchangeable compared to older teachers with less experience and younger teachers with more experience (Jonsson et al., 2012). On the contrary, other studies provided evidence that teachers with more years of experience were more likely to hold more of a growth intelligence mindset than less-experienced teachers (e.g., Aljughaiman & Ayoub, 2017; Ibrahim & Ayoub, 2011; Alrajeh, 2017). From the findings outlined above, it is clear that teachers' years of experience may have an impact on mindset, leading an individual to develop the view that intelligence is either changeable or unchangeable.

1.3.1.7 School system

The school system could be one of the key factors that shapes teachers' mindsets. For example, in a qualitative study conducted by Zilka et al. (2019), it was pointed out that interviewed teachers reported that external factors such as the school learning environment, support from the principal/headmaster, structured mentorship and feedback frameworks and changes dictated externally, including the adoption of recent pedagogies and technology, might enhance a teacher's growth mindset. However, they also reported the external factors that can inhibit a teacher's growth mindset such as unsupportive environments, a lack of binding framework and autonomy, insufficient appreciation and unfair rewards. Sun (2019) also conducted a qualitative study which reported that existing structures in schools and districts, including standards, tracking policies, instructional strategies and standardised assessment, are aspects that may cause maths to be taught in a way that consistently impacts whether students receive growth mindset messages regarding their maths ability. Based on the results of the studies above, it is evident that the school system can influence an individual to develop a growth or fixed intelligence mindset.

To conclude, although this section presents inconsistent findings about whether demographic factors (culture and ethnicity, gender, age, SES, domain, years of experience, and school system) affect an individual's mindset or not, it is worth bearing in mind that all of these factors may have an impact on an individual holding more of a fixed or growth intelligence mindset.

1.3.2 Concepts related to intelligence mindsets

Intelligence mindsets are referred to as an individual's view of the origin of intelligence, and thus it is crucial to recognise the differences between mindsets and other closely related constructs (Smith & Capuzzi, 2019). Although mindsets differ from other concepts, they can indicate whether a person has a positive or negative level of other characteristics (Smith & Capuzzi, 2019). For example,

after a comprehensive literature review of growth mindset and grit, Myers et al. (2016) suggested that developing a growth mindset could be one method of helping an individual to gain non-cognitive skills such as grit. Indeed, studies have shown a positive significant correlation between holding a growth mindset and grit (e.g., Kannangara et al., 2018, study 2; Sigmundsson et al., 2020). In contrast to earlier findings, however, a non-significant small association between a growth intelligence mindset and grit was detected in Myers et al.'s (2016) study.

Intriguingly, no evidence was found of any association between intelligence mindsets and intelligence ability. For example, Li and Bates (2019, study 4) concluded that there was no significant association between children's mindsets and cognitive ability. Furthermore, Macnamara and Rupani (2017) conducted fixed-effect meta-analyses of their findings from three studies and found that the intelligence of participants, which only included females, was not associated with their intelligence mindset. Zirenko (2018) also reported that whether looking at separate sex samples or the whole sample of the study, which included both males and females, it was found that a growth intelligence mindset was not associated with both types of intelligence: fluid or crystallised. However, it was found that a growth intelligence mindset was positively associated with three of the Big-Five personality traits, namely, conscientiousness in both sexes of the sample, and extraversion and openness to experience in the female sample (Zirenko, 2018).

In terms of other psychological concepts, namely, self-esteem and self-efficacy, both are evaluative aspects of self-beliefs, yet they do not indicate whether students view their capacities as unchangeable or having room for improvement (Diseth et al., 2014). Indeed, Bonne and Johnston (2016) stated that theory-of-intelligence differs from self-efficacy, although both are psychological approaches to learning. Self-efficacy refers to an individual's confidence about their self-ability and interest in their current ability, while theory-of-intelligence is the belief in the concept of intelligence itself and being interested in the potential for individual development over time (Bonne & Johnston, 2016). Based on the difference between these concepts, the relationship between intelligence mindsets and self-efficacy has been widely investigated. Several studies have shown that growth intelligence mindsets and academic self-efficacy (e.g., Khalkhali & Aryanpour, 2013; Diseth et al., 2014; Zander et al., 2018; Abu-Nasser and Alasmary, 2018; OECD, 2019a) or maths self-efficacy (Todor, 2014; Huang et al., 2019; significant among the boy's sample only – not for women; King & Trinidad, 2021) are positively correlated.

Yet, Rhew et al. (2018) reported that although the growth mindset intervention had no significant difference in self-efficacy scores, there was a significant difference in the motivation scores of special education students in the treatment group compared to the student in the

comparison group. In addition, a further study indicated that having a growth mindset is positively associated with motivation/diligence, concentration and information processing, but negatively with self-handicapping (Ommundsen et al., 2005). However, a fixed mindset was found to be positively associated with self-handicapping, but negatively with motivation/diligence, concentration and information processing (Ommundsen et al., 2005). Zirenko's (2018) findings also showed that although a growth intelligence mindset was not associated with achievement motivation, it was associated with intraception motivation in the male sample only. Moreover, the OECD (2019a) reported that the PISA 2018 results revealed that students who held a growth mindset negatively correlated with fear of failure and positively correlated with their motivation to master tasks and appreciate the value of schooling.

There are also a few studies that have aimed to explore the relationship between intelligence mindset and self-esteem. For example, it was found that across the four years of college, students who endorsed a fixed mindset dropped in self-esteem, as they faced new academic challenges, while students who endorsed a growth mindset improved their self-esteem (Robins & Pals, 2002). Diseth et al.'s (2014) study also concluded that there was a positive association between a growth intelligence mindset and self-esteem among 6th and 8th graders. Yet, their findings also revealed that a fixed intelligence mindset was only weakly negatively associated with self-esteem and self-efficacy among 8th graders. Moreover, no association was found between these two variables among 6th graders (Diseth et al., 2014). On the other hand, it was reported that there is a relation between growth mindset and the ways of knowing and thinking. For example, a study conducted by Ibrahim (2008) documented that growth intelligence mindset predicted (1) two ways of knowing, namely, connected knowing and separate knowing, (2) eight out of ten styles of thinking, namely, legislative, executive, judicial, hierarchic, global, local, external, liberal, but not conservative and internal styles, (3) and academic achievement. However, it was reported that a fixed intelligence mindset did not predict any of these variables.

Given the expansion of research into intelligence mindset, several studies have aimed to estimate the relationship between growth and/or fixed intelligence mindsets and other psychological notions which might be related to or impact pupils'/students' academic achievement. For example, it has been shown that children who hold a growth mindset demonstrate better classroom behavioural self-regulation than children who endorse a fixed mindset (Compagnoni et al., 2019). A growth mindset was also positively associated with student-rated math engagement (King & Trinidad, 2021). In addition, another study showed that a growth intelligence mindset is positively correlated with resilience, school engagement and psychological well-being (Zeng et al.,

2016). Zeng et al. (2016) also reported that the findings of a structural equation model demonstrated that the effects of a growth intelligence mindset on school engagement and psychological well-being were mediated by resilience. Contrary to previously published studies, some studies were unable to demonstrate a significant positive correlation between mindsets and resilience. For example, an interesting finding reported by Burgoyne et al. (2020) concluded that there was no evidence of the predicted association of a growth intelligence mindset with persistence to overcome challenges, or of the predicted association of a fixed intelligence mindset with the belief that talent alone can create success. Moreover, it was shown that among undergraduate students receiving failure feedback, those who endorsed more of a fixed intelligence mindset outperformed students who held more of a growth intelligence mindset.

Li and Bates (2019) also reported that among the three studies, only study 1 demonstrated a significant positive effect of a growth (cf. fixed) mindset on a moderate difficulty postfailure test performance. That is, two studies (2 and 3) did not show any effects of a growth mindset on children's postfailure performance, whether on moderate or more difficult/challenging material. Additionally, it was shown that children's mindsets were not associated with resilience to failure for any outcome measure. To illustrate, it was found that growth mindset manipulation did not lead children to pursue a learning goal rather than a performance goal, raise task persistence, raise children's enjoyment of solving problems, raise self-rated performance quality, or lead children to attribute their failure to effort rather than ability. Moreover, surprisingly, it was found that endorsing a growth mindset harms their response to more difficult material.

A number of studies have also explored whether mindsets are related to or impact maths anxiety or not. However, previous research findings have been inconsistent and contradictory. For example, Huang et al. (2019) showed that a growth mindset was not associated with mathematics anxiety for either girls or boys. In contrast, Smith and Capuzzi (2019) reported that mindset intervention successfully changed students' mindsets to become more growth-oriented, and this was linked to a reduction in statistics anxiety and an improvement in students' statistics course grade. Samuel and Warner (2021) also found that mindfulness and growth mindset intervention had decreased college students' math anxiety and increased their math self-efficacy by the end of the semester.

Dweck (1986) argued that children who held fixed intelligence mindsets were more likely to exhibit performance goals focussed on obtaining favourable opinions of that attribute, while children who held growth intelligence mindsets were more likely to exhibit learning goals which centred on improving that trait, subsequently these goals appeared to establish various behavioural

patterns. Indeed, previous studies have reported a correlation between achievement goals and intelligence mindsets. The results of many studies are consistent with the assumptions of Dweck's motivational model. For example, it has been shown that learning goal orientation (also labelled as mastery approach goals) has a positive significant association with a growth mindset (e.g., Robins & Pals, 2002; Blackwell et al., 2007, Study 1; Delavar et al., 2011; Magno, 2012; De Castella & Byrne, 2015; Beyaztaş et al., 2017; Diaconu-Gherasim et al., 2019; OECD, 2019a; Burgoyne et al., 2020), and a negative association with a fixed mindset (Delavar et al., 2011; De Castella & Byrne, 2015). It has also been revealed that there is a positive significant association between a fixed mindset and performance goal orientation (also labelled as performance approach goals, e.g., Robins & Pals, 2002; Magno, 2012; Beyaztaş et al., 2017; Diaconu-Gherasim et al., 2019; Burgoyne et al., 2020). However, some studies found the opposite. That is, performance goal orientation was positively associated with a growth mindset (e.g., Magno, 2012; De Castella & Byrne, 2015; Diaconu-Gherasim et al., 2019) and negatively associated with a fixed mindset (e.g., De Castella & Byrne, 2015).

Recently, two achievement goals were added, namely, a mastery-avoidance goal orientation, which is defined as students who make an effort to avoid a lack of mastery or failing in their learning whenever possible, and a performance-avoidance goal orientation, which is defined as students who strive to appear competent or competent enough compared to others (Wolters, 2004). The findings of several studies reported that performance-avoidance goals were positively associated with a fixed mindset (e.g., Magno, 2012), negatively associated with a fixed mindset (e.g., De Castella & Byrne, 2015), positively associated with a growth mindset (e.g., De Castella & Byrne, 2015) and negatively associated with a growth mindset (e.g., Diaconu-Gherasim et al., 2019). Additionally, Delavar et al.'s (2011) results demonstrated that mastery-avoidance goals were negatively associated with a growth mindset and positively associated with a fixed mindset.

Regarding the impact of praise for intelligence or effort on pupils' goals, Mueller and Dweck's (1998) findings revealed that pupils who were praised for their intelligence (cf. praise for effort) after a success tended to focus more on performance (cf. learning) goals. Moreover, when facing failure, the pupils demonstrated lower levels of task persistence and enjoyment, lower ability attributions (rather than ascribing the failures to insufficient effort), and poorer task performance compared to pupils who were praised for their effort.

Taken together, these studies support the notion that the concept of mindsets is related to other psychological concepts, whether this correlation is negative or positive. However, considering all of this evidence, it seems that an individual's own growth intelligence mindset is positively related to other psychological concepts such as grit, self-efficacy, self-regulation, resilience, school

engagement, psychological well-being and other variables. Moreover, the evidence presented in this section suggests that holding a growth intelligence mindset can help student to decrease negative feelings and/or increase positive self-belief.

1.4 Implicit theories of failure

One set of modern theories related to motivation, which was developed in 2016 by Haimovitz and Dweck, are the implicit theories of failure, also known as failure mindsets. Implicit theories of failure refer to individuals' reactions to setbacks such as adults' responses to their children's setbacks (Haimovitz & Dweck, 2016). These theories include two types of reactions: failure-is-enhancing or failure-is-debilitating (Haimovitz & Dweck, 2016). That is, some individuals may view failure as an experience that enhances and facilitates performance, learning and development, while others might believe that failure is an experience that inhibits and debilitates performance, learning and development (Haimovitz & Dweck, 2016).

1.5 Response orientation

The actions and practices of people in a failure and/or success situation are known as response orientations (Haimovitz & Dweck, 2016). There are two types of response orientations: person/performance orientation and process/learning orientation (Haimovitz & Dweck, 2016, 2017). That is, in the event of failure, performance orientation reflects parents' nervousness and anxieties about their children's low capacity and poor performance, which are evident in their conversations and responses to them (Haimovitz & Dweck, 2016). Specifically, they react in a way that shows that they are "pitying their children, doubting their ability, comforting them for not having enough ability" (Haimovitz & Dweck, 2016, p. 864). In contrast, learning orientation reflects parents' view of failure as a positive experience for their children, which helps them to focus on learning and growth, rather than being concerned about setbacks and what they may mean about their children (Haimovitz & Dweck, 2016). Specifically, they react in a way that demonstrates that they are "discussing what their children could learn from the experience and how they might improve in the future" (Haimovitz & Dweck, 2016, p. 864).

1.6 The role of students' intelligence mindsets on their academic achievement

In the last few decades, researchers around the world have sought to discover the factors that affect students' motivation and achievement. Thus, studies have argued that students' psychological factors such as their beliefs and perspectives of their abilities and intelligence can play

a crucial role in influencing their motivation and achievement either positively or negatively. However, the findings from these studies have been conflicting. That is, some studies have demonstrated a positive relationship between students' growth intelligence mindset and their academic achievement/grade point average (GPA; e.g., Paunesku et al., 2015; Tarbetsky et al., 2016; West et al., 2016; Zhang et al., 2019; Diaconu-Gherasim et al., 2019) and other studies have shown a negative relationship between students' fixed mindset and their academic achievement/attainment/ GPA (e.g., De Castella & Byrne, 2015; Mouratidis et al., 2017; Destin et al., 2019; Diaconu-Gherasim et al., 2019). Yet, in other research, no relationships have been reported (e.g., Leondari & Gialamas, 2002; Kornilova et al., 2009; Zhu et al., 2020, Study 4; Dixson et al., 2017; Li & Bates, 2019, Study 4). Interestingly, Bahník and Vranka (2017) reported a slight negative association between undergraduate students' growth intelligence mindset and general academic prerequisites.

Given that intelligence mindsets appear to be domain-specific (see Section 1.3.1.5), several studies have aimed to investigate the associations between both types of intelligence mindset (growth and fixed) and a particular domain such as mathematics. Yet again, studies have provided mixed evidence. Some of these studies have demonstrated a positive correlation between student growth intelligence mindset and maths achievement (e.g., Blackwell et al., 2007, Study 1; Park et al., 2016; Claro et al., 2016; Tarbetsky et al., 2016: Bostwick et al., 2019; 2020; Su et al., 2021) and other studies have shown a negative association between a fixed mindset concerning intelligence and performance and participants' maths achievement (e.g., Stipek & Gralinski, 1996; Warren et al., 2019). However, several studies have failed to find a correlation between these two variables (e.g., Ayeni, 2021; Li & Bates, 2019, Study 4).

The association between growth and/or fixed mindset and academic achievement/attainment has been the subject of some systematic investigation. The first systematic review of the relationship between students' mindsets and their academic achievement/attainment was reported by Zhang et al. in 2017. They suggested that, in general, students' mindsets play different roles in their academic achievement. That is, the findings demonstrated that students' mindsets were related to their academic achievement, whether as a cause of their academic achievement (in 13 studies), as a mediator (in two studies), or as an outcome of students' previous academic achievement (in one study). However, the review also found two studies failed to find an association between students' mindsets and their academic achievement. To conclude, although this systematic review found that students' mindsets play different roles in their academic achievement, most of the studies included in this review found that mindset plays a causal role in academic achievement.

A meta-analytic review was also conducted by Costa and Faria in 2018. It aimed to model the relationship between students' intelligence mindsets and their academic achievement. The review reported that 46 studies (94 effect sizes), with a total of 412,022 students, demonstrated a low-to-moderate association between students' intelligence mindsets in general and their academic achievement. To illustrate, it was found that there was a positive association between the growth intelligence mindset and students' academic achievement including verbal achievement (i.e., language, literacy, and writing-reading achievement), quantitative achievement (i.e., math achievement, advanced math course grade, statistics exam grade, and math exam grade) and general grade assessment, but not with students' self-reported achievement/grades. In addition, although this review failed to find a correlation between the fixed intelligence mindset and students' general grade assessment, a lower magnitude positive correlation (compared to the growth intelligence mindset) was found with students' verbal and quantitative achievement (Costa & Faria, 2018).

Furthermore, an analysis of the moderator effect related to individual differences in this meta-analysis highlighted that although the association between students' intelligence mindsets and their academic achievement was not moderated by gender, it was moderated by students' educational levels (Costa & Faria, 2018). That is, it was found that students' growth mindset is related to higher general academic achievement at different educational levels, namely, middle school, high school and college. However, in particular domains of achievement, it was demonstrated that a growth mindset is only associated with higher verbal and quantitative academic achievement at middle school. In the case of fixed mindset, although the analysis of the middle school was not computed, it was reported that fixed mindset was not related to student's academic achievement at both college and high school levels. Regarding verbal and quantitative achievements, despite only the analysis of high school being computed, students' fixed mindset was positively related to those two types of achievement at high school (Costa & Faria, 2018).

In terms of moderator analyses related to intelligence mindsets measurements, it was shown that the use of domain-specific intelligence mindsets measurements (compared to general intelligence mindsets measurements) strongly moderated the association between growth and fixed intelligence mindsets and students' general academic achievement (Costa & Faria, 2018). The results also showed that a particular growth mindset measurement has a stronger correlation to students' quantitative achievement and global assessment grades compared to the general growth mindset measurement, however, students' verbal achievement was only related to the general growth intelligence mindset scale (not the particular growth intelligence mindset scale). It is important to

note that an analysis of the relationship between the specific domain of fixed intelligence mindset and particular academic subjects was not computed (Costa & Faria, 2018).

Moreover, the findings of this study revealed that using the most recent versions of Dweck's intelligence mindsets scales (i.e., versions 1999 and 2006) and the original measures, instead of those translated into a particular language or adapted for a specific culture, strongly moderated the association between both growth and fixed intelligence mindsets and students' academic achievement (Costa & Faria, 2018). Regarding specific domains of achievement, there was an association between growth intelligence mindset, whether measured using the original or adapted versions of the scales, and students' quantitative achievement, but not with students' verbal achievement. However, the growth and fixed intelligence mindsets scale, when measured using the original or adapted versions, were associated with students' global assessment grade (Costa & Faria, 2018).

The review also analyses the moderator effect related to students' cultural background. The findings presented a positive correlation between a growth intelligence mindset and academic achievement among students from Asia and Oceania (Australia). There was no significant correlation between fixed mindset and achievement among Asian students, whereas students from Europe showed a positive modest association between a fixed intelligence mindset and verbal and quantitative achievement. However, students from North America only demonstrated a negative association between a fixed intelligence mindset and their academic achievement (Costa & Faria, 2018). Concerning specific domains of achievement, it was found that there was only a correlation between growth mindset and students' quantitative achievement (not for verbal, general assessment, and self-report outcomes) in students with a North American cultural background. Nevertheless, in the European sample, only a significant association between a growth intelligence mindset and the global assessment grade (not for verbal or quantitative achievement) was found, however, there was a significant association between a fixed intelligence mindset and verbal and quantitative achievement, but not for the global assessment grade. Additionally, in the Asian sample, a growth intelligence mindset, not a fixed intelligence mindset, was positively correlated with a global assessment grade (Costa & Faria, 2018).

A further meta-analysis reported by Sisk et al. in 2018 (Meta-Analysis 1; see the results of the second meta-analysis in section 2.7) included 129 studies (273 effect sizes), with a total of 365,915 students, that showed that the association between a growth mindset and academic achievement was very weak. Moreover, the analyses of moderator factors related to students indicated that the developmental stages for children and adolescents, but not for adults, showed a

statistically significant weak impact on the association between growth mindset and academic achievement. The findings also demonstrated that academic risk status did not significantly moderate this association. This factor included three levels: the high level reflected students who were at risk of failing, such as students who had a history of failing courses, while the moderate level represented students facing a situational challenge such as moving to a new school or being threatened or manipulated by a stereotype, and low-level included students who showed no signs that they were at risk. SES, whether low, middle or high, was also not found to significantly moderate this association. Additionally, the academic achievement measure, whether for studies that used a course exam, a course grade, GPA, a standardised test or measured laboratory-based achievement, was not a statistically significant moderator of this association. Thus, it is clear that there was a very weak association between mindsets and academic achievement, and this association was only moderated by the children's and adolescents' developmental stages.

Moreover, the PISA 2018 surveyed the intelligence mindsets of students from 78 countries and economies. It was shown that students who adopted a growth mindset about intelligence achieved better in reading, maths and science compared to students who adopted a fixed mindset about intelligence, when accounting for students' and schools' socioeconomic profile (Gouëdard, 2021).

To summarise, it is evident from the above that there is an inconsistency in the results related to investigating the relationship between students' intelligence mindsets (both growth and fixed) and their academic achievement/attainment, whether in general or in relation to a specific subject such as maths.

1.7 The role of adults' mindsets and/or response orientation to their children's mindsets and/or academic achievement

Researchers have sought to find factors that help increase students' motivation and academic achievement. Accordingly, it has been argued that adults' intelligence mindsets impact their children's motivation and intelligence mindsets. Therefore, a number of studies have aimed to understand the relationships between adults' intelligence mindsets and their children's intelligence mindsets. Some of these studies have aimed to explore the influence of teachers' mindsets on their students' mindsets, while others have sought to explore the influence of parents' intelligence mindsets on their children's intelligence mindsets. However, the findings have not been consistent. That is, some of these studies have found that the intelligence/ability mindsets of teachers (e.g., Gutshall, 2016; Mesler et al., 2021) or parents or children's perceptions of parents'

intelligence/ability mindset (e.g., Matthes & Stoeger, 2018; Hayden, 2019, for only younger students) is positively associated with their pupils'/children's own intelligence mindsets. However, other studies have not established any relationships between the intelligence mindsets of teachers (e.g., Sun, 2015; Park et al., 2016) or parents/children's perceptions of parents (e.g., Haimovitz & Dweck, 2016, Study 1; Barba, 2019; Hayden, 2019, only among older students) and their pupils'/children's intelligence mindsets.

Although some studies have not reported any relationship between adults' intelligence mindsets and children's intelligence mindsets, other studies have found that adults' intelligence mindsets correlate with their responses/reactions to their children. For example, Stipek et al. (2001) found that teachers who endorsed a fixed intelligence mindset tended to use more performance-oriented instructional classroom practices. Additionally, Park et al.'s (2016) results revealed an association between teachers' mindsets and their instructional practices. That is, teachers who believed that intelligence is fixed, were more likely to adopt performance-oriented instructional practices (i.e., refer to the practices of teaching that assert the importance of good scores and demonstrating competence). Moreover, teachers who believed that intelligence can be developed were more likely to adopt learning-oriented instructional practices (i.e., teaching practices that emphasise the importance of learning and hard work). Although they found no significant prediction between teachers who held learning-oriented instructional practices and their pupils' mindsets, teachers who tended to use performance-oriented instructional practices significantly predicted pupils who viewed intelligence as an unchangeable ability by the end of the academic year.

Adults' intelligence mindsets have not been shown to correlate with children's intelligence mindsets in some studies, perhaps because in situations of success or failure, parents' or teachers' implicit theories of intelligence are not obvious to pupils/children and, sometimes, do not manifest in parental/teachers' responses (Haimovitz & Dweck, 2016, 2017). However, "adults' theories of *how to motivate children*—how to make them feel good, how to give them confidence, how to motivate future learning" (p. 1855) may be more evident in the practices they use with their children, rather than their theories of intelligence (Haimovitz & Dweck, 2017). Indeed, the implicit theories of failure, which is considered one of the key motivation theories, states that adults' beliefs are sometimes visible in their practices, such as in the concern they show and their attitude, which in turn influence their children to adopt more of a growth or fixed intelligence mindset (Haimovitz & Dweck, 2016, 2017).

Accordingly, some studies have aimed to investigate the correlation between teachers' or parents' self-reported failure mindsets or their children's perceptions of their parents' failure

mindsets and their pupil's/ children's intelligence mindsets. However, there have been conflicting findings. Some of these studies have reported that children's intelligence mindsets were significantly positively associated with their either parents' failure mindsets (e.g., Haimovitz & Dweck, 2016, Study 1) and/or children's perceptions of their parents' failure mindsets (e.g., Haimovitz & Dweck, 2016, Study 3b; Li, 2020; Hayden, 2019, only among younger students) or their teachers' failure mindsets (e.g., Li, 2020). Conversely, Hayden (2019) showed that there was no significant association between adolescents' intelligence mindsets and their perceptions of their parents' view regarding failure. However, Haimovitz and Dweck (2016, study 1) found that although there was no significant direct association between parents' reports concerning their view of failure and their children's reports regarding their view of intelligence when controlling for children's perceptions of their parent's performance-versus-learning orientation, there was an indirect relationship between them that was fully mediated by children's perceptions of parent's performance-versus-learning orientation. That is, parents who believed that failure is debilitating to learning were more likely to have children who viewed their parents as holding more performance-oriented reactions, which led their children to hold more of a fixed intelligence mindset.

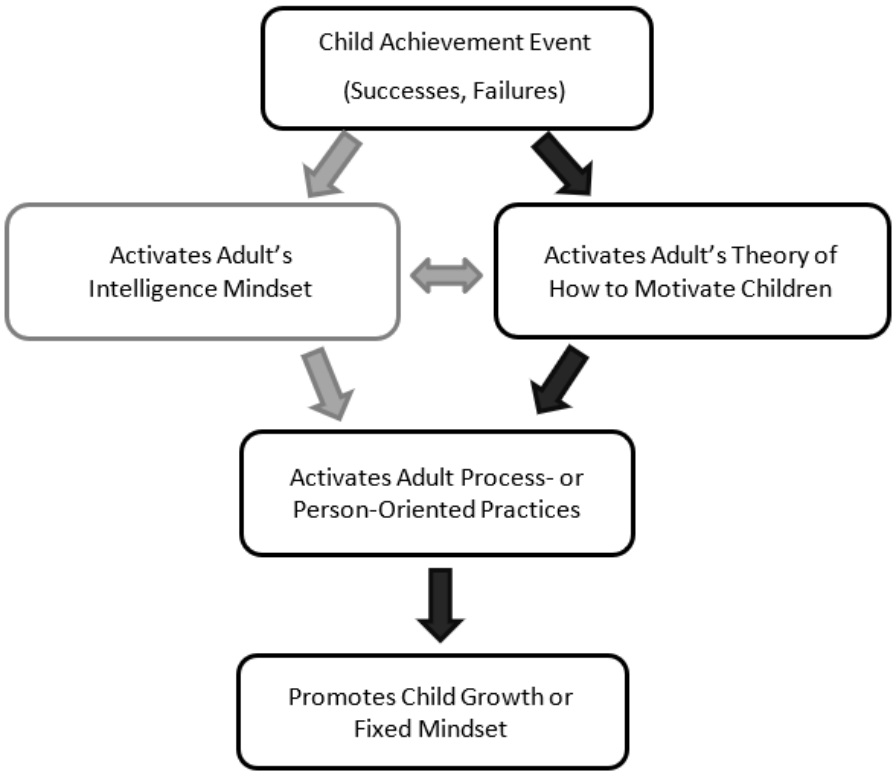
Haimovitz and Dweck (2016) also concluded in studies 2 and 4 that parents who viewed failure as a debilitating (cf. enhancing) experience were more likely to respond to the child-failure scenario with more performance-oriented responses than learning-oriented responses. Indeed, parents' anxieties about their child's performance and lack of ability, specifically, "pitying their children, doubting their ability, comforting them for not having enough ability" were reflected in their performance-oriented response (Haimovitz & Dweck, 2016, p. 864). This orientation is also known as person-oriented practice (Haimovitz & Dweck, 2017). In contrast, parents' support for their child's learning and improvement by "discussing what their children could learn from the experience and how they might improve in the future" was reflected in their learning-oriented responses (Haimovitz & Dweck, 2016, p. 864). This orientation is also referred to as process-oriented practice (Haimovitz & Dweck, 2017).

Consequently, a hypothesised model for how adults promote children's growth and fixed mindsets (see Figure 1) was recently developed by Haimovitz and Dweck (2017). The model is based on the theory that adults' intelligence mindsets and/or failure mindsets might be related to their responses and practices, which in turn influences whether their children hold more of a growth or fixed intelligence mindset. However, they also argued that adults' theories of intelligence might not be closely linked to their theories of motivation such as implicit theories of failure (Haimovitz & Dweck, 2017). Indeed, evidence on that topic has been mixed. For example, several studies have

reported that parents' failure mindsets are positively associated with their own intelligence mindsets (e.g., Haimovitz & Dweck, 2016, Study 1; Li, 2020; Jarsky, 2020). On the contrary, other studies have shown that there is no significant relationship between the intelligence mindset of both teachers and parents (Doedens-Plant, 2018) or even simply parents (Haimovitz & Dweck, 2016, Study 3a) and their failure mindset. Moreover, Tao et al. (2022) demonstrated that there was no significant effect of undergraduate students' failure-is-debilitating mindset at the baseline on their fixed intelligence mindset at follow-up.

Figure 1

Hypothesised model for how adults socialise children's growth and fixed mindsets



Note. From "The Origins of Children's Growth and Fixed Mindsets: New Research and a New Proposal," by K. Haimovitz, and C. S. Dweck, 2017, *Child Development, 88*(6), p. 1856. (https://doi.org/10.1111/cdev.12955). Copyright 2017 by the Child Development.

On the other hand, some researchers have been greatly interested in investigating the role of teachers' practices in classrooms, which deliver messages to their students about their abilities. It has been reported that the type of feedback that adults provide their children is a crucial factor that

influences them to adopt more of growth or fixed mindset. For example, in terms of growth mindset practices, it has been demonstrated that when children received praise about their intelligence in the event of success, for example hearing 'you succeeded because you are intelligent', this led them to adopt a fixed intelligence mindset, however, when children received praise regarding their effort, this led them to endorse a growth intelligence mindset (Mueller & Dweck, 1998, Study 4). Another study also reported that when undergraduate students received a growth mindset message, namely, "Everyone can do well with statistics if they work at it." (P.785) from their instructor at the beginning of a statistics lesson, students were more likely to develop a more growth mindset view about their abilities and to obtain higher scores compared to those who received fixed mindset messages, namely, "Some people do better with math than others." (Smith et al., 2018, P.785). Moreover, it was found that teachers who held a growth mindset (cf. fixed mindset) provided less feedback and focused on grades that reflect progress and the process, not the result (Kraker-Pauw et al., 2017, Study 2). PISA 2018 also reported that the association between teacher feedback and students' growth mindset was significantly negative for lower-performing students across OECD countries (Gouëdard, 2021).

Some studies have reported the practices that teachers use in their classrooms and how they cause their students to hold more growth or fixed intelligence mindsets about their abilities. Regarding practices that may help to convey messages promoting growth mindsets to students, it was revealed that teachers who regularly provided students with additional tuition, gave them a number of opportunities to improve and resubmit tasks, praised positive student attitudes and encouraged them to value and learn from their mistakes, promoted a growth mindset through these practices (Sun, 2018). Moreover, it was reported that teachers who affirmed the importance of failure and mistakes when learning and the value of struggling, provided extra help and/or used explicit growth mindset messages with their students (i.e., 'every student has the chance to succeed and the possibility to develop') delivered growth mindset messages to their students (Sun, 2019).

Additionally, PISA 2018 reported that there were positive significant correlations between the three teacher indices and students' growth mindset across OECD countries. These indices are (1) teacher support, namely, teachers helping their students with their learning, providing extra help, continuing teaching until their students understand, and showing an interest in every student's learning; (2) teachers adapting instruction to the class's needs and knowledge, providing individual help to students facing difficulties, and changing the structure of the lesson when students struggle to understand a topic; (3) teacher feedback – but only for those performing averagely in reading

(Gouëdard, 2021). Therefore, teachers who consistently assist their students provide a safe learning atmosphere that promotes the development of growth mindsets (Gouëdard, 2021).

Moreover, Francome and Hewitt (2020) reported that teachers from schools that used mixed-attainment maths groups were more likely to report a stronger growth mindset than teachers of maths classes divided into sets. However, Sun (2019) reported that teachers who used practices that included dividing students into heterogeneous grouping in the class and/or provided both types of praise, process praising and outcomes praising focused, for correctness delivered mixed mindsets messages to their students. It was also demonstrated that teachers who divided students into mixed-ability groups sent mixed mindsets messages to them (Sun, 2018).

In contrast, in terms of fixed mindset practices, it was reported that maths teachers who held fixed mindsets employed strategies they believed were beneficial, however, it was unlikely that these strategies would promote future achievement and engagement (Rattan, Good, et al., 2012). These strategies included providing low ability students with less maths homework, providing feedback that was aimed at helping them to accept their low abilities, as well as determining from a single test score if a student had poor maths ability (Rattan, Good, et al., 2012). In addition, teachers delivering fixed mindset messages to students about their ability to improve their maths skills had low expectations of weaker pupils and displayed the excellent scores of stronger students in public spaces in the school (Sun, 2018). Sun (2019) showed that teachers who requested their students follow procedures rather than asked them to develop their own methods and/or divided their students into high and low ability groups sent fixed mindset messages to their students. Stipek et al. (2001) also demonstrated that maths teachers who held fixed intelligence mindsets reported that grades and extrinsic rewards are useful methods that help motivate students to make an effort and engage them in activities related to maths.

The impact of teachers' fixed intelligence mindset was not limited to negatively affecting students' mindset about their abilities and their educational achievement, but extended to affecting students' motivation, their work in the classroom and other psychological aspects. Indeed, Canning et al. (2019) found that students taught by STEM professors who endorse a more fixed mindset showed poor performance in STEM courses, were less motivated to do their best work in classes by their professors, and they reported that their professors were less likely to use pedagogical practices that encourage improvement and learning in classes compared to students taught by STEM professors who endorsed a more growth mindset. A further study also revealed that college students who held the view that their STEM professors had a more fixed mindset were more psychologically vulnerable in their professors' classes, less engaged in their classes, less interested in

STEM at the end of the semester and obtained lower scores (Muenks et al., 2020). Additionally, across three experimental studies, LaCosse et al. (2021) found that when STEM subjects were taught by professors who held fixed mindset concerning intelligence compared to growth mindset, their college students anticipated more negative psychological experiences, were less interested in STEM, and performed poorly.

It is worth noting that although there have been some studies that have proven the positive impact of a growth intelligence mindset intervention on students' mindset and/or their educational achievement (see Section 3.2), this intervention alone may not be important if it is not supported by other factors. Therefore, it has been suggested that students' growth intelligence mindsets must be supported by their teacher's own growth intelligence mindsets in a class environment, in order to allow the proffered beliefs to be instilled, and thus thrive, since it is not enough for students to only autonomously implement their growth intelligence mindsets in the classroom (Yeager et al., 2022). Indeed, Yeager et al. (2022) conducted a growth mindset intervention for students aged 14 to 15 years old and found that students in classes with growth-minded teachers exhibited significant gains in their math grades compared to students in classes with fixed-minded teachers at the end of the academic year. That is, students who attended the intervention and then went back into class with fixed mindset teachers did not increase their math grades compared to students in the control group and students in classes with growth-minded teachers. Importantly, in comparison to students who reported more of a growth mindset at baseline, students who reported having a more fixed mindset at baseline, received a growth mindset intervention, and were then taught by a growth-minded teacher showed greater gains in maths achievement at the end of the year.

To sum up, it is clear from the results of the previous studies described above that adults' intelligence and failure mindsets impacts their practices and responses to their children in the event of both success or failure, which in turn influences their children to adopt more growth or fixed intelligence mindsets.

Chapter 2 Mindsets and Education in the Kingdom of Saudi Arabia

2.1 Introduction

Two of studies included in this thesis took place in Riyadh, in the KSA. Saudi Arabia is located in the far southwest of the continent of Asia and occupies four-fifths of the Arab Peninsula, with an area of about 2,000,000 square kilometres (KSA General Authority for Statistics [GASTAT], 2021). The official language of the country is Arabic. The population of the KSA is estimated at more than 34 million (specifically, 34, 110, 821) as of mid-2021 (KSA GASTAT, n.d.-b). Riyadh is the capital of the KSA and is inhabited by 8,660,885 citizens as of mid-2019 (KSA GASTAT, n.d.-a).

The participant data from the two empirical studies included in this thesis (i.e., the qualitative study conducted in 2018/19 and the quantitative study conducted in 2020/21) were collected in schools located in Riyadh, Saudi Arabia. Therefore, this chapter begins with a literature review of the intelligence mindsets in the context of the KSA. Next, a description of the history of education in the KSA is provided by describing the emergence of the MOE. Then, it describes the education stages and school categories in the KSA. Following that, it presents the national education development plan. Subsequently, it demonstrates the assessment system in primary schools by briefly explaining the previous assessment criteria issued by the MOE in Saudi Arabia. It then presents the current criteria applied to determine the success or failure of pupils in primary schools. Following that, it describes students' performance in mathematics assessments. Finally, the rationale, contributions, application of the research in education, aims, design and questions of the thesis are also introduced in this chapter.

2.2 The implicit theories of intelligence in a Saudi Arabian school context

A search of the literature revealed that, to the best of the researcher's knowledge, few studies have explored the topic of intelligence mindsets in the context of schools in Saudi Arabia. Most of these studies have aimed to explore the type of mindsets that the sample holds regarding intelligence and creativity. For example, a study conducted by Ayoub and Aljughaiman (2016) of 174 gifted pupils (including both genders, aged 11 to 12 years old) aimed to identify to what extent the academic performance of gifted pupils varied depending on their emotional, social, analytical, creative, practical, and implicit intelligence. It also focused on identifying which of these factors had the greatest influence on pupils' performance. Moreover, it sought to establish the direct impact of various types of intelligence on student performance, as well as develop a structural model to

demonstrate the association between various types of intelligence, pupils' implicit theories of intelligence and pupil performance. The results reported that the greatest positive effects of the different types of intelligence on pupils' performance were in the order as follows: emotional, analytical, creative, implicit, practical, and social. They also found that implicit intelligence was a strong factor that impacted different types of intelligence, including creative, analytical, practical, emotional, and social.

Aljughaiman and Ayoub (2017) also conducted a study among 195 teachers across all school stages (primary, middle and high schools) and among 241 students aged 13 to 15 years old. This study sought to identify the implicit theories that teachers held regarding intelligence, giftedness, and creativity according to their specialisation (i.e., teachers of gifted students and regular classroom teachers) and the relationship with their years of teaching experience. It also aimed to identify the giftedness patterns that teachers discriminate against and in favour of when nominating gifted students. Additionally, it investigated the variations between the impact of school enrichment programmes and summer enrichment programmes on the performance of students. Regarding the implicit theories results, it was reported that teachers of gifted students were more likely to hold a growth mindset in intelligence, giftedness and creativity, while regular classroom teacher were more likely to have a fixed mindset regarding these three fields. In terms of the impact of years of experience, it was found that teachers with less than five years of experience adopted more of a fixed mindset compared to those who had more than five years' experience.

A further study aimed to investigate the type of implicit theory in intelligence and giftedness that 288 maths female teachers in primary and middle schools held. Moreover, it sought to explore the impact of the teaching stage and years of teaching experience on teachers' mindsets. The results revealed that maths teachers adopted more of a growth mindset than a fixed mindset in the field of intelligence and giftedness. It was also found that there was no difference in the intelligence and gifted mindsets of teachers according to teaching stage, however, there was a difference according to years of experience. That is, teachers with more years of teaching experience tended to hold more of a growth mindset compared to teachers with fewer years of experience, who adopted more of a fixed mindset (Alrajeh, 2017).

Ibrahim and Ayoub (2011) aimed to investigate the biases of 210 primary teachers when nominating gifted pupils for gifted programmes. Moreover, their study sought to explore teachers' beliefs about the implicit theories of giftedness, intelligence, creativity and personality. It also aimed to examine to what extent these implicit theories predicted teachers' nominations of pupils. In terms of intelligence mindsets, it was demonstrated that teachers of gifted pupils endorsed more of

a growth mindset in intelligence, giftedness, creativity, and personality than teachers of a regular classroom. It was also found that male teachers held more of a growth mindset than female teachers, who held more of a fixed mindset. Additionally, it was reported that teachers with more years of experience adopted a more growth mindset than teachers with fewer years of experience, who adopted more of a fixed mindset.

Abu-Nasser and Alasmary (2018) aimed to explore the implicit theories of intelligence and giftedness that 30 gifted pupils with learning disabilities aged 9 to 12 years old held. Their study also focused on investigating the relationship between intelligence mindset and self-efficacy. The results found that pupils were more likely to adopt more of a growth mindset in intelligence and giftedness than a fixed mindset. It was also reported that there was a significant positive association between growth mindset and pupil's academic self-efficacy in maths, reading, participating and study skills, as well as their total score in academic self-efficacy.

A further study conducted by Ayoub et al. (2021) sought to determine the level of performance of 131 gifted students aged 16 and 17 years old, as well as their academic orientations and implicit theories of intelligence, talent and personality. It also aimed to detect the variation in the performance of the groups based on their implicit theories and their academic orientations. Moreover, it provided a constructive model to explain the role of students' academic orientations as a mediator between their implicit theories and their performance. The findings presented three groups of gifted students' performance, categorised as high, average and low. There were also significant differences between the level of gifted students in terms of academic orientation, implicit theories, and performance and the default average of the community. A positive effect of the three types of implicit theories on academic orientations and performance was revealed. With the aid of the model, it was also found that the strongest effects on academic orientation were the implicit theories of talent, while the strongest effects on performance were the implicit theories of intelligence.

Regarding the PISA 2018 results for students aged 15 years old in the KSA, it was reported that less than half of the students who participated (43%) viewed it possible to develop intelligence (Echazarra et al., 2019). The report also revealed that students from 78 countries and economies (including the KSA) showed that students who held a growth intelligence mindset performed better in reading, maths and science than students who had a fixed intelligence mindset when accounting for the students' and schools' socioeconomic profile (Gouëdard, 2021). It is important to bear in mind that although a few studies conducted in the KSA have investigated the impact of gender, domain-specific and years of experience on mindsets, only the PISA 2018 has investigated the

differences in intelligence mindsets between socio-economically disadvantaged students and advantaged students (see Section 1.3.1). Furthermore, the PISA 2018 report also provides results about the effect of teachers' practices on students' mindsets (see Section 1.7).

To sum up, it is clear from the above that only one study has explored mindset among maths teachers. Moreover, two studies have involved pupils from primary school, while three studies have included students from middle and high schools. Among the seven studies, two studies have included teachers and their students, while three studies have only included pupils/students, and two have only included teachers. Thus, no previous study has investigated the relationship between teachers' mindsets and their students' mindsets. Additionally, no previous study has explored parents' mindsets and their role in shaping their children's mindsets.

2.3 Education in Saudi Arabia

2.3.1 The emergence of the Ministry of Education

In 1926, the first education system for boys, called 'the Directorate of Knowledge', was established in the KSA (KSA MOE**,** 2021c). Then, in 1928, 'the Knowledge Council' was formed, with the goal of establishing an education system (KSA MOE, 2021c). Following that, in order to design and supervise education provided by primary, middle and secondary schools, the 'Ministry of Knowledge' was established in 1952 (KSA MOE, 2021c). Regarding girls' education, 'the General Presidency for Girls' Education' was formed in 1959 (KSA MOE, 2021c). Then, to supervise the execution of the Kingdom's higher education policy at universities, the 'Ministry of Higher Education' was established in 1975 (KSA MOE, 2021c). In 2003, a royal decision was made to combine the General Presidency for Girls' Education with the Ministry of Knowledge (KSA MOE, 2021c). Following that, the name was changed to the MOE in 2004 (KSA MOE, 2021c). In 2015, both ministries, namely the MOE and Ministry of Higher Education, were merged into one ministry called 'the MOE' and so it remains so to the present day (KSA MOE, 2021c).

2.3.2 Education stages and school categories and types

Education stages in the KSA are divided into five stages, each of which comprises five levels: early childhood, primary school, middle school, secondary school, and university/college (KSA Unified National Platform [UNP], 2022a). To clarify, the early childhood stage refers to education for children under 6 years old and includes nurseries and pre-schools (KSA UNP, 2022a). Primary school covers six years of study for pupils (i.e., aged from 5 years and 6 months to 11-12 years old; KSA

UNP, 2022a). Middle school includes three years of study for students (i.e., aged 12 to 14-15 years old) and secondary school covers a further three years of study for students (i.e., aged 15 to 17-18 years old; KSA UNP, 2022a). In terms of higher education, there are three types of education: technical and vocational training, and public or private colleges and universities for both those with and without special educational needs (KSA UNP, 2022a, 2202b). Each university/college varies in the number of years of study according to a student's specialisation.

Schools in Saudi Arabia are classified into four categories. The first category is general schools, where students study a variety of commonly studied subjects such as maths, science, religion, Arabic and English. The second category is religious schools, where students study the same subjects as at general schools, but religion makes up a bigger part of the curriculum, in order to ensure that pupils memorise the Holy Qur'an (KSA MOE, 2021a). The third category is special education, which includes personalised education, inclusive education, and spatial integration. Personalised education is for individuals with special educational needs, as they may be hearing impaired, visually impaired or have an intellectual disability (KSA UNP, 2022b). Inclusive education takes place in general education schools to ensure that individuals with special educational needs, such as those with autism, learning disabilities and behavioural disorders, receive the required educational and rehabilitative assistance, as well as allowing them to progress with their classmates in different classes (KSA UNP, 2022b). Spatial integration means placing individuals in classes that are only for individuals with special needs within the general school, to ensure their participation with their peers during extracurricular activities and morning assembly (KSA MOE, 2021a). The fourth category is adult schools, which provide free continuing education and literacy programmes for individuals who did not start or complete their studies in childhood, and therefore they exceed the official age to be accepted at schools in the morning (KSA MOE, 2022b, n.d.). Furthermore, there are three other types of schools and universities: public schools and universities funded by the government, private schools, universities and institutes, and international schools which provide a non-Saudi education, as they apply foreign curricula (KSA UNP, 2022a). Some examples of international schools are American and British schools.

2.4 The education development plan in Saudi Arabia

In 2016, the government of Saudi Arabia published their 'vision' for the country, which focused on three issues, namely, developing a vibrant society, a thriving economy, and an ambitious nation, and aimed to improve many areas such as education, health, entertainment and economy in the country by 2030 (KSA's Vision 2030, n.d.-b). To plan effectively for these improvements, in 2016,

the 'National Transformation Programme' (NTP) was created by the government to develop the required infrastructure and create a climate that allows the kingdom's Vision 2030 to be realised by the governmental, private, and non-profit areas (KSA's Vision 2030, n.d.-a).

As mentioned above, the education sector is targeted for development by the Saudi Vision 2030 programme, with the MOE aiming to implement its strategy from 2016 to 2020, presenting its vision and mission, which included eight strategic objectives (KSA MOE, 2019a). The vision of the MOE from 2016 to 2020 was to provide citizens with a distinguished education, thus creating an internationally competitive knowledge society (KSA MOE, 2019a). The mission of the MOE from 2016 to 2020 included providing education to everyone, improving the quality of education outputs, increasing the effectiveness of scientific research, encouraging creativity and innovation, developing community partnerships, and improving employees' skills and abilities (KSA MOE, 2019a).

In terms of the strategic objectives of the MOE from 2016 to 2020, the first objective was to diversify innovative financing sources and improve the financial efficiency of the education sector. Secondly, it sought to strengthen the capacity of the education system, to meet development and labour market requirements. Thirdly, another objective was to enhance students' values and skills. Fourthly, it endeavoured to increase the participation of the private sector in education. The fifth objective was to reform the curriculum, together with learning and assessment styles. The sixth aim was to improve the educational environment, thus motivating students to create and innovate. The seventh aim was to recruit, retrain and ensure teaching staff continued to develop professionally. Finally, the eighth objective was to ensure that every student received good, fair, and comprehensive education and enhanced learning opportunities throughout their life (KSA MOE, 2019a).

More recently, in 2020, the MOE announced its strategy between 2020 and 2023, presenting its nine strategic objectives that will be implemented during those years. The first objective is to promote Islamic values and national identity. Secondly, it aims to improve learning outcomes. Thirdly, it will endeavour to improve equal educational opportunities for all groups. Fourthly, it will enhance digital transformation. The fifth objective is to improve the school environments and support services. The sixth objective is to better govern and develop work systems environments. The seventh aim is to improve human resources professional development. The eighth goal is to increase the efficiency of spending and develop and diversify financial resources. Finally, the ninth objective is to develop community partnerships (KSA MOE, 2020).

Overall, the MOE has outlined a general vision which aims to cultivate individuals who can compete globally by providing them with superior, high-quality learning, and qualified employees (KSA MOE, 2021d). The general mission of the MOE includes providing education to everyone, increasing the quality of education procedures and outcomes, creating an educational atmosphere that encourages creativity and innovation to meet development needs, enhancing the governance of the educational system, improving employees' skills and abilities, and providing students with the values and abilities they need to become decent citizens who are conscious of their duties to their family, community and nation (KSA MOE, 2021d).

To implement the goals and objectives of education, the KSA is paying great attention to education and allocating a large amount of its annual budget to achieve these goals and objectives. To illustrate, a snapshot of recent years shows that the MOE fiscal budget for 2016 was 161,727,385,340 Saudi riyal, the highest amount ever spent, and 135,574,788,480 Saudi riyal in 2021, which was the lowest amount spent during that six-year period (KSA MOE, 2022c).

In short, the KSA attaches considerable importance to education and is intent on improving it. Therefore, the current thesis seeks to support the MOE's objectives for the years 2016 to 2020, specifically the third objective, which seeks to develop students' values, skills and scientific knowledge in all areas, including mathematics and science, in a way that contributes to raising the quality of their educational outcomes and shaping students' personalities, as this, in turn, will contribute to building, developing and improving their knowledge and skills (KSA MOE, 2019a). The goal also contributes to enhancing family involvement in developing their children's skills by creating an interactive environment between schools and families (KSA MOE, 2019a). The present thesis also supports the MOE 's objectives for the 2020 to 2023 period, specifically the second objective, which aims to improve the educational outcomes of students, as well as increase the position of the Saudi educational system internationally (KSA MOE, 2020).

2.5 The assessment system in primary schools

In the pursuit of development and improvement, the MOE continuously updates and improves their regulations explanatory report and the executive rules for students' assessment list. Thus, this section will detail the latest four assessment lists reported by them. The first assessment list was released in 2016/17 and was in effect until the start of the 2019/20 academic year. The second list was released in 2019/20, the third list was released and came into effect in the 2021/22 academic year, while the fourth list was released and came into effect in the 2022/23 academic year. It is important to note that teachers who participated in the qualitative study in this thesis followed

the assessment list released in 2016/17, while teachers involved in the quantitative study followed the assessment list released in 2019/20.

The regulations explanatory report and executive rules of the student's assessment list that was released in 2016/17 explained that point five of the regulations of the MOE includes nine statements regarding teaching and evaluating pupils progress at primary school, including:

1) Focussing on the acquisition of skills, knowledge, and practical experiences in each subject.

2) Using teaching methods that lead to real understanding of the subject content.

3) Focussing on the practical part of the subject and evaluating pupils' performance, to ensure that they can demonstrate the skill or knowledge.

4) Avoiding negative psychological effects on pupils that may become linked to their study experiences, such as anxiety due to a focus on competition or feeling that simply achieving good grades is the goal of education.

5) Promoting positive habits and attitudes towards education in pupils.

6) Providing positive motivation for success and progress and making the reason for learning and going to school about succeeding and not because of a fear of failure.

7) Sharing pupils' progress with their parents, so that they can support their children to overcome any difficulties they may face.

8) Identifying pupils with special educational needs, such as learning disabilities, at an early age and guiding them in the correct manner during that stage of their education.

9) Being aware of the aptitudes of gifted pupils and guiding them towards specialised programmes (KSA MOE, 2016).

Up to the year 2020/21, the academic year in KSA was comprised of two semesters. In 2016/17, each semester had at least two evaluation time points for the primary stage, which included an age-appropriate assessment of pupils' performance and progress as part of their continuous evaluation to assess whether they were meeting the approved standards (KSA MOE, 2016). This type of assessment was known as continuous formative assessment and included various methods of assessment such as short tests, teacher observations of pupils' performance in their classrooms, pupil participation, practical performance, educational projects and homework related to the subject (KSA MOE, 2016).

Teachers informed parents about their child's progress in a report called "the student's follow-up record" on a daily basis (KSA MOE, 2016). This report aimed to facilitate cooperation

between the family and the school to monitor the pupil's progress and address any educational difficulties that may have encountered (KSA MOE, 2016). Additionally, parents received a report after each evaluation, pupils also received a certificate at the end of the year via "Noor" (KSA MOE, 2016). The "Noor" program is a system that provides every student and their parents in the KSA with free services for registering and monitoring their children's educational progress (KSA MOE, 2021e). According to pupils' results, a decision was made as to whether the pupil was ready to move to a higher grade or not at the end of the year (KSA MOE, 2016).

In terms of assessment, each subject had a number of primary and secondary requirements that the pupil was assessed on (KSA MOE, 2016). The primary requirements included a set of criteria, and it was essential that the pupils met each of the primary items to move to the next grade at the end of the academic year (KSA MOE, 2016). For example, a primary requirement in maths for pupils aged 11 in grade six was the ability to add and subtract decimal fractions, whereas writing decimal fractions in the simplest form was deemed a secondary requirement. Furthermore, for each subject, pupils' grades were classed as either excellent (i.e., a pupil had completed 95% or more of the subject criteria, including all the primary items, and had attained a mark of 100% for each criteria), advanced (i.e., a pupil had completed 85% or more of the subject criteria, including all the primary items, and had shown they could achieve 90-100% for each criteria), skilled (i.e. a pupil had completed 75% or more of the subject criteria including all the primary items, and had provided evidence of their ability to meet 80-90% for each criteria) or failed (i.e., a pupil had completed less than 75% of the criteria of the school subject or s/he had not passed one or more of the primary items of the subject; KSA MOE, 2016).

In the situation when pupils had not achieved enough to move to the next grade at the end of the year, the school guidance committee reviewed the pupil's level by evaluating their ability from the beginning to the end of the school year (KSA MOE, 2016). In cases where the pupil did not progress to the next grade because of special needs, the school helped to transfer them to an appropriate special education programme, to ensure they could access the education and support services they needed (KSA MOE, 2016).

In 2019/20, the MOE released an amended regulations explanatory report and executive rules for the student assessment list. It explained that the evaluation of pupils in the first and second grades would continue by using the same continuous formative assessment explained above (KSA MOE, 2019b). However, pupils from the third to sixth grades (8 to 11 years old) would be evaluated using two types of assessments, namely, formative (i.e., during the semester) and summative (i.e., at the end of the semester) moving forward (KSA MOE, 2019b). Each subject was scored out of 50 in

each of the two semesters, with the total score being 100 (KSA MOE, 2019b). The scores for each semester were divided into a score of 20 for pupils' work during the semester and a score of 30 for the final exam of the semester (KSA MOE, 2019b). The pupil could succeed and move to the next grade if s/he met at least one of the following two conditions: obtaining a minimum of 50% in each subject and/or obtaining 20% in the exam during the second and final semester (KSA MOE, 2019b). If the pupil did not pass one of these requirements, s/he was given a second and final chance and allowed to re-take the final exam (KSA MOE, 2019b).

In the 2021/22 academic year, the MOE released an updated regulations explanatory report and executive rules for the student assessment list. It explained that the MOE had decided to divide the school year into three terms instead of two semesters. It also explained that the evaluation of pupils in the first and second grades (6 and 7 years old) would continue with the same continuous formative assessment explained above (KSA MOE, 2021b). However, pupils from the third to sixth grades (8 to 11 years old) would be evaluated using different types of assessments, namely, preliminary (i.e., at the beginning of the semester), formative (i.e., during the semester) and summative (i.e., at the end of the semester; KSA MOE, 2021b) from that point onward. Now, each subject is marked out of 100 each term (KSA MOE, 2021b). A pupil's average score is calculated at the end of the academic year. Additionally, the assessment list presents the weight assigned to each term as follows: the first term counts for 25%, the second term accounts for 35%, and the third term makes up 40% of the total mark (KSA MOE, 2021b). A pupil can move to the following grade if s/he meets the following conditions for success: s/he obtains a minimum of 50% for each subject, receives a minimum of 20% per cent in the third and final term, and sits the exams at the end of the first and second terms (KSA MOE, 2021b). If a pupil does not pass these requirements, s/he will be assessed by combining their scores from all of the short tests that s/he did during the year and also given a second chance to re-take the final term exam (KSA MOE, 2021b). The fourth and latest list was released and came into effect in the 2022/23 academic year and includes similar executive rules for the student assessment list as the previous year (KSA MOE, 2022a).

2.6 Students' performance in national and international mathematics exams

In the academic year 2016/2017, the Education and Training Evaluation Commission (ETEC) was created as a corporate body with a connection to the President of the Council of Ministers following the Council of Ministers Resolution No. 94 (KSA ETEC, n.d.-b). The mission of the ETEC as a specialised organisation in Saudi Arabia is to evaluate, assess, and accredit qualifications from both public and private sectors related to education and training domains, in order to improve their

effectiveness and quality, as well as increase their contribution to the economy and the development of the country, thus also supporting the Saudi vision 2030 (KSA ETEC, n.d.-b). The ETEC also have a vision that aims to enhance/improve the quality and effectiveness of education and training in Saudi Arabia, to reach exceptional levels in the world (KSA ETEC, n.d.-d).

Therefore, given the ETEC's mission and vision, the National Centre for Assessment, which follows the ETEC, collaborated with the MOE to conduct national exams in core subjects, namely, reading, science and mathematics (KSA ETEC, n.d.-f). These exams were conducted in 2018, in order to assess pupils' levels in science and mathematics, and then in 2019 to evaluate reading for students in the fourth and eighth grades (9 and 13 years old; KSA ETEC, n.d.-g). The national exams aimed to evaluate students' skills, knowledge, and level of achievement in various fields, to evaluate the reality of education in the KSA (KSA ETEC, n.d.-g). In addition, questionnaires were distributed to school leaders, teachers, students, and guardians for the same reason (KSA ETEC, n.d.-g).

In late 2019, the ETEC announced the results of the national exams detailed above on their website and Twitter account, however, since this study focusses specifically on maths achievement, only the maths results will be presented. The results of students in the fourth grade (9 years old) showed that girls obtained marginally better percentages in maths compared to the boys. To illustrate, the girls' percentages were as follows: 3% of students obtained advanced mastery level, 17% achieved the upper-normal/high mastery level, 32% reached the normal mastery level, 16% scored below the normal level of mastery and 32% obtained a very low level of mastery (KSA ETEC, 2019). However, the boys' percentages were as follows: 3% of students obtained the advanced mastery level, 15% reached the upper-normal/high mastery level, 29% achieved the normal mastery level, 16% scored below the normal level of mastery and 37% obtained a very low level of mastery (KSA ETEC, 2019). Regarding the results of students in the second middle grade (13 years old), once again, the results show that girls obtained slightly better results in maths compared to the boys. To illustrate, the girls' percentages were as follows: 3% of students obtained the advanced mastery level, 15% achieved the upper-normal/high mastery level, 28% achieved the normal mastery level, 17% scored below the normal level of mastery and 37% obtained a very low level of mastery (KSA ETEC, 2019). However, the boys' percentages were as follows: 3% of students obtained the advanced mastery level, 12% reached the upper-normal/high mastery level, 24% achieved the normal mastery level, 17% scored below the normal level of mastery and 44% obtained a very low level of mastery (KSA ETEC, 2019). It is clear from these results that in the fourth grade, a total of 53% of boys and 48% of girls achieved scores which are below the normal level of mastery in maths. Furthermore, a

total of 61% of boys and 54% of girls in the second middle grade also obtained scores which are below the normal level of mastery in the Saudi national maths exam.

More recently, in 2022, new national exams called "NAFS" have been introduced by the ETEC for core subjects, namely, reading, science, and mathematics (KSA ETEC, n.d.-e). The ETEC announced that these exams will be conducted annually starting from the year 2022 for students in: the third grade (8 years old; only in reading and mathematics), and the sixth and ninth grades (11 and 14 years old) (KSA ETEC, n.d.-e). These grades were selected specifically to represent educational milestones. That is, the third grade of primary school represents the end of the early/lower primary grades stage, the sixth grade represents the end of the upper primary stage, and the ninth grade, which is considered the third grade in middle school, represents the end of the middle stage (KSA ETEC, n.d.-f). These exams are implemented in accordance with the complementary roles and continuous coordination between the ETEC and MOE, with the aim of achieving national goals, such as the Saudi Vision 2030's Human Capacity Development Programme (KSA ETEC, n.d.-e).

The NAFS national exams measure students' level of achievement and their abilities at the end of each educational stage. This helps education officials to gain clarity about the educational system's strengths and weaknesses, which allow them to improve the educational process according to these reliable results (KSA ETEC, n.d.-f). Indeed, the NAFS national exams have four objectives, which are: to evaluate the educational attainment of students, measure national exam indicators as part of the Human Capacity Development Programme, inform parents of the level of educational attainment at their children's schools, and create positive competition between schools and education offices and departments in the MOE (KSA ETEC, n.d.-e). Therefore, the results of those exams will provide a realistic description of students' educational attainment/achievement in reading, mathematics, and science (KSA ETEC, n.d.-e). Additionally, as part of the quality assurance processes, these exams are based on the idea of evaluation for development and improvement, to raise the efficiency and quality of learning and teaching in the KSA (KSA ETEC, n.d.-e). It should be noted that since these exams were first set in the first half of 2022, the exams' results had not been announced before this thesis was submitted.

Furthermore, to assess the level of student achievement in core subjects in Saudi Arabia compared to their peers in other countries, the MOE began participating in international assessments of core subjects, namely, the Trends of the International Mathematics and Science Studies (TIMSS). Additionally, once the ETEC was established, the ETEC and the MOE have continued participating in international assessments of core subjects such as TIMSS and PISA.

The TIMSS assessment was first undertaken in 1995 and is held every 4 years, however, Saudi Arabia participated for the first time in 2003 (Mullis et al., 2008). The KSA has participated in the TIMSS five times, specifically in 2003, 2007, 2011, 2015 and 2019; the latter was the seventh and last assessment cycle of TIMSS so far (Mullis et al., 2008; Mullis et al., 2020). TIMSS aims to compare the results of students in mathematics and science in grades four and eight (9.5 or 13.5 years old) between countries and within the country itself over a long period (Mullis et al., 2020). In addition, this assessment also involves surveying students and teachers about the factors that affect them in the education setting, namely, the support they receive at home, the school composition and resources, the school climate, school discipline and safety, teacher preparation, professional development and job satisfaction, the challenges of teaching and learning, students' attitudes, curriculum and instruction, and the use of technology in instruction (Mullis et al., 2020).

In each round of TIMSS, the results of Saudi Arabia for both maths and science revealed that the average scores of students of both in grades four (9 to 10 years old) and eight (13 to 14 years old) were significantly lower (see below) than the average score (500 points) on the TIMSS scale. It should be noted that in 2003 and 2007 only students in grade eight participated (Mullis et al., 2008). However, since the current research focuses on maths, only the maths results will be presented. Interestingly, the average score in maths of the pupils in grade four in Saudi Arabia has decreased over the three cycles (2011 to 2019), from 410 to 383 to 398, respectively (Mullis et al., 2020). Whereas the average score in maths for students in grade eight in Saudi Arabia has fluctuated over the five cycles (2007 to 2019), from 332 to 329 to 394 to 368 to 394, respectively (Mullis et al., 2008; Mullis et al., 2020).

In terms of the fourth-grade students' average maths achievement in the KSA compared to students/peers in other countries, KSA ranked at the bottom of the list as follows: in TIMSS 2011, 45 out of 50 participating countries; in TIMSS 2015, 46 out of 49 participating countries; and in TIMSS 2019, 53 out of 58 participating countries (Mullis et al., 2012; Mullis et al., 2016; Mullis et al., 2020). Regarding the average position for eighth grade students' maths achievement in KSA compared to students/peers in other countries, KSA ranked at the bottom of the list as follows: TIMSS 2003, 43 out of 46 participating countries; in TIMSS 2007, 46 out of 49 participating countries; in TIMSS 2011, 37 out of 42 participating countries; in TIMSS 2015, 39 out of 39 participating countries; and in TIMSS 2019, 37 out of 39 participating countries (Mullis et al., 2004; Mullis et al., 2008; Mullis et al., 2012; Mullis et al., 2016; Mullis et al., 2020).

Accordingly, the ETEC stated in their 2021 report that the results from TIMSS 2019 showed that many students in Saudi Arabia lacked a basic knowledge in maths and science. Consequently,

these students would not be able to successfully continue their education (KSA ETEC, 2021). These results highlight the fact that a lack of distinguished students in mathematics and science will be a challenge for Saudi Arabia in the future, as it aspires to develop a knowledge-led economy (KSA ETEC, 2021). Thus, an increased effort from schools and teachers to improve the level of education is expected, to ensure that students are provided with a strong foundation in the early stages of education and continue their development in the later stages of education (KSA ETEC, 2021).

Another international assessment that the ETEC and the MOE in Saudi Arabia are keen to carry out among students is PISA, which is provided by the OECD (OECD, 2019a). The KSA participated for the first time in 2018, which was the seventh PISA assessment cycle (OECD, 2019a). PISA is an assessment tool that was first implemented in 2000 and continues to be held every three years, in order to evaluate the knowledge and skills of students aged 15 years old in three subjects, namely, mathematics, science, and reading (OECD, 2019a). It is important to note that one subject is thoroughly tested in each PISA cycle, accounting for close to half of the entire testing time (OECD, 2019a). That is, in 2000, 2009, and 2018 the main subject was reading, while in 2003 and 2012, the main subject was maths, and in 2006 and 2015, the main subject was science (OECD, 2019a).

This exam aims to evaluate the extent to which students acquire crucial knowledge and skills which are related to both social and economic life, as well as the extent to which students can reproduce and extrapolate what they have learned and use this knowledge in situations new to them whether inside or outside the school (OECD, 2019a). The PISA maths results demonstrate that tenth-grade students in Saudi Arabia achieved a score of 373, which is statistically significantly below the OECD average/mean in maths (489; OECD, 2019b). As a result, Saudi Arabia has ranked 66 out of 79 participating countries and economies on average in maths (OECD, 2019b).

To sum up, it is clear from the above that the results of the national exams are in line with the results of the international exams in maths, thus highlighting that maths students generally perform poorly and achieve low results. This is an issue that need addressing to fulfil the Saudi Vision 2030, one of the objectives of which is to improve and develop the KSA in different fields, including education.

2.7 Rationale, contributions and application of the research in Saudi education

All recent national and international assessments of mathematics undertaken by pupils/students in the KSA have shown that their performance is below average (see Section 2.6). Despite the government spending a large proportion of the budget on this every year and the huge efforts made by the MOE to improve the performance of pupils/students and develop the

educational system in KSA (see Section 2.4), the evidence shows that the achievement of pupils/students is still below the required level that parents, the MOE and the State of Saudi Arabia aspire to. Improving pupils' academic level is clearly beneficial for them, as it will help them to increase their knowledge, expand their skills and raise their academic achievement. Additionally, it may help them to develop positive psychological aspects that they need to overcome setbacks and challenges. Furthermore, it will help to achieve the MOE's objectives, which will reflect positively on the Saudi Vision 2030 and ensure it achieve its goals, thus ensuring the development of Saudi Arabia in all respects as state officials and citizens wish.

Thus, this research is motivated by the desire to find a method that will help pupils to improve their maths achievement and support the MOE and Saudi Vision 2030, thus improving education in the KSA. The first thing to be done is to look beyond this issue and solve the problem at its roots. It has been argued that some students tend to view maths as a difficult, complicated, and anxiety-inducing subject (See Vitasari et al., 2010; Mutodi & Ngirande, 2014; Gudyanga, et al., 2016). Indeed, it was reported in the Saudi setting that most high school students (Alghamdi & Alghamdi, 2019) and all undergraduate students (Obeidat, 2016) who participated in these two studies had anxiety about maths, and such a negative belief is harmful to their learning and achievement in this subject. For example, two meta-analyses reported a significant negative association between students' maths anxiety and their maths' achievement (Hembree, 1990; Namkung et al., 2019). Further studies conducted within the non-Saudi education context (e.g., Yüksel-Şahin, 2008; Luo et al., 2009) and in the Saudi education context (e.g., Altamimi, 2009; Obeidat, 2016; Alghamdi & Alghamdi, 2019) also found similar results.

Boaler (2016) stated that the majority of pupils can master any level of maths at school, except for a small number of pupils who needs special education, as this subject is a challenge for them. Therefore, the question is why some pupils find mathematics challenging if they do not have a maths learning disability, namely, dyscalculia. Why do they view maths as a difficult, complicated and anxiety-inducing subject? It might be because they share the widely held belief that spans the globe that "only some people can be good at math" (p. xii), and it could be that this belief leads many students around the world to achieve poorly in this subject (Boaler, 2016). The finding of PISA 2018 showed that only 43% of students in Saudi Arabia believe that intelligence can be developed (Echazarra et al., 2019). The results of PISA 2018 also revealed that a total of 47% of students in Saudi Arabia compared to the OECD average (i.e., 56% of students) "agreed or strongly agreed that, when they fail, they worry about what others think of them" (Echazarra et al., 2019, p.7).

Accordingly, if students do not have self-confidence in their abilities, this may hinder their learning process and achievement. Indeed, the best learning opportunities arise when pupils have confidence in themselves (Boaler, 2016). In addition, when students face adversity in the learning process, the main responsibility of adults is to enable students to develop resilience to these unavoidable challenges (Yeager & Dweck, 2012). This can be done not by boosting their self-esteem or trait labelling, but by guiding them to develop a mindset that views challenges as tolerable and as obstacles that can be overcome with time, effort, focussed learning, experimenting with new strategies, support from others, and patience (Yeager & Dweck, 2012). Therefore, adults need to ensure their students/children develop such a mindset during their initial experiences studying maths and emphasising the notion that maths is "a subject of growth and their role is to learn and think about new ideas" (Boaler, 2016, p.34). Indeed, at primary/elementary school, which is a less challenging environment, pupils who hold a fixed intelligence mindset might be protected against the consequences of their belief, however, once they transition to middle school and face setbacks or failures, they become less equipped to overcome them (Blackwell et al., 2007).

Thus, since mindsets are considered "a theory of challenge-seeking and resilience" (p.482), as defined by Dweck and Yeager (2019), it may be an effective solution for pupils. Dweck and her colleagues stated that mindsets are considered the core of the meaning-systems framework, which means that mindsets may organise a number of variables such as goals, attributions, helplessness, and effort beliefs into a single meaning system (Dweck & Yeager, 2019). That is, individuals who believe that capacity is unchangeable, tend to hold performance goals or avoid challenges, view sustained effort and setbacks to be indicative of poor capacity (Dweck & Yeager, 2019). As a result, persistence can be limited (Dweck & Yeager, 2019). On the contrary, individuals who believe that an individual's capacity can be developed, tend to hold learning goals and seek challenges, view effort as an instrument and setbacks as information about the learning process (Dweck & Yeager, 2019). As a result, persistence can be more easily maintained (Dweck & Yeager, 2019). In addition, students who believe that intelligence can be improved perform better academically because they are more ready to face challenges, put in the effort, learn from failures, and ask for advice (Gouëdard, 2021).

Indeed, many of the studies on this subject have either revealed that there is a positive association between a growth intelligence mindset and academic achievement (both in general and in a specific subject such as maths) or have reported a positive effect of growth mindset intervention on maths achievement (e.g., Lee et al., 2021; see also Section 1.6). However, it is crucial to keep in mind that growth mindset interventions might not improve learning outcomes directly. Nevertheless, they might help students to feel less anxious about maths or develop more self-

efficacy (Simms, 2016). In other words, although some studies failed to find a direct relationship between mindsets and academic achievement (see Section 1.6), other studies reported a positive association between a growth mindset and other motivational concepts, which in turn may positively affect pupils' academic achievement. Therefore, mindset could represent a valuable intervention, as it is a cognition/implicit theory that theoretically positively influences or is associated with other motivation-related concepts such as grit, the Big-Five personality characteristics, self-efficacy, self-esteem, resilience, school engagement, psychological well-being and learning achievement goals, besides also decreasing mathematics anxiety (see Section 1.3.2). In turn, these concepts might positively impact academic achievement. For example, evidence from two studies found positive associations between students' self-esteem and/or self-efficacy and their academic achievement (e.g., Diseth, 2014; Bonne & Johnston, 2016). However, these positive motivation-related concepts have not been proven to be linked to a fixed intelligence mindset (see Section 1.3.2). Conversely, another study showed that having a fixed view of intelligence was not significantly associated with positive emotions such as enjoyment, hope, and pride, but did positively predict negative activating emotions, namely, anger, anxiety, shame, and negative deactivating emotions such as boredom and hopelessness (King et al., 2012).

Although many studies have found a correlation between both kinds of intelligence mindsets and academic achievement among students of different genders, ages, backgrounds, and levels of achievement, it could be argued, based the results of previous studies, that mindsets may either have no relationship, a weak correlation or limited impact on students learning and achievement. For example, Dixson et al. (2017) findings showed that in the group of high-achieving African American adolescent students, a growth mindset was not associated with academic achievement. It is likely that the high achievers in that study had already reached their growth mindset ceiling and that the effect of this mindset on accomplishment had already been considered (Dixson et al., 2017). This could also imply that top-performing students do not care about teacher comments, as they already have a growth mindset or access to resources outside of the classroom (Gouëdard, 2021). The null effect of growth mindset interventions on students can also be interpreted as students in the control group already receiving high-quality teaching, including growth mindsets messages from their teachers (Simms, 2016).

Indeed, despite the weak correlations between students' mindsets and academic achievement, interventions that support growth mindsets may nevertheless be successful, especially for specific subgroups (Sisk et al., 2018). That is, although growth mindset interventions can help students with their learning, it might be that not every student can benefit from such interventions

(Bosch, 2021). Indeed, it was found that this type of intervention is effective and beneficial for particular groups such as students scoring a low GPA. For example, Bosch (2021) provided evidence that growth mindset intervention was effective for students who had previously obtained poor academic achievement (Bosch, 2021). Paunesku et al. (2015) also found that mindset interventions increased GPA in core academic subjects among students at risk of dropping out of high school, as well as increased the percentage of students completing core courses with a. satisfactory performance.

The second meta-analysis conducted by Sisk et al. (2018; see the results of the first meta-analysis in section 1.6) also revealed that growth mindset interventions had a very weak impact on academic achievement, and these interventions were significant for only academically high-risk students, who had formerly failed their courses, as well as low SES students. That is, in terms of moderator results, interventions were not significant for other student factors, namely, (1) their developmental stage, including for adolescents and adults; (2) low- and/or moderate- academic risk status, meaning there was no indication that students were at risk, or for students who faced situational challenges such as moving to a new school or experiencing a stereotype threat; (3) student SES level, specifically those in the middle- and/or upper-class (Sisk et al., 2018).

It might be that instilling a growth mindset for students facing challenges in their learning such as underachieving students (compared to their peers) provided distinct results because they had previously held the belief that they could not change or improve their abilities. Indeed, it has been reported that students with learning disabilities, compared with students without, were more likely to have low academic self-efficacy, hold a fixed (vs. growth) intelligence mindset, endorsed performance (vs. learning) goals, and perceive effort as a sign of limited levels of ability (Baird et al., 2009). This is consistent with the essence of the theory of mindsets, which asserts that the influence of students' motivational beliefs such as their own intelligence mindsets or intervention about intelligence mindsets does not generally become apparent/present until students encounter challenges, setbacks or failure (Dweck, 2002a; Dweck, 2008; Paunesku et al., 2015). Moreover, variables such as the impact of learning and performance goals on motivation, coping, and achievement are more likely to be seen in situations when the degree of difficulty is great for a large number of individuals and the outcome is of paramount importance (Grant & Dweck, 2003).

Consequently, since maths is a process that is often taught as an outcome subject, and it is not uncommon for students to face setbacks and challenges in their maths achievement, thus adults have to instil a growth intelligence mindset in students, to increase their positive psychological traits, as this will in turn help them to address challenges, and, subsequently, increase their academic

performance. One of the major obstacles to the establishment of a growth mindset is the provision of pertinent feedback (Gouëdard, 2021). This goes beyond praising the effort and involves recognising progress, as well as the provision of efficient learning strategies and learning processes (Gouëdard, 2021). Some messages that students are given in school regarding their own potential lead them to believe that they are inferior to others and that they lack their peers' potential, which harms their learning (Boaler, 2016). Indeed, recent findings from brain studies have shown that anyone can succeed at the greatest levels of maths achievement with the proper teaching and messages (Boaler, 2016). Additionally, numerous results from scientific studies have found that individuals' pathway to life, messages they are given concerning their abilities, and the learning chances provided to them are more important predictors of success than the brains they are born with (Boaler, 2016). Consequently, it is paramount that teachers foster a growth intelligence mindset, to enhance students' self-efficacy and resistance in their studies (Khalkhali & Aryanpour, 2013).

It is clear from the literature review (see Section 1.7) that the mindsets of adults can affect their practises and responses, and this impacts students' intelligence mindsets, which in turn may influence their academic achievements. Indeed, it was found that teacher practices moderated the association between students' growth mindsets and their reading, maths and science performance in the PISA (Gouëdard, 2021). Based on a series of studies conducted by Haimovitz and Dweck in 2016, as well as a literature review of studies on the topics of failure mindsets, intelligence mindsets and response orientations, Haimovitz and Dweck (2017) put forward a model that illustrates how adult intelligence and/or failure mindsets can impact their responses to and practices with their children in the event of success or failure, which in turn causes them to adopt either more of a growth or fixed intelligence mindset. Similarly, a review of the literature conducted by Sun (2019), concluded that it is necessary to develop a "theory of action". This theory refers to the fact that teachers' mindsets are associated with their classroom practices, and that these practices send messages to students about the fixedness or malleability of their maths ability. Consequently, this can impact students' mindsets and, in turn, their maths achievement (Sun, 2019).

Thus, this thesis aims to include both teachers and mothers and their pupils/children as the samples, to investigate the mindsets of teachers and mothers, as well as explore how they motivate pupils in the context of success and/or failure, which in turn causes pupils to develop more of a growth or fixed intelligence mindset. In addition to that, it explores the association between teachers' intelligence mindsets and their students' maths achievement. This will be done through three research papers, each taking a different approach: a systematic review, a qualitative study and

a quantitative study. In addition, both empirical studies used two different types of methods to test Haimovitz and Dweck's (2017) hypothesised model: qualitatively via interviews and quantitatively through questionnaires. To the best of the researcher's knowledge, although no previous study investigating implicit theories of failure and response orientations to a failure has been conducted in Saudi Arabia, a few studies on the subject of implicit theories of intelligence have been conducted in the context of Saudi Arabia (see Section 2.2). However, none of these studies has explored how maths teacher's and/or mother's maths mindsets and/or response orientations affect their pupil's/children's maths intelligence mindset and/or maths achievement. Moreover, this is the first study in Saudi Arabia that has included parents, since previous studies have only included either students, teachers or students and teachers (see Section 2.2). For this reason, the present thesis will provide evidence relating to mindset theories from a new population in Saudi Arabia. Nevertheless, only mothers will be chosen to participate in this research. This is because, mothers typically take more practical accountability for their child's education than fathers do (Kärkkäinen & Räty, 2010). Indeed, in the KSA, mothers traditionally take responsibility for their children's learning more often than fathers (Al Lily, et al., 2021).

The two empirical studies (i.e., the qualitative study and quantitative study) in this current thesis will be conducted among pupils from primary schools, because it is during the primary stage that children's mindsets begin to be shaped. Furthermore, children at this stage learn a great number of skills and undergo their initial experiences of academic success and failure, which helps them to face academic difficulties in the future. This is contrary to secondary school, where students' beliefs are already formed and might be difficult to change. Indeed, a study conducted by Robins and Pals (2002) showed that adults' beliefs about their implicit theories of intelligence are more likely to remain unchanged from high school to college. Furthermore, primary schools funded by the government will be chosen as the setting to conduct the two empirical studies for two reasons. The first reason is that around half of all Saudi families and residents residing in Saudi Arabia enrol their children in this type of school. The second reason is that there are a large number of these schools compared to other categories of schools, namely, private schools and international schools. To illustrate, in 2018/2019, the number of primary government schools in Riyadh was 571 for girls and 568 for boys, with a total of 1,139 schools, while in 2020/2021, it was 574 schools for girls and 572 schools for boys, with a total of 1,146 schools in Riyadh (see Appendices A1 and A2).

In conclusion, it has been shown that the MOE in Saudi Arabia currently pays a great deal of attention to education, in particular to students, which is clear from its vision, mission and objectives (see Section 2.4). However, there is still a gap in Saudi education, which is also clear by the evidence

that presents the poor academic achievement of students in mathematics compared to their peers in other countries. Moreover, the PISA 2018 revealed that more than half of students were more likely to hold a fixed intelligence mindset, and 47% of students worried about what others thought of them when they failed (Echazarra et al., 2019). Thus, the objectives of this thesis are supported and consistent with the objectives of the MOE, particularly the one that seeks to improve students' skills and knowledge in mathematics and enhance family involvement in improving their children's skills (KSA MOE, 2019a). Since an individual's beliefs may vary according to the domain (see Section 1.3.1.5), this research tends to focus on maths intelligence mindsets, since it is the best concept that explores and explains reactions to challenges to failure compared to others. Accordingly, this thesis aims to contribute to this by understanding how both maths teachers' and mothers' mindsets, motivational techniques and practices influence pupils'/students' mindsets and learning in maths. Another objective is to address the gaps in the literature concerning Saudi studies (see Section 2.2), particularly, in terms of the influence of parents. Additionally, it aims to contribute to the knowledge of positive developmental and educational psychology, to ensure academic optimum achievement for pupils in Saudi Arabia.

2.8 Research aims, design and questions

Overall, this thesis aims to investigate the relationship between teachers' intelligence mindsets and their students' maths achievement. Furthermore, it aims to explore the roles played by maths teachers' and/or mothers' intelligence and/or failure mindsets on their responses and reactions to their pupils'/children's intelligence mindsets, and whether this leads them to adopt more of a growth or fixed intelligence mindset. Thus, according to the aims of this thesis, three types of methodological approaches will be employed in three studies respectively: a systematic review, a qualitative approach and a quantitative approach. The qualitative and quantitative studies are designed to empirically test the hypothesised model developed by Haimovitz and Dweck (2017), in terms of how adults foster growth and fixed mindsets among their children. Four questions drive the thesis as follows:

Study 1: Is there a relationship between maths teachers' intelligence mindset and the maths achievement of pupils in primary (4-11 years) and secondary education (11-18 years)?

Study 2: What is the role of primary school maths teachers' intelligence mindset and reactions to their pupils' maths achievement and failure in Riyadh, Saudi Arabia?

Study 3:

1) Do the relationships suggested in the model created by Haimovitz and Dweck (2017; shown in Figure 1 in Section 1.7) hold true when this model is statistically implemented for primary maths teachers and mothers?
2) Comparing the relationships shown in Haimovitz and Dweck's model (2017; shown in Figure 1 in Section 1.7) and an expanded version of the Haimovitz and Dweck model (shown in Figure 4 in Section 5.2), do the additional relationships included in the expanded version improve upon our understanding of what promotes a growth or fixed intelligence mindset in children (aged 10 and 11 years old) beyond that obtained by only considering the relationships in Haimovitz and Dweck's model (2017)?
    a. Does any improvement hold true when considering primary maths teachers and/or mothers?

Chapter 3 Study 1: A systematic literature review investigating the relationship between maths teachers' mindsets and students' maths achievement

In Chapter 1, the literature review highlighted the fact that many studies have sought to investigate the relationship between students' intelligence mindsets and their academic achievement. Some of these studies have highlighted no relationship between these factors, whereas many other studies have found a link between students' intelligence mindset and their academic achievement. A number of these studies have found a positive association between growth intelligence mindset and academic achievement, while others have reported a negative association between fixed intelligence mindsets and academic achievement (see Section 1.6). Therefore, a number of questions have been raised by other studies concerning how students' intelligence mindsets are formed, as well as the factors that cause students to believe that mathematics intelligence is fixed and unchangeable or hold the view that mathematics intelligence is malleable and can be grown. Some researchers have argued that it may be the mathematics teachers that shape students' intelligence mindsets in the context of mathematics. Subsequently, it may be the case that students' mindsets affect their maths achievement, as many studies have demonstrated a relationship between these two variables. Thus, the first objective in the current thesis was to search for studies that had previously investigated the association between teachers' intelligence mindsets and students' achievement in mathematics, in order to explore and present the key findings of these studies. Accordingly, the most appropriate methodology for presenting these results was deemed to be a systematic review of the literature on mindsets.

Although some systematic reviews have been conducted on the topic of mindsets, to the best of the researcher's knowledge, there has been no previous review that has systematically reviewed how a math teacher's baseline (i.e., teacher self-belief/view about either the teachers' or students' abilities before any intervention that aims to teach and/or change teachers' self-belief about those abilities by introducing the concept of growth mindset to them) intelligence mindset affects their students' academic achievement in maths. Therefore, the present review is considered to be the first systematic review about the association between these two variables.

This chapter begins by introducing the review and then presents the method used in the review. Following that, the results of the review are provided and discussed. Finally, the strengths, limitations and the conclusion of the review are also presented.

3.1 Abstract

According to Dweck et al. (1995), the term mindset refers to the assumptions/beliefs a person holds about learning and is typically categorised as either fixed (i.e., cognitive ability and capability are unchangeable and limited) or growth (i.e., cognitive ability and capability may improve based on the application of effort). Several studies have found that teachers' mindsets can influence teaching style, behaviour and feedback, and this in turn impacts students' mindsets and achievement at school. This systematic literature review explored the relationship between teacher mindset and student achievement, with a specific focus on those studying maths. The search was conducted across five databases and seven studies that met the inclusion criteria (including a qualified maths teacher, a measurement of teacher mindset and an index of student achievement in maths) were identified. In addition, all of the studies in the systematic literature review considered the relationship between teacher mindset and pupil achievement in maths using a correlation design and had either been published in a peer-reviewed journal or reported in the grey literature between 1980 and 2020. The findings showed that three out of seven of the studies reported an association between maths teacher mindset and student achievement in maths. The results revealed mixed evidence in this area, and therefore there is a need for further research to address the methodological limitations identified, including different age groups, different types of education and different cultures.

Keywords: implicit theories of intelligence, fixed mindset, growth mindset, teacher mindset, maths achievement.

3.2 Introduction

Beliefs regarding an individual's capacity to develop their abilities are called implicit theories or mindsets (Haimovitz & Dweck, 2017). Mindset is typically categorised into two types: fixed and growth. A fixed mindset is an individual's belief that their ability is limited and immutable (also referred to as entity theory) while a growth mindset is the belief that ability can improve and develop with effort (also referred to as incremental theory; Dweck & Leggett, 1988; Dweck et al., 1995). These implicit theories of intelligence, which were first outlined by Bandura and Dweck in 1981 (as cited in Dweck & Leggett, 1988), can provide a basis to analyse and interpret human behaviours (Dweck et al., 1995).

Some studies have shown that an individual's mindset affects their academic achievement. For example, a meta-analysis conducted by Costa and Faria (2018), which included students from

middle schools, high schools and colleges, found a low-to-moderate correlation between students' mindsets and their academic achievement, although this was not found to be the case if this achievement was self-reported. They also found that students who reported a growth mindset were more likely to have obtained higher scores in the verbal domain (i.e., language, literacy and writing-reading achievement), the quantitative domain (i.e., maths achievement, advanced maths course grade, statistics exam grade, and maths exam grade) and in general assessment (i.e., GPA, final exam score, final course grades and the mean grades of different subjects). However, it was also found that a fixed mindset was only linked to positive achievements in specific verbal and quantitative subjects. Additionally, the review reported that, aside from student gender, students' educational level, their cultural background, the mindset measure used, as well as the type of mindsets measured, all moderated the association between students' mindsets and their academic achievement. Another meta-analysis reported by Sisk et al. (2018, the first meta-analysis in their study) also found a very weak association between growth mindset and academic achievement. They reported that although the academic risk status, SES and academic achievement measure did not affect this relationship, the developmental stage the students were in (specifically for children and adolescents, but not adults) moderated the relationship.

It has also been noted that people can hold various mindsets for different fields and personal attributes; for example, people may believe that intelligence is fixed, yet believe that moral character can be developed (Dweck et al.,1995). Indeed, some studies have found that individuals differ in their mindset, and this is due to the impact of their specific subject area (e.g., Jonsson et al., 2012; Kraker-Pauw et al., 2017; Aljughaiman & Ayoub, 2017). For example, Jonsson et al. (2012) found that teachers of languages, social sciences, and practical disciplines were more likely to hold a growth intelligence mindset than a fixed intelligence mindset; nevertheless, preferences for these two types of mindsets among teachers of math and science were not statistically different.

Accordingly, some researchers have focused their research on investigating the mindsets in a single academic field such as maths. Some of these studies have found a positive association between student growth mindset and maths achievement (e.g., Blackwell et al., 2007, Study 1; Park et al., 2016; Claro et al., 2016; Bostwick et al., 2019; Rahardi & Dartanto, 2021). For example, Claro et al. (2016) found that there was a positive relationship between students' (aged 15 to 16) growth mindset and their achievement in language and maths regardless of SES. Interestingly, it was reported that students from lower-income families were less likely to endorse a growth mindset compared to students from top-income families, however, the achievement of students from lower-income families with a growth mindset was not affected by the harmful effects of poverty.

Previous studies have reported that there is a link between mindset and academic achievement, and much of the current research into mindset aims to improve student achievement by encouraging the development of a growth mindset, often as a result of following an intervention. These social psychological interventions typically do not involve teaching academic subjects to students, but instead their focus is on the psychology of the students, such as their beliefs about intelligence, which they are encouraged to improve (Yeager & Walton, 2011). Working with students to develop an adaptive mindset can help them academically, particularly in the case of socioeconomically disadvantaged students and academically at-risk students. That is, when academically at-risk students participate in remedial activities, this may affect them adversely and cause them to perform at a lower level, because they feel that they are less intelligent, however, helping them to believe that intelligence can be improved based on effort can have a positive effect on their academic achievement (Sriram, 2014). For example, some studies have reported contrasting findings and identified the positive impact of growth mindset interventions on students' achievement, including for students' (aged 14-15) scores for core subject (i.e., maths, science, English or language arts, and social studies) among those who had previously obtained poor academic achievement in these subjects (Yeager et al., 2016, 2019).

Moreover, two recent meta-analytic studies have investigated the effectiveness of student growth mindset interventions on their academic achievement (Sisk et al., 2018; Sarrasin et al., 2018). Sisk et al.'s (2018, their second meta-analysis) study concluded that the impact of growth mindset interventions on students' academic achievement is weak. In addition, the review found that among student factors, although the developmental stage (i.e., children, adolescents, and adults) was a nonsignificant moderator, SES was a significant moderator, as intervention only significantly increased the achievement of socioeconomically disadvantaged students. Furthermore, they reported that the intervention significantly increased the achievement of academically high-risk students. In terms of the control and intervention-related factors, it was reported that both the interventions administered through reading materials (cf. computer programs) and outside regular classroom activities (cf. integrated into regular classroom activities) were significant moderators. However, the factors related to the measurement of academic achievement did not affect the relationship between intervention and mindset.

The second meta-analysis was carried out by Sarrasin et al. (2018), who reported an overall small to medium beneficial effect of neuroplasticity interventions, which aimed to stimulate a growth mindset in three types of academic achievement (i.e., general achievement/GPA, reading and mathematics) among children and adults (from 7 years of age to adulthood). To clarify, in terms

of the intervention's influence on general academic achievement, the intervention was found to positively impact general academic achievement. The results also showed that the intervention positively impacted students' maths achievement and this impact was particularly strong among academically at-risk students.

Growth mindset interventions can be delivered in person or online, and studies have found mixed results regarding their impact on achievement. One study that used an online growth mindset intervention and evaluated its impact on students' maths achievement found that, after controlling for teacher characteristics, the students (aged 11 to 14) placed in the intervention group obtained higher scores in terms of growth mindset and maths creativity and felt less fearful of maths than the students in the control group (Boaler et al., 2018). Moreover, students in the intervention group engaged more in the classroom and obtained higher scores in standardised mathematics assessments compared to the students in the control group.

Additionally, although several studies have also reported that growth mindset interventions conducted by instructors or trained interventionists improve students' maths achievement (e.g., Blackwell et al., 2007, Study 2; Good et al., 2003), some researchers have indicated that to promote a growth mindset effectively among students through interventions, teachers' mindsets also have to be addressed (e.g., Fraser, 2018). Indeed, academic interventions can successfully be managed by teachers, especially as teachers are able to manage the intervention based on their students' needs, in order to help them to succeed (Wu & Kraemer, 2017). Specifically, it was found that science teachers played a key role in supporting interventions in the seventh-grade classroom (Schmidt et al., 2015). Thus, in recent years, attention from researchers has focused on the impact of interventions for both qualified maths teachers and students on students' maths achievement. That is, teachers received an intervention that they then delivered to their students. There is mixed evidence regarding the impact of this sort of training on pupil mindset/achievement. Some studies have found no impact on students' maths achievement (e.g., Dommett et al., 2013; Orosz et al., 2017; Tecker, 2017). However, Tecker's (2017) results showed a higher percentage of students (aged 11 to 12) in the intervention group passed with satisfactory grades compared to the students in the comparison group, who had not received a growth mindset intervention. The justification for the lack of influence may be because the consequences on pupils might not appear right away (Dommett et al., 2013).

By contrast, another study employed three different types of interventions for teachers and students and explored how these interventions impacted students' (aged 10 to 14 years old) motivation and learning in mathematics (Star et al., 2014). Teachers and their students were

randomly separated into one of three intervention groups, which included either playing an Immersive Virtual Environment (IVE) game, using the Brainology program (from www.mindsetworks.com) to educate students about growth mindset or watching a video titled Fractals: Hunting the Hidden Dimension. The results showed that students' scores in a maths learning post-test slightly improved for all of the groups. Interestingly, it was reported that the impact of the interventions was not influenced by students' demographic factors such as free or reduced lunches, ethnicity and gender, but that grade level was a factor. It was indicated that the growth mindset intervention and playing the IVE game intervention were more effective for students in lower grades, while the intervention that included watching a video on mathematical patterns was more effective for students in higher grades. It is also interesting to note that this study found that teacher-level variables, including teachers' mindsets, had no impact on students' maths test scores.

It has been argued that rather than conduct experimental studies, which involve taking students from their classrooms to attend intensive lectures for a limited time, teachers can conduct micro-interventions in their classrooms as part of their educational practices, to meet students' learning needs and fit with the culture of the school (Bonne & Johnston, 2016). Indeed, an injection of perpetual culture changes inside the classroom might be the sole effective method to ensure long-range development (Bonne & Johnston, 2016; Fraser, 2018). For example, some studies have aimed to investigate the improvement in students' maths achievement by fostering their growth mindset, which was done by encouraging teachers to adopt a growth mindset in their pedagogical practices and activities, often by only including teachers in the growth mindset interventions. However, the findings from these previous studies have also been inconsistent. Some studies have reported that pupils whose teachers attended the growth mindset intervention group did not increase their maths achievement (Rienzo et al., 2015; Seals, 2018). Interestingly, Seals (2018) reported that teacher beliefs did not moderate the effect of the intervention on student (aged 11 to 18) achievement. In contrast, other studies have found that pupils in primary schools whose teachers received a professional development intervention (including the growth mindset concept) improved their achievement in a maths test compared to pupils in the control group, whose teachers had not received the professional development intervention (Bonne & Johnston, 2016; Anderson et al., 2018). Another point of interest is that Anderson et al. (2018) found that the intervention group saw an increase in maths achievement, specifically among female students, English learners and economically disadvantaged students.

In the educational environment, the mindset of teachers plays a key role, as it guides students to improving their knowledge, skills and beliefs (Zilka, et al., 2019). According to the "theory of action", which was developed by Sun (2019), teachers baseline intelligence mindsets may affect their responses toward students and, in turn, these beliefs and responses might highlight to students whether their ability is fixed or can be improved, thus influencing students' achievement in maths. The evidence regarding the link between the teachers' mindsets and their reactions can be clearly seen in a number of studies (see Section 1.7). The associations between the mindsets of students and their academic outcomes are also evident in several studies (see Section 1.6). Moreover, some researchers have expressed a particular interest in how qualified teachers' existing or baseline mindsets affect students' academic outcomes, and accordingly, they have examined the relationship between them. However, there are limited findings with regard to the impact of this. Only one study has investigated the association between teachers' beliefs (i.e., self-efficacy, collective-efficacy, intrinsic motivation, extrinsic motivation and incremental beliefs) and student overall academic achievement at primary and middle schools (Cunningham & Farmer, 2016). The results showed that no single teacher belief was associated with students' overall academic achievement. However, it was found that, collectively, all five of the teacher beliefs that were measured impacted student achievement, and intrinsic motivation was the teacher belief that most significantly impacted students' overall academic achievement when considering all five of the teacher beliefs together.

Furthermore, to the best of the researcher's knowledge, only one systematic review, conducted by Zhang et al. (2017), has attempted to examine the relationship between student and teacher mindsets and student academic achievement. In terms of the teacher mindset review (the second review), which included five studies conducted in only primary and middle schools, it looked at the relationship between teachers' mindset as a causal factor in students' academic achievement, and teachers' mindset as a mediator of the association between parents' mindset and their child's academic potential. The review concluded that teachers' mindsets had a greater direct impact on students' academic achievement than when teachers' mindsets were included in the model as a mediator. While the findings of Zhang's systematic review support the role of pupil mindset on achievement, it recognised that teacher mindset (both as a causal factor or as a mediator) also plays an important role in shaping students' academic achievement.

It is important to note that four out of five studies included in Zhang et al.'s (2017) second review used a correlational design. The first study included in their review conducted by Kärkkäinen et al. (2010) investigated the association between teachers', pupil's and their parents' view of the

malleability of their academic competencies in maths and Finnish. The second study by Shim et al. (2013) explored the correlation between teachers' achievement goals for teaching and beliefs about the malleability of students' intelligence and their classroom goal structures that they establish in their classes. The third study conducted by Jonsson and Beach (2012) investigated how pre-service teachers' praise (person and process praise) were related to their beliefs concerning social comparison, stereotype acceptance and implicit theories of intelligence in maths and social science. The fourth study by Kärkkäinen and Räty (2010) explored if teachers' perceptions of the child's potential for improvement in maths and Finnish was closer to the mothers' perceptions than the fathers' perceptions. The fifth study by Schmidt et al. (2015) looked at the impact of a mindset intervention (including the Brainology program and teachers' instructional practices) on students' beliefs and achievement in science. Therefore, most of the studies included in Zhang et al.'s (2017) review did not measure students' academic achievement. In addition, only three out of five studies included looked at the field of maths, as the other studies focused on other subjects such as science or were in general. Moreover, one of the studies included pre-service teachers. Thus, the five studies included in Zhang et al.'s (2017) review did not investigate the actual relationship and real effects that can exist between teachers' baseline mindsets and students' academic achievement.

Although few researchers have attempted to estimate the relationship between qualified teachers' baseline intelligence mindsets and their pupils' academic achievement, much uncertainty still exists about this relationship. Moreover, no previous systematic review has investigated how maths teacher's baseline intelligence mindset impacts pupils' maths achievement. Thus, the goal of this systematic review was to extend the previous research by focusing on the correlation studies that measured the association between teacher baseline intelligence mindset and pupils' achievement in maths. This goal was achieved by exploring the relationship between maths teachers' mindset and the maths achievement of pupils in primary (4-11 years) and secondary education (11-18 years).

3.3 Method

3.3.1 Search strategy

Using the PROSPERO website, a scoping search was conducted, and the review was registered (no. CRD42018095318). The key terms in the search included single words and word combinations, as shown in Table 1. The key terms were searched across five electronic databases, including Teacher Reference Center via Ebsco, PsychInfo via Ebsco, Eric via ProQuest, Scopus and Web of Science Core Collection. Additionally, a hand search of all other reviews deemed relevant

was also conducted (i.e., Zhang et al., 2017). This review included published literature and grey literature. The published literature included research from commercial publishers including peer-reviewed journals. Following Boland et al. (2017), the search of the grey literature included studies from "annual reports, … dissertation or theses, conference proceedings and research registers of ongoing or unpublished studies" (p. 65). There was no restriction on age, years of teaching experience, country or language. The first search of only published literature began in November 2018 and focused on pupils in schools, it was then extended to include students at university in December 2018. Then, a second search was performed of the grey literature in March 2019. In order to include more studies and to update the search, a final search was conducted of both the published and grey literature in August 2020, and two new studies were found that met the inclusion criteria.

3.3.2 Inclusion and exclusion criteria

Bandura and Dweck developed their mindset theory in 1981 (as cited in Dweck & Leggett, 1988), therefore, the search was limited to between 1980 and 2020. To include studies in the current review, each study must include all the three criteria, as follows: (1) the study's participants had to be qualified maths teachers; (2) the study's tools had to measure teachers' mindset regarding intelligence or maths ability rather than students' own perception of their teachers' mindsets; (3) and the study had to contain students' maths outcomes by either measuring students' maths achievement or obtaining their maths' results from schools. Consequently, any study that did not meet the three criteria given above was excluded. Lastly, the articles deemed eligible for inclusion were read in full and were quality assessed and reviewed in detail.

3.3.3 Screening and selection

The search identified 1,238 studies, and after the duplicates had been removed, 1,108 remained. The titles and abstracts of each paper were reviewed, and 1,098 studies were excluded, because they did not meet all three inclusion criteria (see Section 3.3.2). It is important to note that although mindset theory first appeared in 1981 (as cited in Dweck & Leggett, 1988), no studies had explored the relationship between teachers' mindsets and students' maths achievement before 1998. To ensure the reliability of the review, 20% of the articles from the total records screened through the search were reviewed by an independent reviewer. The full text of ten studies was considered and this led to three studies being excluded (see Appendix B1). Figure 2 illustrates the search process.

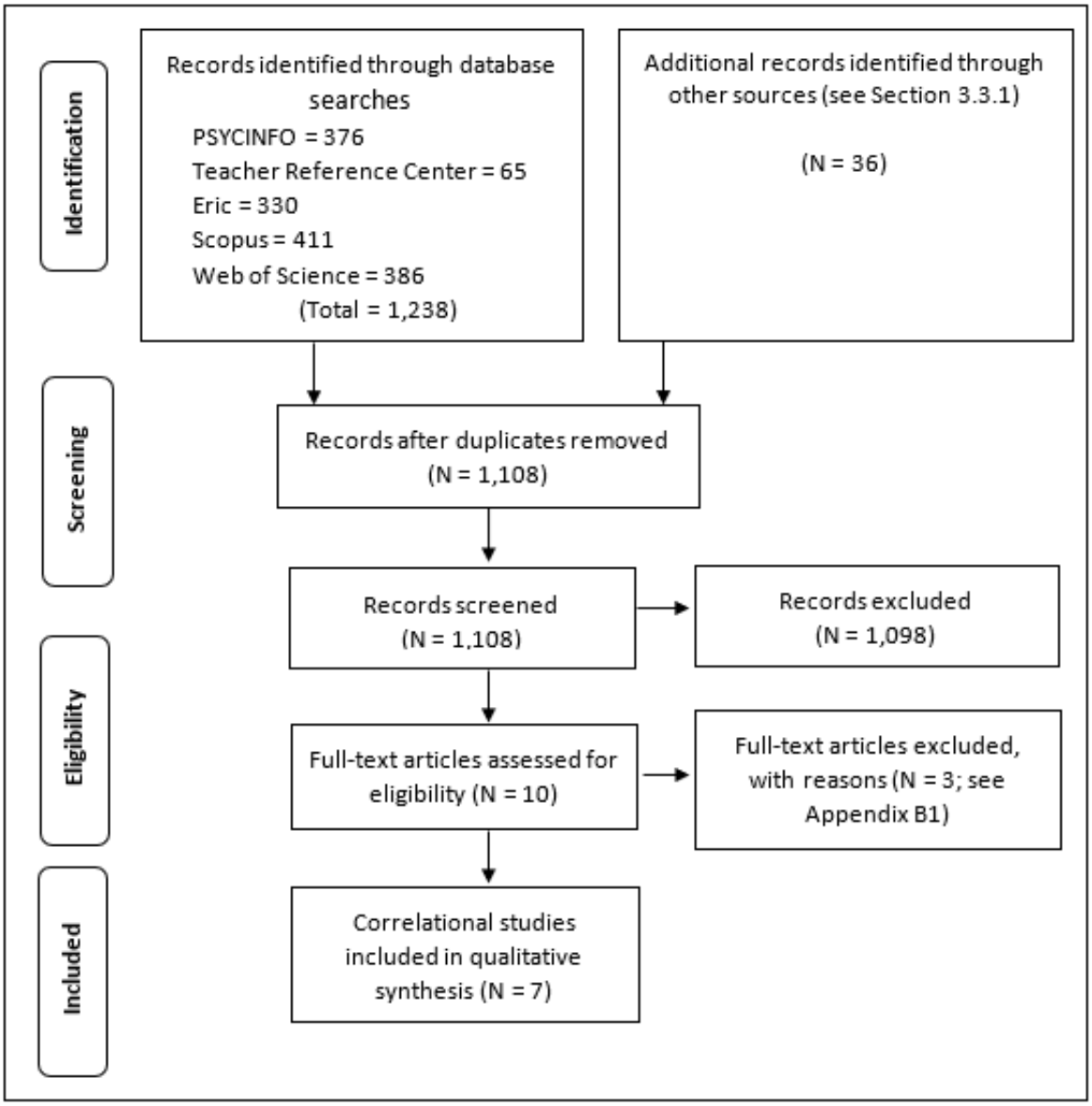
Table 1

Key terms used in the current systematic search

Main terms	Synonyms	Synonyms combined together	Different concepts combined together
Mindset* (9 terms)	"Implicit Theor* of Intelligen*" "Entity Theor*" "Entity belief*" "Fixed mindset*" "Incremental Theor*" "Incremental belief*" "Malleable intelligen*" "Growth mindset*"	The main term and their synonyms were combined in the search using the word OR = (S1) = <u>For example:</u> Mindset* OR "Implicit Theor* of Intelligen*" OR "Entity Theor*" OR "Entity belief*" OR "Fixed mindset*" OR "Incremental Theor*" OR "Incremental belief*" OR "Malleable intelligen*" OR "Growth mindset*" = (S1) =	(S1) AND (S2) AND (S3) = (S4) Results
Teacher* (7 terms)	Educator* Tutor* Instructor* Pedagogue* Lecturer* Professor*	The main term and their synonyms were combined in the search using the word OR = (S2) =	
Achievement* (9 terms)	Attainment* Outcome* Progress* Mark* Grade* Score* Performance* Assessment*	The main term and their synonyms were combined in the search using the word OR = (S3) =	

Figure 2

PRISMA Flowchart of the selection process used in the Systematic Literature Review



Note. PRISMA Flowchart. Adapted from: "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," by D. Moher, A. Liberati, J. Tetzlaff, D. G. Altman, and the PRISMA Group, 2009, PLoS Medicine, *6*(7), Article e1000097. Retrieved from https://doi.org/10.1371/journal.pmed.1000097

3.3.4 Data extraction

Extracted data included the authors, year of publication, title, type of study (i.e., published literature or grey literature), study design, country, core aims, measures, participant numbers,

demographic characteristics of teacher and student participants (i.e., gender, age, ethnicity, SES and teachers' years of experience), and a summary of the results (see Table 6 in Appendix B2).

3.3.5 Quality assessment tool

The AXIS tool for Cross-Sectional Studies (CSSs) was used to appraise the quality of the cross-sectional studies (Downes et al., 2016). This tool contains 20 items divided into five evaluation criteria for the introduction, methods, results, discussion and others, namely the interpretation of the results and ethical approval or the consent of participants (see Table 7 in Appendix B3). Each item is rated as "yes", "no" or "do not know", and assigned a numeric rating in line with Moor and Anderson (2019) and Deslandes and Anderson (2019), who scored "yes" as 1 and "no" or "do not know" as 0. However, in the current review, an exception was made for items 13 "Does the response rate raise concerns about non-response bias?" and 19 "Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?", which were scored differently (i.e., "yes" or "do not know" were scored as 0 and "no" was scored as 1). The total score ranged between 0-20, and the quality level was categorised as low (1 to 7), medium (8 to 14) and high (15 to 20).

An independent reviewer completed the quality assessment of the included studies to compare the results with those of the researcher. Then, the researcher and the independent reviewer met to discuss any disagreement in the scores of the items and, at the end, they reached an agreement on these for all of the items used for the quality assessment of each individual study.

3.4 Results

Seven studies were included in this review, as they considered the relationship between maths teachers' mindsets and pupils' maths achievement.

3.4.1 General elements

3.4.1.1 Types of evidence

Only two studies were published in peer-reviewed journals (Gadeyne et al., 2006; Bostwick et al., 2020) and five studies were found in the grey literature. Four of the studies found in the grey literature were doctoral dissertations (Hubacz, 2013; Balzer, 2014; Jones, 2016; Chiarelli, 2018), and one study was a paper presented at the Annual Meeting of the American Educational Research Association (Schullo & Alperson, 1998).

3.4.1.2 Study designs

In terms of design, all of the studies included in this review had a correlational design. Hubacz's (2013) study used secondary analysis of data from an educational longitudinal study (ELS) between 2002 and 2012. However, Hubacz only focused on data collected in 2002, which was presented by the National Center for Education Statistics. Although Gadeyne et al. (2006) used a longitudinal measurement, measuring pupil's (pre-) academic achievement tests in kindergarten and then again in first-grade, they only measured the mindsets of first-grade teachers.

3.4.1.3 Geographic locations

The seven studies were conducted in three different countries. Five studies were conducted in the USA (Schullo & Alperson, 1998; Hubacz, 2013; Balzer, 2014; Jones, 2016; Chiarelli, 2018), one study was conducted in Belgium (Gadeyne et al., 2006) and one study was conducted in Australia (Bostwick et al., 2020).

3.4.1.4 Aim of the studies

The seven studies all investigated the relationship between maths teachers' mindset and students' maths achievement (see Appendix B2).

3.4.2 Study characteristics

3.4.2.1 Sample description (size, age, gender and years of experience)

All of the studies involved qualified maths teachers and their students. Only one study included special education teachers co-teaching (Chiarelli, 2018). The number of maths teachers participating ranged from 12 to 113. Only two studies reported the age of the teachers (Schullo & Alperson, 1998; Bostwick et al., 2020), and four studies (Schullo & Alperson, 1998; Hubacz, 2013; Balzer, 2014; Bostwick et al., 2020) reported the teachers' gender (see Table 2). In addition, five studies reported that the teachers' years of experience ranged from less than one year to more than 25 years (Schullo & Alperson, 1998; Hubacz, 2013; Balzer, 2014; Chiarelli, 2018; Bostwick et al., 2020), while two other studies (Gadeyne et al., 2006; Jones, 2016) did not identify the teachers' years of experience (see Appendix B2). The sample sizes of students ranged from 80 to 6,800 and of the seven studies, two included pupils from primary schools, aged 6 to 11 years old (Gadeyne et al., 2006; Jones, 2016), while four of the studies (Schullo & Alperson, 1998; Hubacz, 2013; Balzer, 2014; Bostwick et al., 2020) involved students from secondary schools, aged 11 to 18 years old. Only one study (Chiarelli, 2018) included students from both primary, middle and high schools. Four of the

seven studies reported students' gender (Schullo & Alperson, 1998; Gadeyne et al., 2006; Hubacz, 2013; Bostwick et al., 2020), while three studies did not report students' gender (Balzer, 2014; Jones, 2016; Chiarelli, 2018; see Table 2).

3.4.3 Socio-demographic profiles

3.4.3.1 Participants' ethnicity

The ethnicity of the participants in the five studies (Gadeyne et al., 2006; Hubacz, 2013; Balzer, 2014; Jones, 2016; Chiarelli, 2018) was not reported. Only one study reported teacher ethnicity (Schullo & Alperson, 1998), which included participants who identified as: African American (2.5%), Asian American (11%), European American (75%), Latino/a (6%) and other (5%). Student ethnicity was also only reported in one study (Schullo & Alperson, 1998), specifically: African American (8%), Asian American (19%), European American (19%), Native American (2.5%), Latino/a (49%) and other (2.5%). Bostwick et al. (2020) reported that the majority of teachers and students were primarily English-speaking at home, and a small percent of students were identified as Aboriginal or Torres Strait Islanders.

3.4.3.1.1 Students' Socioeconomic Status

All of the students in two studies were from low/disadvantaged SES (Schullo & Alperson, 1998; Balzer, 2014). Schullo and Alperson (1998) stated that students' SES was identified by their teachers and based on their parents' occupation. Hubacz (2013) reported that the students' SES "has a value of approximately 0.02, with an SES range from -2.11 to 1.81. A value of 0 represents average SES" (p.71), as defined by parent occupation and level of education and family income. Bostwick et al. (2020) stated that students had a mean SES that was slightly higher than the national average. In addition, three studies (Gadeyne et al., 2006; Jones, 2016; Chiarelli, 2018) did not report their students' SES.

Table 2

Summary of the seven studies included in this Systematic Literature Review

Author(s) and year	Description of Samples		
	Ages ranged from	Number	Gender
Schullo and Alperson (1998)	Students: 12 to 18 years old Teachers: 24 to 66 years old	160 divided into 80 student-teacher dyads (one teacher and one student) from 33 public schools	Students: an equal number of genders Teachers: 37 female and 43 males
Gadeyne et al. (2006)	Students: 6 to 7 years old Teachers: NR[a]	22 teachers and 346 pupils in maths classes from "11 regular education schools" (p.67)	Students: an equal number of genders Teachers: NR
Hubacz (2013)	Students: 15 to 16 years old Teachers: NR	6,800 students and the number of teachers was not reported	Students: 52.3% female and 47.7% male Teachers: 55% female and 45% male
Balzer (2014)	Students: 11 to 14 years old Teachers: NR	35 teachers and 1,095 students in nine public schools	Students: NR Teachers: 27 females (77%) and 8 males (23%)
Jones (2016)	Student: 8 to 11 years old Teachers: NR	113 teachers from 35 primary schools. Pupil numbers were not reported	Students: NR Teachers: NR
Chiarelli (2018)	Students: NR Teachers: NR	In total 17 teachers, 12 of whom were maths teachers, and 416 students, 171 of whom were students in maths class at a primary, middle and high school in one school district [b]	Students: NR Teachers: NR
Bostwick et al. (2020)	Students: On average, students were 14.3 years old Teachers: On average, teachers were 45.6 years old	91 maths teachers and 1,414 students from 15 secondary schools	Students: 46.7% male and 53.3% female Teachers: 56.0% male and 44% female

Note. [a] NR = Not Reported; [b] This review only reported the maths sample.

3.4.4 Methodology of the studies

3.4.4.1 Measures of mindsets

In four studies (Gadeyne et al., 2006; Balzer, 2014; Jones, 2016; Bostwick et al., 2020), teacher mindset was measured using the same tool: The Implicit Theory of Intelligence Scale, which was developed or provided by Dweck et al. (1995), Dweck and Henderson (1989), or Dweck (2000). Three studies (Gadeyne et al., 2006; Balzer, 2014; Jones, 2016) used the short scale of mindset which included only three or four items, while one study (Bostwick et al., 2020) used the long scale of mindset which included eight items. An example of the intelligence mindset items included in the four studies above is: "You have a certain amount of intelligence and you really can't do much to change it'' (Balzer, 2014, p.123). Moreover, Schullo and Alperson (1998) used a scale that included ten items, five of which were developed by Dweck and measured teachers' beliefs about students' intelligence, while the other five items measured teachers' beliefs about students' maths abilities, which had been previously developed by MacGyvers et al. (1993). An example of an intelligence mindset item is similar to the example mentioned above, while an example of a maths item is: "Math ability is something that I have a certain amount of and there isn't much I can do to change it." (Schullo & Alperson, 1998, p.26). Participants' responses to items, whether using the short or long scale, on a Likert scale reflect if the individual holds a growth or fixed intelligence mindset.

In addition, Chiarelli (2018) used the "What's Your Mindset" survey (Mindset Works, Inc., from https://www.mindsetworks.com), which returns a gradient scale. This survey, which is grounded in Dweck's (2006) work about mindsets, is divided into 10 levels of mindsets; five levels related to a growth mindset (from G1 to G5) and five associated with a fixed mindset (from F1 to F5). The teachers who participated in the study demonstrated scores across five different mindset levels (F1, G1, G2, G3, and G4), however, due to the small number of participants, the levels were combined into three growth groups (A, B and C), which corresponded to the level to which the teacher's view was that learning is flexible. Moreover, Hubacz (2013) used the teacher implicit theory of intelligence measure, which includes two statements, from a dataset provided in the ELS in 2002, that is similar to the scale created by Dweck et al. (1995). These statements are: "a. Most people can learn to be good at mathematics." and "b. you have to be born with the ability to be good at mathematics." (Hubacz, 2013, pp. 65-66). Across the seven studies included in this review, only one study (Gadeyne et al., 2006) used a translated version of the mindset measure, which was translated by Waeytens (1998).

3.4.4.2 Measures of maths achievement

Schullo and Alperson (1998) used students' final scores from the Algebra 1. Furthermore, three studies used standardised maths tests. To clarify, Hubacz (2013) used student scores from the cognitive test of mathematics ability provided in the ELS in 2002. Gadeyne et al. (2006) employed a maths test from a Flemish fully standardised pupil monitoring system, which was developed by Dudal (2000). Additionally, Balzer (2014) used students' maths scores from the State of Texas Assessment of Academic Readiness, and the percentages for students' yearly progress in the state maths exam.

Bostwick et al. (2020) employed a maths test that they had previously used in a study in 2017, which had been previously adapted from another study (see Martin et al., 2012). However, Jones (2016) measured maths achievement using the Average Growth Index (AGI), which was defined as, "a measure of student progress across the tested grade levels in a school" (Pennsylvania Department of Education, 2019, p. 2). Chiarelli (2018) used the Northwest Evaluation Association's (NWEA) Measures of Academic Progress (MAP) Conditional Growth Index (CGI) score during the middle and the end of the year in the context of maths and reading.

All of the other measures (non-mindset, non-maths achievement) that were used in the included studies are explained in Appendix B2.

3.4.5 Critical appraisal of the studies

Using the AXIS tool (see Section 3.3.5), six studies (Gadeyne et al., 2006; Hubacz, 2013; Balzer, 2014; Jones, 2016; Chiarelli, 2018; Bostwick et al., 2020) obtained a "high" rating (scores between 15-20), while one study (Schullo & Alperson, 1998) obtained a "medium" rating (scores between 8-14; see Table 8 in Appendix B4).

3.4.6 Summarise the findings of studies that investigated the relationship between teachers' mindset and students' maths achievement

Of the seven studies, four (Gadeyne et al., 2006; Balzer, 2014; Jones, 2016; Chiarelli, 2018) found that there was no overall significant relationship between teachers' mindsets and students' maths achievement. However, Balzer (2014) reported a significant positive association between teachers' mindsets and the yearly progress of their economically disadvantaged students in the standardised state maths exam. To illustrate, a teacher who had a high score in terms of his/her

growth mindset had a higher number of students who made more progress in one year than the previous year in the standardised state maths exam.

Contrary to the earlier findings, three studies indicated that there was a significant, positive association between teachers' growth mindset and students' higher scores in maths. A study by Schullo and Alperson (1998) found that the students of male teachers who held a growth mindset achieved higher scores in their algebra performance compared to students of male teachers who held a fixed mindset. Conversely, there were no differences between the students taught by female teachers in the growth minded teachers' group and fixed minded teachers' group. Additionally, Hubacz (2013) found that the students of teachers who endorsed a growth mindset obtained a higher score in maths tests when all other predictors of achievement were controlled for (e.g., teacher's self-efficacy and student's mindset), compared with the scores of maths students whose teachers endorsed a fixed mindset. Bostwick et al.'s (2020) results also reported a significant positive correlation between teacher growth orientation (which includes intelligence mindsets, self-based growth goals and task-based growth goals) and classroom maths achievement even when controlling for prior maths achievement in the classroom.

3.5 Discussion

This systematic review evaluated the academic literature regarding the relationship between qualified maths teachers' baseline intelligence mindsets and students' maths achievement at primary (4-11 years) and secondary schools (11-18 years). This review included seven studies, of which no study had previously been included in a systematic review on this topic in this past (c.f. Zhang et al., 2017; see Section 3.2).

Overall, the studies included in the current review provide mixed evidence for the relationship between qualified maths teachers' mindset and students' maths achievement. Among the seven studies, four (Gadeyne et al., 2006; Balzer, 2014; Jones, 2016; Chiarelli, 2018) found no significant relationship between maths teachers' mindsets and students' maths achievement. However, Balzer (2014) reported a significant, positive association solely between maths teachers' growth mindset and their economically disadvantaged students' yearly progress in maths. These findings are consistent with two intervention studies that showed that pupils whose teachers attended a growth mindset intervention did not increase their maths achievement (Seals, 2018; Rienzo et al., 2015). Furthermore, these results are also in agreement with those studies that included an intervention for qualified teachers and students and showed that students' maths achievement did not improve (Dommett et al., 2013; Orosz et al., 2017; Tecker, 2017). Additionally,

these results are in line with those of Star et al. (2014), who found that although students' maths achievement increased as a result of the intervention led by their teacher, there was no relationship between teachers' mindsets regarding maths ability and students' maths test scores. Failing to find a correlation between teachers' mindset and students' maths achievement may be explained by the fact that the impact on pupils might not present straight away (Dommett et al., 2013). That is, it may be that the influence of teachers' mindsets takes longer to show results in their students' outcomes.

On the other hand, the other three studies in this review (Schullo & Alperson, 1998; Hubacz, 2013; Bostwick et al., 2020) found a significant positive association between teachers' growth mindset and students' higher scores in maths achievement. These findings are in line with those reported by Cunningham and Farmer (2016), who found that although there was no relationship between any one individual motivational concept held by the teachers and students' overall academic achievement, the teachers' motivational concepts, including self-efficacy, collective-efficacy, intrinsic motivation, extrinsic motivation, and incremental beliefs, as a whole, did have a positive effect on students' academic achievement. Moreover, the findings from the current review also support Zhang et al.'s (2017) review results, which concluded that teachers' mindsets, whether as a cause or a mediator, were linked to students' academic achievement. These results are also in agreement with Star et al.'s (2014) findings, which found that those students that were part of the growth mindset intervention group led by their teachers improved their maths achievement. In addition, these results are consistent with those of Anderson et al. (2018) and Bonne and Johnston (2016), who found that pupils whose teachers received a professional development intervention (including the growth mindset concept) increased their achievement in a maths test compared to pupils in the control group, whose teachers had not received the intervention.

The observed relationship between teachers' mindset and students' maths achievement might be explained by the fact that teachers who hold a growth mindset, that is, the belief that intelligence can be developed and increased, are able to transmit that to their students and support their improvement regardless of past achievements or failures (Balzer, 2014). Furthermore, intelligence growth minded teachers might strive to enhance their teaching, master the material they are teaching, and use more effective teaching practises, and therefore, it is likely that these actions influenced how well students performed in math (Bostwick, 2020). Together, this reflects the "theory of action", developed by Sun in 2019, and explains that teacher's beliefs might be associated with their interactions and reactions to their students in the classroom, and how, in turn, these practices might either deliver the message to students that their traits and abilities are unchangeable or can be grown, thus impacting students' maths achievement. Indeed, several

studies have concluded that teachers' mindsets are related to their practices (see Section 1.7), and many studies have found that students' mindsets are related to their achievement (see Section 1.6).

Interestingly, the findings of two studies included in this review highlighted that teachers' mindset was effective at increasing the maths achievement of students who were from low SES backgrounds (Schullo & Alperson, 1998), as well as their yearly progress (Balzer, 2014). These results are consistent with the data obtained in Sisk et al.'s (2018) second meta-analysis, which found that intervention studies significantly increased the achievement of high academic risk students and socioeconomically disadvantaged students. Moreover, these findings are in line with those of Anderson et al.'s (2018) study, which highlighted that the intervention (including growth mindset concept) group saw an increase in maths achievement, specifically among female students, English learners and socioeconomically disadvantaged students. A possible explanation for this might be that poor academic results could be due to the family's low income, as this could leads students to hold the view that they are unable to develop their intellectual capacities (Claro et al., 2016). Thus, when this group of students is exposed to teachers with a growth mindset through feedback and practices used in their classroom, they can develop the belief that it is possible to develop their abilities and skills in a way that helps them achieve a greater level of achievement. In addition, this effect might be more evident among them than their peers from middle- or high-income families.

Again, the findings of the studies included in this review are consistent with similar research carried out previously (e.g., Cunningham & Farmer, 2016; Zhang et al.,2017) and further the suggestion that there is limited evidence and mixed findings concerning how teachers' mindsets are linked to students' achievement. Furthermore, since it is clear from the findings of the current review that three out of the seven studies found that teachers' mindset affected students' maths achievement (Schullo & Alperson, 1998; Hubacz, 2013; Bostwick et al., 2020) and one further study (Balzer, 2014) reported that teachers' mindset impacted students' yearly progress in maths, there are a number of important implications that should be taken into account for future practice. Most importantly, more research in this area is needed in the form of longitudinal studies to measure the impact of teachers' mindsets over a long period of time, in order to obtain a clearer understanding of the impact of such mindsets. Moreover, there remains a paucity of evidence about the effect of qualified teachers' mindsets on students' maths achievement. After all, this review only included seven studies, all of which were conducted in primary and secondary schools. Thus, further investigation into the impact of qualified teachers' mindsets on students' maths achievements is strongly recommended among different age groups such as those at pre-school, undergraduates, and adult students. In addition, only one study included co-teaching special education teachers

(Chiarelli, 2018), so further research should be undertaken to investigate this relationship in different types of educational settings such as special education schools and hospital schools. Furthermore, the majority of studies included in this review (Schullo & Alperson, 1998; Hubacz, 2013; Balzer, 2014; Jones, 2016; Chiarelli, 2018) were carried out in the USA, thus there is a lack of studies related to this subject among other cultural contexts. Therefore, further studies are needed in order to include a wider range of cultural contexts – particularly non- Anglophonic and non-Western contexts.

3.6 Strengths and limitations of this systematic review

The key strength of this systematic review was that it focused on studies that included qualified maths teachers and their real-world students, rather than lab-based proxy teachers and students. Thus, the external validity of the findings is increased.

A further strength was the method used to reduce the risk of bias in this systematic review, which involved asking an independent reviewer to review 20% of the articles from the total records screened and to complete the quality assessment tool for all of the included studies.

Despite the existing strengths, the studies included in this review used a range of different measures, specifically for maths achievement (e.g., standardised maths tests, the Average Growth Index, or final grades of Algebra 1), making it difficult to conduct a meta-analysis featuring truly like-for-like comparisons for the findings.

3.7 Conclusion

This review investigated the association between qualified maths teachers' mindsets and students' maths achievement in primary and secondary education. This review was carried out across five databases and other sources and included just seven studies. The current systematic review concludes that evidence for the relationship between qualified maths teachers' mindsets and the maths achievement of students is low in volume and has been mixed. It is therefore recommended that further research be undertaken regarding the association between qualified maths teachers' mindsets and students' maths achievement among all age groups, different types of education, and different cultures.

Chapter 4 Study 2: A qualitative exploration of maths teachers' mindsets and reactions to pupils' successes and failures in primary classrooms in Riyadh, Saudi Arabia

It has been argued that students' mindsets and achievements might be affected by adults' mindsets and practices. The literature review in chapter 1 demonstrated that students' mindsets are related to their academic achievement (see Section 1.6). Previous research has also shown that teachers' mindsets are linked with their students' mindsets (see Section 1.7). In addition, the results of the systematic review (i.e., study 1, chapter 3) in the current thesis provided mixed evidence regarding the relationship between qualified maths teachers' baseline intelligence mindsets and their students' maths achievement. That is, some studies have found that teachers' intelligence mindsets correlated with their students' achievement in maths. Therefore, further studies have aimed to explore how teachers' mindsets influence or correlate with their students' mindsets and achievements. For example, some studies revealed that teachers' mindsets are associated with their practices (see Section 1.7), as well as Haimovitz and Dweck (2017) hypothesised in their model (see Figure 1 in Section 1.7) that adults' mindsets might be related to their practices and responses toward children, which in turn, might promote a growth or fixed intelligence mindset on them.

However, the literature still has a gap and a further delve into the role of teachers' mindsets and practices on their students' mindsets and achievements are still needed. Indeed, a search of the literature on intelligence mindsets revealed few studies that aimed to investigate that qualitatively through interviews (e.g., Sun 2018, 2019) since many of the studies about mindset utilized a quantitative approach. Therefore, to address this gap, more research using a qualitative method is needed. This can be done by employing interviews asking teachers how they motivate pupils and how they manage their successes and failures in their classroom to attain a deeper understanding of the mechanisms and beliefs that are reflected in their practices and responses towards their pupils in the class. Furthermore, the literature review in chapter 2 (see Section 2.2) and the systematic review (i.e., study 1, chapter 3) in this thesis highlighted the lack of studies on the subject of mindset in a non-Western cultural context. Although there are a number of studies on intelligence mindsets in KSA, there has been no study that explores the role and impact of adults' intelligence mindsets and practices on the intelligence mindsets of their children/pupils. Moreover, only a few studies including a sample of teachers aimed to explore the intelligence mindsets adopted by them using a quantitative methodology (see Section 2.2).

Consequently, the second objective in this thesis aims to address the gap in the literature, specifically, in the Saudi context, by exploring the intelligence mindsets of mathematics teachers in

primary schools in Saudi Arabia using a qualitative methodology to achieve a better understanding of the role of teachers' maths intelligence mindsets and their educational practices and responses towards pupils' success and failure in maths. Thus, to gather data from teachers, interview questions will follow Haimovitz and Dweck's (2017) hypothesised model (see Figure 1 in Section 1.7) regarding how adults promote children's growth and fixed mindsets. Primary maths teachers were chosen because children at this stage begin to deal with situations of success and failure in their learning, through which their beliefs about their educational abilities and capabilities are formed through the beliefs and practices of adults around them. Indeed, Robins and Pals (2002) reported that adults' beliefs about their intelligence mindsets are more likely to remain unchanged from high school to college.

This chapter begins with an introduction and then presents the methodology used in the study. Following that, the study's results are provided and discussed. Finally, the strengths, limitations, implications and study's conclusion are provided.

4.1 Abstract

A growing body of evidence indicates that students' growth or fixed mindsets impact their academic achievement. However, few studies have investigated how teachers' beliefs impact their practices and/or influence their students' mindsets and achievement. In particular, mathematics is a topic that is often subject to beliefs about inherent ability, and knowledge of how teachers motivate students in the context of successes and failures is required to inform interventions that adjust mindsets, as these may be especially important instructional tools in this field. What little research that exists on this topic is centred around Western cultures, and little is known about how mindsets influence teaching in Saudi Arabia. This study aimed to explore the views of 30 primary maths teachers concerning their mindsets and how these influence pupils' maths achievements. Following reflexive thematic analysis, five overarching themes emerged. The themes highlight some practical implications for the MOE, including providing courses for teachers to help them to raise their pupils' motivation, as well as improve the educational environment in schools. The findings also suggest further research is required to develop a deeper understanding of the impact of adults' mindsets and the methods used by adults to motivate their children/pupils.

Keywords: teaching strategies, growth or fixed mindsets, mathematics, pupils, success and failure.

4.2 Introduction

Beliefs concerning the nature of individual characteristics are known as implicit theories (Carr et al., 2012). One such belief is the implicit theories of intelligence, or mindsets, which aims to explain people's beliefs around whether intelligence is fixed at birth or malleable over time and with experience (Dweck, 2006; Yeager & Dweck, 2012). Researchers have argued that individuals tend to hold one or the other implicit theories of learning and intelligence, that is, either a fixed or growth intelligence mindset (Dweck, 2006; Yeager & Dweck, 2012). Individuals with a fixed intelligence mindset believe that intelligence is stable and does not change over time, while those with a growth intelligence mindset believe that intelligence can be improved (Dweck, 2006; Yeager & Dweck, 2012). There are also a number of individuals who hold mixed mindsets, as presented in Claro et al.'s (2016) study, that is to say, they do not strongly hold either a fixed or growth mindset.

A large and growing body of literature on implicit theories has investigated the impact of individuals' intelligence mindsets on their academic achievement. These studies have found conflicting findings. In the school context, some studies have shown a positive association between students who hold a growth mindset and their academic achievement, while others have indicated a negative correlation between students who hold a fixed mindset and their academic achievement (e.g., West et al., 2016; Zhang et al., 2019; Destin et al., 2019; Diaconu-Gherasim et al., 2019). However, other studies have not found a relationship between students' mindsets and their academic achievement (e.g., Leondari & Gialamas, 2002; Bonne & Johnston, 2016; Dixson et al., 2017; Li & Bates, 2019, study 4). It is important to bear in mind that individual mindsets might be influenced by both internal and external factors. That is, it has been argued that culture and ethnicity, gender, age, SES, domain, years of teaching experience and the school system can play a role on impacting peoples' beliefs (see Section 1.3.1). For example, it has been argued that implicit theories might differ by subject, that is, individuals may hold multiple beliefs for different skills and subjects (Dweck et al.,1995; Dweck, 2006). Indeed, much of the current literature on intelligence mindsets pays particular attention to exploring this concept in a specific domain such as mathematics and several studies have shown that maths achievement is positively associated with students who hold a growth mindset (e.g., Park et al., 2016; Claro et al., 2016; Tarbetsky et al., 2016; Bostwick et al., 2020: Rahardi & Dartanto, 2021).

Additionally, as mentioned above, students' mindsets and academic achievement may be influenced by the classroom climate, specifically the interactions between teachers and students (McCutchen et al., 2016). Some researchers have argued that adults' mindsets may impact children's mindsets, which in turn may impact the child's achievement. Recently, there has been an increasing

amount of literature on the effect of teachers' intelligence mindsets on their students' mindsets in maths, however, studies have found conflicting findings. For example, it was reported that primary and middle school teachers' intelligence mindsets were positively associated with their students' intelligence mindsets and fully mediated by students' perception of teachers' mindsets (Gutshall, 2016).

Conversely, Sun (2015) found that maths teachers' intelligence mindsets at the beginning of the academic year did not significantly predict the maths intelligence mindsets of their students (11-14 years old) at the end of the year, when controlling for students' mindsets at the start of the academic year. Park et al. (2016) also failed to find a relation between pupils' intelligence mindsets (6 to 8 years old) and their teachers' intelligence mindsets. However, a relationship was found between teachers' intelligence mindsets and their instructional practices, which in turn related to their pupils' mindsets, and these mindsets related to their achievement. That is, teachers who held a growth mindset were more likely to hold learning-oriented instructional practices (i.e., teaching practices which affirm the importance of learning in and of itself and hard work), while teachers who held a fixed mindset were more likely to adopt performance-oriented instructional practices (i.e., teaching practices which affirm the importance of good scores and demonstrating competence). Although they reported that there was no significant relationship between teachers who held learning-oriented instructional practices and their pupils' mindsets, they found that teachers who reported they used performance-oriented instructional practices had more pupils with a fixed mindset by the end of the academic year. A further study also demonstrated a correlation between teachers who held fixed mindsets and their tendency to use more performance-oriented instructional classroom practices (Stipek et al., 2001). Together, these findings suggest that it is important to understand the implicit theories that teachers hold, as these beliefs are integrated into the instructional practices they use.

Indeed, some studies have explored how teachers' mindsets related to or influenced the motivational practices they adopted and used with students in their classroom. For example, Kraker-Pauw et al. (2017) found that teachers who held a growth mindset provided less feedback and placed a higher emphasis on scores that reflected progress compared to teachers who held a fixed mindset. Moreover, they highlighted that the most critical factor for growth-oriented teachers was the process, not the result. Rattan, Good, et al. (2012) also found that maths teachers who endorsed fixed mindsets were more likely to adopt comfort-oriented strategies. That is, they provided feedback to their students that was aimed at helping them to accept their presumed lack of abilities instead of feedback that would support them to improve their work. Teachers with fixed mindsets

also used strategies they believed were helpful but were unlikely to foster future achievement and engagement, such as giving low achieving students less homework, and were likely to identify a student as having low maths ability from one test score alone (Rattan, Good, et al., 2012).

A further study conducted by Sun (2018) aimed to investigate how the teaching practices used by maths teachers in their classrooms impacted students' ability to adopt more of growth or fixed mindset. Based on the literature and classroom observations of eight teachers, the researcher developed a codebook called "The Math Teaching for Mindset Framework" (MTMF) which consists of 14 maths teaching practices divided into four categories that deliver messages regarding fixed, growth or mixed mindset about maths ability, namely: sorting, norm-setting, engaging in mathematics, and assessing and giving feedback. The results of this study presented a case study of two teachers, one of whom held a fixed mindset, while the second teacher endorsed a growth mindset. It was shown that the teacher who divided students into mixed-ability groups delivered mixed mindsets messages to them, whereas the teacher who conveyed fixed mindset messages concerning students' ability to learn maths did so by expressing the fact that s/he only expected a few students to keep up with the advanced class's pace, as well as displayed the names of the students with excellent scores on a noticeboard. This public recognition of pupils who were constantly at the top can send an inadvertent reinforcement to other students that the list is fixed. In contrast, it was also reported that the teacher who regularly tutored students, gave them several chances to master and resubmit the material, provided praise focused on a specific student's process, encouraged them to understand their mistakes and struggle to show them that they had a chance to learn from these mistakes and progress as a result of that sent growth mindset messages aligned with their assessment practices.

Sun (2019) also examined the relationship between maths teachers' self-reported beliefs and teaching practices, and the mindset messages that these practices may convey to their student. According to the MTMF, some of these practices reflected maths instruction based on a growth mindset. For example, these practices involved emphasising the importance of failure and mistakes when learning, encouraging students to carefully investigate the conceptual foundations of the error, valuing the importance of struggling when improving intelligence, allowing students to resubmit tasks, and offering extra help and/or using explicit mindset messages with their students, including the message that every student has a chance to succeed and the potential to improve. However, some practices were reported as possibly delivering fixed mindset messages to students as they involved asking students to follow procedures instead of developing their own approaches and/or dividing students into high and low ability groups. It was also reported that teachers who

divided students into heterogeneous groups in the class, provided both types of praise, namely, process praising and outcomes praising, or focused on correctness, all delivered mixed mindset messages to their students. However, Francome and Hewitt (2020) found that teachers from schools that had mixed-attainment maths groups were more likely to report a stronger growth mindset compared to those teaching maths classes divided into sets. Additionally, Stipek et al. (2001) reported that there was a correlation between elementary class maths teachers' belief that maths ability is unchangeable, and that grades and extrinsic rewards are beneficial methods to motivate students to make an effort and engage in maths activities.

Adults' motivational messages that are triggered and used in the context of successes or failures have also been examined in some studies, in order to investigate how they impact students' mindsets. A study conducted by Mueller and Dweck (1998) aimed over two out of six studies (i.e., studies 4 and 6) to understand how praise influenced the development of mindsets. They found that children (aged 9 to 12) who received praise for their intelligence when they succeeded (e.g., you succeeded because you are intelligent) were more likely to hold a fixed mindset, while children who received praise for effort were more likely to hold a growth mindset. Smith et al. (2018) also found that undergraduate students who received introductory growth mindset statements such as "Everyone can do well with statistics if they work at it." (P.785) from the instructor at the beginning of a statistics lesson were more likely to hold more growth mindset beliefs about their abilities than those who received fixed mindset statements from the instructor, including comments such as "Some people do better with math than others." (P.785). They also obtained higher scores in statistics compared to the fixed mindset group and control group. By contrast, an intervention study revealed that there were no significant differences in intelligence mindsets between 45 college students who attended 15 weeks of classes given by two professors who used growth mindset language compared to 38 college students taught by two other professors who did not receive such an intervention (Moore, 2018).

Accordingly, Haimovitz and Dweck (2017) hypothesised that in the event of children's academic success or failure, adults' implicit theories of intelligence and/or adults' theories of how to motivate children impacted their practices and responses toward children and, in turn, these practices influenced whether their children fostered more of a growth or fixed intelligence mindset. However, they argued that adults' intelligence mindsets are not usually directly triggered in key circumstances when children succeed or fail. That is, in the context of success or failure, they suggested that adults' theories of how to motivate children are more activated. For example, in the context of children's academic success or failure, adults' theories of how to motivate children to feel

better, boost their confidence, and motivate them to engage in their learning in the future may be the ones that more directly dictate if children develop a growth or fixed intelligence mindset (Haimovitz & Dweck, 2017; see Figure 1 in Section 1.7).

Whilst some studies have provided an in depth understanding and rich descriptions of the maths teachers' mindsets and how they influence or are related to their classroom practices in Western cultures, there has been no research asking maths teachers themselves about their classroom practices, neither in non-Western countries nor in the KSA. Yet, this would be of value, as it would provide an opportunity to analyse whether teachers' classroom practices are affected by their mindsets, and the possible subsequent impact on students' maths mindsets and achievement. Thus, this study has sought to do this in the KSA. Although there has been some initial research conducted to quantitively investigate the kind of mindsets that teachers adopted regarding implicit theories of intelligence in KSA (see Section 2.2), it is worth noting that much of the literature on maths in the KSA context pays particular attention to quantitatively exploring maths teachers' views about the factors that negatively influence their ability to teach the maths curriculum and/or students' maths achievement (whether in school exams or international assessments such as the TIMSS or PISA). These studies reported several factors related to the teachers themselves, the students, the schools' environment and equipment, and parent engagement. For example, numerous studies revealed that according to the participating maths teachers' point of view, large class sizes, many teaching hours and/or administrative tasks, and a shortage of aids and resources for teaching and learning in the school, were major factors that negatively impacted teaching maths and/or might have been one of the reason that led some students to achieving poor results (e.g., Alharbi & Almatham, 2013; Ali & Abdulhakim, 2013; Alaomry et al., 2013; Ezz Aldeen & Subahi, 2014; Hassan & Hamid, 2014; Rayyani, 2018). Indeed, Alghamedi (2010) found that in China and Singapore, where students (aged 13-14) obtained a high achievement in the TIMSS test in 2007, had larger, better-equipped schools compared to those in Saudi Arabia.

It was also reported that the underuse of different types of methods employed by teachers is one of the factors that might hinder the teaching of mathematical concepts (e.g., Rayyani, 2018). Another factor that may have affected students, and resulted in them obtaining lower grades, was their negative attitudes towards maths and/or poor foundation in maths (e.g., Ali & Abdulhakim, 2013; Alsaedi, 2015; Shahadah & Alkaramiti, 2016; Aldosary & Alrawis, 2018). Existing research in the Saudi context has also highlighted the critical role parents play in their children's achievement. For example, in two studies it was shown that poor parent follow-up was one of the significant challenges that Saudi teachers mentioned that they faced, as they considered it one of the primary

reasons for students achieving lower maths' outcomes (e.g., Alharbi & Almatham, 2013; Aldosary & Alrawis, 2018).

On the other hand, in numerous quantitative studies, Saudi maths teachers have also highlighted other factors that might help students in their learning and improve their maths outcomes. For example, it was mentioned that the school's motivation and encouragement of students (Almalki, 2018), students' intrinsic motivation to learn mathematical concepts (Alaomry et al., 2013), using a cooperative learning strategy in teaching (Alkhamaiseh, 2012), and parents following up with their children (Almalki, 2018) played a key role in helping students to improve their achievement at school in the KSA. This view is supported by Alsilami's (2020) findings, which showed that there was a positive relationship between the level of motivation achievement among undergraduate students studying maths or Arabic and their GPA. Albabtain's (1991) results also revealed a positive association between students' attitudes towards maths and their maths achievement.

To summarise, due to the fact that the outcomes of students in the KSA are poor, which has been proven by both national or international assessments over many years (see Section 2.6), it has become increasingly urgent to ascertain the possible causes of this, in order to identify solutions that will increase students' motivation, and thus, improve their achievement. Although the MOE is always striving through its development plans to increase the quality and efficiency of education and to provide students with the skills and knowledge they need (see Section 2.4), it still needs to pinpoint the factors that can cause poor outcomes and the subsequent solutions to overcome these. Consequently, although there is some evidence to support the notion that it is beneficial to students if teachers have a growth mindset, since it impacts their teaching style and can enhance students' maths growth mindsets and achievement, to the best of the researcher's knowledge, no qualitative study investigating Saudi teachers' mindsets and reactions towards their students' success and failure had been conducted prior to this study. In addition, nor had it previously been examined how teachers' mindsets and reactions might foster students to adopt more of a fixed or growth mindset regarding their abilities in maths in the KSA. This study, therefore, aims to address the gap by qualitatively exploring the role of primary school maths teachers' intelligence mindset and their reactions to their pupils' maths achievement and failure in Riyadh, Saudi Arabia.

4.3 Methodology

4.3.1 Research method and Epistemological Position

A qualitative method was employed in this research. This method was selected, as it offers an effective way to gain insights into how maths teachers managed the successes and failures of pupils in their classrooms and how this was influenced by their implicit theories of intelligence. Moreover, this study is based on a critical realist epistemological approach. This type of approach does not presume that the data are a mirror that reflects an accurate representation of what is happening in the real world (Willig, 2013). However, the interpretation of the data is considered important, in order to better understand the implicit mechanisms that underpin the observable phenomena that we seek to have knowledge about (Willig, 2013). Thus, a critical realist approach was adopted because it helps to analyse and interpret participants' practices and responses, in order to identify the implicit mechanisms that exist in the world. Indeed, although peoples' theories of intelligence are implicit and not visible to others, they may be reflected in their practices and reactions to situations (Haimovitz & Dweck, 2016, 2017). Additionally, a critical realist approach supports several varieties of qualitative methods such as some versions of thematic analysis (Braun & Clarke, 2013).

4.3.2 Ethical Considerations

This study received approval (ERGO II study ID number: 41750) from the Faculty Ethics Committee (i.e., Faculty of Social, Human and Mathematical Sciences,) at the University of Southampton, UK (see Appendix C1). Following the translation of the study materials from English to Arabic, the researcher then contacted the MOE in Saudi Arabia via email to obtain permission to conduct the study in Saudi Arabia, and a letter from the MOE in Saudi Arabia officially giving the researcher permission to interview maths teachers in primary schools in Riyadh was received at the beginning of October 2018 (see Appendices C2, C3, C4 and C5).

4.3.3 Materials

4.3.3.1 The interview protocol

A semi-structured interview was used to gather information from the participants about how they manage pupils' successes and failures in their classroom. The questions were developed by the research team and followed Haimovitz and Dweck's (2017) hypothesised model for how adults

promote children's growth and fixed mindsets (see Figure 1 in Section 1.7). That is, the interview questions were developed to reflect the content of the variables highlighted in the hypothesised model created by Haimovitz and Dweck (2017). The questions that were prepared included the main questions, prompts and possible probes, and were divided into three categories: detail-oriented, elaboration and clarification (see Appendices C6 and C7).

The interview questions were designed to focus on how teachers addressed their pupils' successes and failures during maths lessons and sought to activate the adult's intelligence mindset, by asking the teachers about the factors that help pupils to succeed or fail in maths. A second set of questions were designed to activate adult's theories regarding how to motivate children. The third set of questions focused on activating adult process- or person-oriented practices, during which teachers were asked what they had said to a pupil who had succeeded or failed in maths. Finally, the participating teachers were asked to discuss what they thought promotes pupil growth or fixed mindsets and, in particular, how they ensured that their pupils continue to succeed in maths. For each question, the teachers were asked to focus on particular pupils who were either at the top or bottom of their maths set and asked how they worked with those specific pupils to motivate and teach them.

Since the participants' first language is Arabic, the interview questions were translated from English into Arabic. The process of translating the questions from English to Arabic followed the translation guidance from the World Health Organisation (The process of translation, n.d.). Specifically, first, the researcher translated the interview questions from English into Arabic. Then, two bilingual individuals, one of whom was a Saudi PhD student at the School of Psychology and the other one a professional translator, were asked to check the Arabic translation of the interview questions. Next, a third professional bilingual translator was asked to translate the Arabic version into English. After that, a British PhD student at the School of Psychology and a British English teacher were asked to compare the two English versions, that is, the original and the back-translated version, to ensure that the two English versions were identical in meaning. Finally, the interview questions were piloted with four maths teachers, one of whom was British (in English) and the other three who were Saudi (in Arabic). The pilot interviews were conducted to test the appropriateness and clarity of the questions and allow the researcher to develop or amend any questions as necessary. The main interview questions were not changed as a function of this pilot phase. Thus, the final Arabic version of the interview questions was produced.

4.3.4 Participants

Once the permission letter from the MOE in Saudi Arabia had been obtained, participants were recruited via letters to the headteachers at schools for both boys and girls in Riyadh. In the letter, the researcher asked for permission to interview grade five or six maths teachers at the school (see Appendix C3). Recruitment was stratified across the regions in Riyadh and included 26 schools (out of 1,139 state-funded general schools; see Appendix A1). Out of 26 headteachers, a total of 24 headteachers said they were happy for the study to be conducted at their school. Following that, a total of 34 maths teachers were invited to participate in the interview and were provided with all of the study documents, including the official permission letter from the MOE, the information sheet, the consent form and the debriefing statement (see Appendices C8, C9 and C10). The final sample consisted of 30 Saudi maths teachers (15 females and 15 males) who taught grade five and/or six (children aged 10 and 11) at 24 state-funded general primary schools (13 girls' schools and 11 boys' schools) during the 2018/19 academic year. Participation was completely voluntary. Six teachers (three females and three males) participated from each region (north, south, central, east and west) in the city of Riyadh, Saudi Arabia. Participants' ages ranged from in their twenties to in their forties, and all held a diploma and/or bachelor's degree. Twenty-eight teachers had a degree in maths or a related field, while two teachers had different majors unrelated to mathematics (i.e., science, chemistry and biology). In terms of their teaching experience, 19 teachers had taught for more than 11 years, while 11 teachers had less than 11 years' experience.

The interviews with the teachers from the girls' schools were conducted in the school setting in a quiet room. In terms of the participants from the boys' schools, the interviews were conducted over the phone at their schools. The interviews lasted between 29 and 70 minutes.

4.4 Data handling and analysis

The data were analysed in Arabic by the researcher using thematic analysis. Thematic analysis allows for theoretical freedom and is a flexible and useful method that identifies, analyses, organises, describes and presents the themes from the data in a rich and detailed way (Braun & Clarke, 2006). Thematic analysis also allows for interpretation when the researcher recognises the themes that reflect latent meanings (e.g., in the case of identifying underlying mindsets in action; Willig, 2013). The six phases of thematic analysis outlined by Braun and Clarke (2006) were employed. In the first phase, all of the recorded interviews were transcribed into Arabic. Then, the transcripts were read and re-read to compile an initial list of ideas from each transcript. Subsequently, this initial list of ideas was presented and discussed with the research team. Following

this, the transcripts were read again and all of the interesting initial ideas from across the dataset were coded. The main codes, subordinate codes and quotes from each transcript were collated and placed into a table and presented as a coding manual. Next, the main and subordinate codes were associated with potential sub-themes and themes. These potential sub-themes and themes were presented and discussed as an initial thematic map with the research team (see Appendices C11 and C12). Following this, all of the themes, sub-themes, main codes, subordinate codes and quotes were reviewed and refined and were then presented and discussed as a final thematic map with the research team. Finally, after the final step of the thematic analysis, as outlined by Braun and Clarke (2006), examples of the quotations from the data were selected for translation into English, in order to include them in the final write up.

4.5 Key findings

Five main themes related to how maths teachers motivate their pupils in the context of success and failure were identified in the analysis and are presented as a final thematic map in Figure 3. Additionally, the number of quotes used within each main code and/or their subordinate code for each participant, as well as more illustrative examples, are presented in the codebook Table (see Appendix C13).

4.5.1 The impact of national policy on maths education

The first theme captures teachers' views of how the maths curriculum, as well as education policy and systemic issues by the MOE in Saudi Arabia, impact pupil achievement. A minority of the teachers interviewed identified negative aspects of the maths curriculum in their interviews, for instance a few stated that there is too much information in the curriculum to teach pupils and that it is often aimed at more advanced levels of maths proficiency. Conversely, some teachers highlighted their positive views of the maths curriculum, including the fact that it uses real-life examples, identifies the maths skills taught in each lesson, that the presentation of lessons in the assigned maths textbook is engaging and includes a number of different problems that help to develop pupils' thinking.

Just under half of the teachers voiced more general concerns about the education policy and its impact on teaching and pupil achievement. These included concerns about allowing teachers who are not specialised in maths to teach the subject, and the fact that there were large numbers of pupils in the class. They also mentioned that there was insufficient time to cover the assigned

material during the class, pupils attended too many classes during the course of the day, and that teachers had to teach too many classes every week.

> I have struggled with overcrowded classes and 8 underperforming students in one classroom in the past years. The teacher has to explain the required skills to the student and give her practice exercises to solve at home, so that the skill becomes properly digested, which is something a teacher can't do in overcrowded classes. (P16)

4.5.2 The importance of the school's ethos and provision of adequate resources

This theme incorporates teachers' perspectives of how school officials recognise pupils' maths achievement, how positive school leadership can ensure pupils' success in maths, and how ineffective school leadership and management can affect pupils' outcomes. It also includes accounts of the difficulties some teachers experienced due to a lack of resources.

Half of the teachers described the ways schools recognise pupils' maths achievements, including the giving of motivational incentives and prizes, which are typically given out by the school leadership team. However, some teachers spoke about the lack of provision of school supplies in the school, including motivational incentives and prizes, or reported that their school lacked critical resources such as smart boards or software, which might impact pupils' performance. They expressed the belief that schools should have these resources to help pupils to succeed.

> Naturally, that depends on the school environment. Public schools here are not properly equipped. But if we had a maths lab, smart boards and other visual aids that help students be more interactive, things would be different. With conventional boards, you use chalk for writing and that takes too long and distracts the student. (P3)

A small number of teachers reported issues related to effective and ineffective school leadership and management that had impacted their teaching. For example, one maths teacher highlighted that they were not able to attend training courses or engage in continuous professional development. By contrast, other teachers reported how effective the school leadership and management were in terms of developing policies that supported pupils to succeed.

4.5.3 Classroom teaching strategies and behaviours

This theme covers two key issues raised by the participants. The first issue is that teachers held strong beliefs regarding the teaching practices used by other teachers and the effect on their

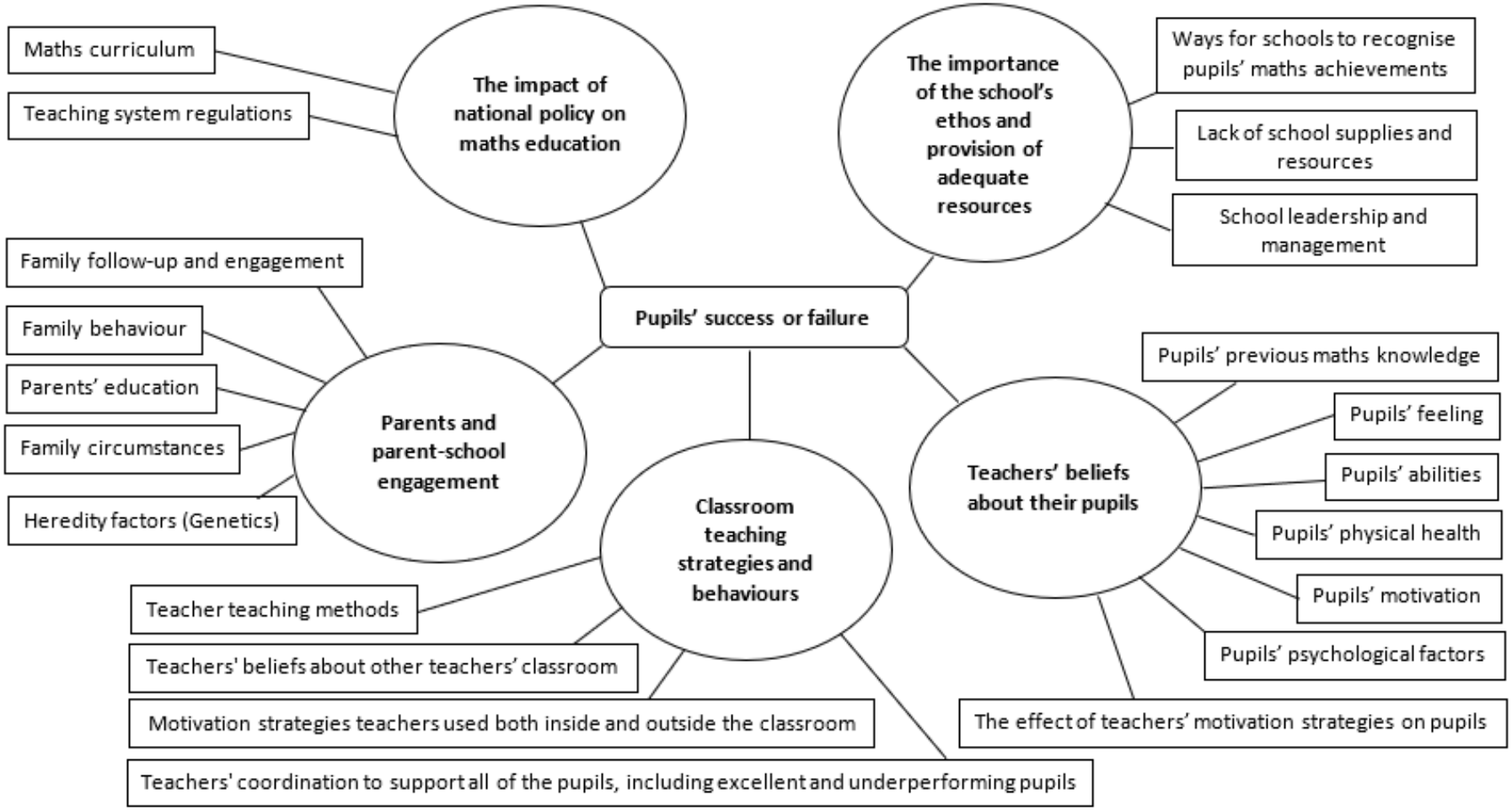
pupils. The second issue relates to the participants' own teaching behaviour and pedagogical practices in their classrooms, including their teaching methods, motivation strategies and how they coordinate support for their pupils.

Teachers' provided accounts of both effective and ineffective classroom behaviours that might impact pupils' results at school. In terms of ineffective behaviours, a number of teachers mentioned their knowledge of other teachers' negative behaviour or attitudes toward their pupils and how these impacted their pupils' maths success. For example, teachers talked about colleagues who were too serious or stressed and/or criticised and demoralised their pupils, as well as those who did not adequately motivate their pupils. They also criticised teachers who did not consider pupils' individual differences or did not actively support pupils to overcome any perceived fear of maths. Moreover, teachers were critical of practices that they denoted as poor teaching, including being unable to deliver the information in an easily digestible way, not giving pupils the adequate time and support to think through and solve maths problems, or failing to use strategies, technology, or materials available at the school in their teaching.

> "Some teachers solve everything in class by themselves, thus causing the students to be fully reliant upon them and denying them any opportunity to be creative or to discover anything on their own." (P8)

Figure 3

The final thematic map



Conversely, teachers also talked about effective teaching practices which included simplifying their teaching for pupils or making their teaching attractive to their pupils, acting as a mentor to their pupils, using the latest, effective teaching methods, tools and strategies, helping their pupils to become interested in or fall in love with maths, and actively linking maths lessons with 'examples from real life'. Moreover, teachers spoke about positive attributes, including supporting the individual differences between pupils, using a variety of methods to motivate pupils, or making lessons 'fun' so that pupils enjoyed maths more.

> "The teacher's spirit and the way he approaches teaching, so that the student sees mathematics as an attractive and lovable subject, is the key factor, since students in general view mathematics as a boring subject, though teachers can change this point of view. Naturally, there are teachers that makes a student love a subject and other that make the student detest it." (P10)

Regarding the behaviours and strategies used by the teachers who were interviewed, all of the teachers highlighted the methods they use to attract interest and/or teach their pupils maths in class. For example, some teachers commented that they tried to link maths lessons to reality and make their teaching more engaging by including elements of play, as well as tried to be flexible when dealing with their pupils and not put them under pressure. A third of the teachers reported that they used a number of different ways to spark pupils' interest in the class and to help them to focus on the lesson, such as asking their pupils to solve the problems on the blackboard. Many teachers also described their way of guiding their students who answered incorrectly and how they ensured that their pupils understood maths. Moreover, most of the teachers indicated that they tried to provide extra help to pupils, either during the class or during tutoring, in order to help them pass their maths exam, improve their performance and succeed in maths.

Furthermore, the majority of the teachers reported using a variety of tasks and activities both inside and outside the classroom such as engaging their pupils in the multiplication festival activity at school. Some participants also revealed a range of methods they used to evaluate pupils such as conducting periodic tests, so pupils have more than one opportunity to be evaluated. A minority of the teachers reported that they informed their pupils about their rules in the class to ensure, for example, that pupils do not laugh when one of their classmates answers a question.

With respect to how teachers motivated their pupils, many of the teachers said that they tried to develop a relationship through writing or discussion with their pupils, such as wishing the

pupil a brilliant future, advising the pupil to work hard, or engaging with pupils about subjects outside the field of maths such as sport, to build rapport with them and, thus, be in a better position to encourage their pupils to love maths. Teachers also spoke of explicit mindset messaging that they communicated to their pupils. Most of the teachers described how they set out to increase pupils' morale regarding their maths abilities, for example, by telling the pupils that they could succeed in maths by explaining to them that maths is an easy subject and telling pupils that they had the same abilities as an excellent pupil. Many of the participants also described how they avoided pupils becoming frustrated, for example, they did not single out one pupil as being particularly good in the class or in front of her/his classmates. However, a number of teachers expressed sadness regarding a pupil's poor performance or reacted to a pupil's performance decreasing by drawing a sad face in their book, for example. A minority of the teachers also reported that they linked maths to geniuses or told the pupil to challenge himself/herself and to remind himself/herself that s/he was intelligent.

Moreover, many of the teachers interviewed indicated that they encouraged and motivated their pupils to try or try again, in order to improve their performance, which they commented helped their pupils to acquire more maths skills. They also mentioned that they did not tell their pupils that there was a problem if they answered their homework incorrectly, but they emphasised that the important thing was that they had tried. Some of them also gave an example of someone who had struggled at first and then later succeeded. Additionally, they reported that they gave their pupils a second chance if they did not pass an exam, or they let their pupils choose the lesson and/or time for the re-test.

Almost all of the teachers indicated that they had a strong belief that challenging pupils plays a very important role in helping them succeed and advance, therefore, they used a variety of methods. For example, giving them difficult problems to solve, teaching lessons that developed pupils' higher-order thinking skills, creating competition among pupils and using the reinforcement board or ranking method. Moreover, many teachers revealed a range of methods they used to increase pupils' confidence in themselves. They stated that they believed that increasing pupils' confidence, either in person or in front of her/his classmates, was an important aspect of supporting pupils' improvement in their studies.

> "If I have an easy question in the same lesson, I ask, 'Who is an intelligent student and can answer it?' When a student raises his hand, I ask him to answer, despite knowing that the answer is easy" (P12)

Most of the teachers referred to the auxiliary methods they used in the class to deliver information and with their pupils, specifically the programmes, tools, strategies and educational methods they used when teaching maths. For example, they activated learning strategies such as peer teaching and/or collaborative learning by dividing pupils into groups which contained pupils performing at different levels. They then, identified a temporary leader for each group, which rotated among the members of the group during the academic year.

Teachers indicated that they differed in their ways of announcing pupils' results and tasks. Some of them reported that they announced the results of all of the pupils during the class. Others said that they only announced the results of outstanding pupils in the class, while underperforming pupils were given their results separately to avoid embarrassing them. Some teachers said that they asked pupils whether or not they wanted the teacher to announce their results, or they gave each pupil their results separately, while other teachers compared their pupils' scores with others from other classes. A small number of teachers stated that they announced the best pupils' answer/work by displaying the information on the classroom wall or ranked them on the wall, based on their level of mastery.

A crucial issue that all of the teachers spoke about was teachers' rewards and/or praise given to their pupils. The majority of the teachers preferred to use external gifts or incentives, frequently using their own money to motivate pupils. Teachers expressed the fact that they liked to provide contingent rewards, because they held a strong belief that rewards and/or praise play an important role in motivating and encouraging pupils, which in turn positively impacts their performance in the class and their maths results in the exams. Teachers also reported that they clarified the rewards method to their pupils at the beginning of the year. Moreover, they mentioned that whether the reward and reinforcement were physical or moral/verbal, varied according to their pupils' age and was not always given to them to increase their enthusiasm. Teachers also stated that they provided different types of praise to their pupils, whether individually or in front of others such as their classmates. For example, they praised their pupils' abilities, correct answers or improvement, and/or provided general praise to their pupils, either by thanking them or making comments such as 'excellent', 'well done', and so on.

> "Public praise in front of their classmates works best with fifth and sixth graders, because they like to be publicly and directly recognised, but star stickers and merit boards may not really appeal to them." (P12)

Teachers also spoke about other feedback strategies they used with their pupils to ensure that they succeeded in maths. Most of the teachers reported that they met with pupils individually, specifically underperforming pupils, and informed the pupil of their weak points that needed more focus on. In addition, some teachers reported that they continued to follow up pupils' progress the following year or even years later.

Working together with school administration efforts, which aim to increase pupils' performance and ensure pupils' success, some teachers stated that they provided the pupil counsellor with the names of underperforming pupils, so s/he could contact their family and ask about the reason for the decline in the pupils' performance. Additionally, other teachers spoke about how they informed the Learning Disabilities Specialist or the Gifted Students Specialist at the school about those requiring special education. A number of teachers also informed the school administration about the names of pupils who were excelling and who should be honoured by the headteacher or the pupil counsellor.

Due to the fact that teachers held strong beliefs about parents playing an important role in helping teachers to ensure the success and progress of their children, the majority of the teachers reported that they sought to regularly record pupils' performance in the pupils' follow up record and contacted parents to inform them about their child's academic performance. Consistent with the above, more than half of the teachers highlighted that they praised and thanked families, and also advised them how to support their child's progress and reward them, in order to motivate the pupil to continue at that level.

4.5.4 Teachers' beliefs about their pupils

This theme provides teachers' perspectives concerning their pupils, specifically: their previous maths knowledge, feelings, abilities, physical health, motivation, and psychological factors affecting their studies. Moreover, it also considers the impact of teachers' motivation strategies on pupils' academic outcomes, feelings and personalities.

The majority of the teachers expressed the belief that pupils' previous maths knowledge affects their performance later on. That is to say, some teachers indicated that pupils who had received a good standard of maths teaching at lower grades or who had attended kindergarten were more likely to have a good foundation in maths. Furthermore, half of the participants emphasised

that pupils who had not received a good standard of maths teaching at lower grades or who had not attended kindergarten tended to have a poorer foundation in maths.

Most of the teachers reported that when a pupil hated maths, or believed that maths was difficult, s/he demonstrated particular behaviour or attitudes which reflected this, such as not doing their homework or bringing the materials required, which, in turn, sometimes led them to fail this subject. Additionally, almost all of the participants stated that they believed that pupils who loved maths demonstrated particular behaviour or attitudes and, consequently, these helped them to succeed in maths. For example, one strategy used for pupils who loved maths involved offering them an opportunity to describe a different way of solving the problem other than the way their teacher had presented to the class.

> "I expect the main reason for that student's success was her love of maths and passion for problems and numbers. The second reason is that she reads the lessons in advance, so that she comes to class well prepared" (P26)

Moreover, just under half of the teachers talked about the fact that when pupils liked the teacher, it led them to love maths. Similarly, just over a quarter of teachers reported that when pupils disliked the teacher, felt uncomfortable with their teacher or did not cooperate with the teacher, it led them to dislike maths and, thus, affected their maths studies.

> If the student hates the subject teacher, or if a situation happens between the student and their teacher, this might motivate the student to work harder and continue progress or will discourage her from working, then she will hate school as well as the subject. (P29)

Another issue that arose from the teacher interviews was pupils' differences in ability, and how pupils with a natural or exceptional ability in maths were more likely to succeed in maths. Some of the teachers explained that there were a number of reasons for a poor outcome, specifically: pupils' capabilities being limited, learning disabilities related to maths, namely dyscalculia, or pupils being easily distracted or less focused. In contrast, just under half of the teachers spoke about how pupils' high abilities and/or talent helped them to succeed in maths.

> Also, there is the student's IQ to consider, since excelling in maths depends primarily upon the student's intelligence and quick responses, … and how the student's intelligence and superiority help him to solve difficult and even the most complex mathematical problems, because that is where the difficulty lies. (P3)

A minority of teachers indicated that pupils' performance might be affected if they had a physical health issue or lacked the motivation and willingness to study maths. Indeed, some teachers talked about how a pupil who has a high level of motivation and enjoyed either challenging themselves or their classmates was much more likely to succeed in maths.

> "It is because of the student's intrinsic motivation, which is inbuilt in the student's personality and is the fundamental factor in learning." (P2)

Some teachers reported that pupils who had a high level of self-confidence in their abilities or who felt psychologically stable were more likely to succeed in maths. Others also reported that the academic performance of pupils was likely to be affected if they had low self-confidence.

> The most important thing is the psychological factor, also our students do not have confidence in themselves… I mean, they think that this is a difficult problem, so I cannot solve it, because it is difficult This is also one of the things that affects them. (P17)

Moreover, teachers said that pupils' level of maths anxiety or fear of answering incorrectly, as well as pupils' fear of their teacher or of their classmates or shyness, all had a negative influence on some of their pupils' maths results.

> "Also, I noticed that some students don't want to participate in class activities out of shyness or fear of a negative reaction from their classmates, who may laugh at them if they don't answer correctly." (P2)

In addition, over a third of the teachers reported how their motivation strategies had a positive impact on their pupils' academic outcomes and their feelings and personality.

4.5.5 Parents and parent-school engagement

The fifth and final theme relates to teachers' views regarding parents' involvement with the school and parenting characteristics. Teachers reported both positive and negative views of family engagement. Over half of the teachers interviewed indicated that a lack of parental interest in their child's studies, as well as parents not cooperating with the teacher, negatively affected the child's maths achievement. Indeed, most of the teachers emphasised the importance of positive family engagement, stating that families that took an active interest in their child's studies and cooperated with the teacher had a positive impact on the child's maths' achievement.

> In fact, I believe that the family accounts for 75% of the student's success, while the teacher, whose contact with the student only lasts 45 minutes per day, only accounts for 25%. I can say, from personal experience, that all of my outstanding students have parents who regularly come to me and ask about how their daughters are doing … while outstanding students always have parents who are closely following up on their daughters' scholastic performance. (P16)

Teachers also reported how both negative and positive aspects of parental behaviour influence pupils' maths performance. Approximately a third of the teachers emphasised their belief that positive family behaviours, including encouraging and supporting their child in their studies or to love maths, had a positive result. However, just under a third of the teachers considered that parents' negative behaviour, including spoiling their children, criticising and/or demoralising their children, allowing their child to frequently be absent, or pupils being afraid of their mother's response when losing marks, had a negative effect on their child's academic outcomes.

> "Also, continuous bashing by classmates, teachers or parents, like always being told that you are stupid, until the student eventually takes such negative messages and thinks to herself why take the trouble if I'm stupid and will certainly fail anyway?" (P19)

A few teachers reported that whether parents were educated or illiterate was likely to have an impact on their children's academic outcome. A third of the teachers also spoke about how challenging family circumstances, such as divorced parents and being from a family at a low economic level, affected children psychologically and, as a result, their studies also suffered. Only one teacher mentioned the effect of genetics, explaining her experience was that a child who had inherited a talent in maths from their family was likely to excel in this subject.

4.6 Discussion

This research sought to explore the views of Saudi primary school maths teachers regarding their practices in the cases of pupils' maths successes and failures, and the role teachers' intelligence mindset plays in this. The thematic analysis of the interviews with 30 maths teachers from Riyadh, Saudi Arabia, identified five overarching themes, with each of them providing rich and detailed information reflecting the teachers' beliefs and pedagogy. The key themes identified were (1) the impact of national policy on maths education, (2) the importance of the school's ethos and provision

of adequate resources, (3) teachers' strategies and behaviour in the classroom, (4) teachers' beliefs about their pupils, and (5) parents and parent-school engagement.

It is worth remembering that this study was designed to test Haimovitz and Dweck's (2017) hypothesised model using a qualitative method. This model aimed to investigate how adults' implicit theories concerning intelligence and their theory of how to motivate children can be reflected in their practices and responses to their children's successes or failures, which in turn, promotes children's growth and fixed mindsets. Therefore, the practices teachers employ with their pupils can lead the latter to receive messages about their potential in terms of developing their abilities in maths. Therefore, the practices mentioned by teachers will be linked to the practices reported in the literature that have been shown to potentially lead to either sending a growth mindset, delivering a fixed mindset, or conveying a mixed mindset to children. Despite the few qualitative studies available in this regard, the available studies give us an idea of the impact of teachers' theories on their practice and reactions, which in turn, promote children to adopt either more of a growth or fixed mindset.

In general, several factors were found to be regarded by teachers as important for their pupils' success in maths. Teachers were generally positive about the MOE's compulsory maths curriculum, which they said helped them to engage pupils in the subject by presenting real-life examples. It also featured the textbooks that included exercises to develop higher-order thinking skills. This may be explained by connecting math lessons to real-world situations, such as by giving pupils maths problems that are relevant to their daily lives and have varying levels of difficulty (e.g., problems involving buying and/or selling). In addition, this may make it simpler for pupils to understand mathematical concepts and motivate them more to turn to the practical exercises section of their textbook to solve these problems, which would have a positive impact on pupils' achievement.

However, teachers voiced their concerns regarding their working conditions, which they felt impacted their teaching and, in turn, affected their pupils' outcomes. For example, teachers commented that there was pressure put on them to teach a large number of pupils in one class, while a disproportionately short amount of time was allocated to maths as a subject relative to the rest of the curriculum, thus making it difficult for them to take into account all of their pupils' needs. Teachers also mentioned other factors that negatively influenced their teaching and their pupils' outcomes such as the daily pressure that they faced due to the large number of classes they had to teach, as well as the daily pressure that their pupils encountered as a result of the large number of

subjects they had to learn. In addition, they stated that maths teachers in Saudi Arabia have to teach around 24 classes a week (each class being 45 minutes) and this considerable workload negatively impacted their teaching and the quality of the education they provided. Moreover, teachers reported that a lack of supplies, materials and resources at their schools negatively affected the effectiveness of their teaching and some pupils' learning.

The above findings are consistent with other studies of maths teachers in the KSA, who reported that difficult to manage large classes, being overloaded with teaching and/or administrative tasks, and a lack of lab equipment and facilities were some of the reasons that their ability to teach the maths curriculum was affected (e.g., Alharbi & Almatham, 2013; Ali & Abdulhakim, 2013; Alaomry et al., 2013; Ezz Aldeen & Subahi, 2014; Hassan & Hamid, 2014; Rayyani, 2018). Indeed, Alsubaie and Alghamdi (2020) found that large class sizes and the lack of equipped laboratories in schools in the KSA led students to achieve poorly in international exams such as the TIMSS exam in 2015. Moreover, Alghamedi (2010) compared the characteristics of schools in the KSA with those in China and Singapore, whose students obtained a high level of achievement in the TIMSS test in 2007. To clarify, it was found that China and Singapore had larger, better-equipped schools than those in the KSA. This result may be explained by the educational settings in Saudi Arabia, which do not always consist of purpose-built school buildings. In fact, a number of Saudi public-school buildings are old, on loan or rented, and therefore, are not always ideal in terms of their size or how the space is used. For example, in the academic year 2018-19, with regard to Riyadh's primary schools, there were 2 girls' schools on loan and 117 rented girls' schools, while there was one boy's school on loan and 153 rented boys' schools (see Appendix C14 for more details).

Moreover, teachers mentioned that one of the methods more frequently used to keep their pupils motivated during their maths lessons was to use rewards. They highlighted the importance of a school's contribution to motivating pupils via the school leadership team providing motivational incentives and prizes, and how this had a positive impact on pupil achievement. This finding is supported by Almalki's (2018) result, which reported that from the point of view of Saudi primary teachers, motivation and encouragement from the school was the most influential factor that helped pupils to increase their achievements. This result may be explained by the fact that any extrinsic motivation that pupils receive from school leaders, in the form of honouring them and/or rewarding them in front of their classmates, can have a positive psychological impact, thus motivating them to continue learning and being diligent. This, in turn, affects their achievement

positively. Indeed, Alsilami (2020) found a positive association between undergraduate students' level of achievement motivation and their GPA in maths.

In addition, almost all of the teachers highlighted the importance of a pupil's foundation in maths and expressed that a good foundation was reflected positively in their pupils' performance, similarly a poor foundation in maths was regarded as a one factor that led to some pupils' poor maths performance. Moreover, most teachers emphasised the role of children's feelings in their academic achievement. Specifically, they clarified that a pupil's love or hatred of maths or their maths teacher was another factor that impacted their achievement in maths. This result is in keeping with previous quantitative results, which concluded that, from maths teachers' perspectives, negative attitudes towards maths and/or the belief among students that maths is a difficult subject, is one of the most important causes of students performing poorly in maths in the KSA (Ali & Abdulhakim, 2013; Alsaedi, 2015; Shahadah & Alkaramiti, 2016; Aldosary & Alrawis, 2018). These results correlate with the fact that teachers held the belief that if a pupil loves maths, s/he will try to do well, but if s/he hates it, s/he will not be willing to even try. Indeed, a study conducted in Riyadh, KSA by Albabtain (1991) found a positive relationship between male pupils' attitudes towards maths and their achievement in maths.

A further factor likely to influence pupils' achievement that was mentioned by the teachers was self-motivation, with teachers stating that a high level of intrinsic motivation was crucial, because it helped pupils to succeed in maths, while pupils with low intrinsic motivation tended to obtain poor results in maths. This finding seems to be consistent with Alaomry et al.'s (2013) quantitative results, which found that a large percentage of maths teachers agreed that students' motivation to learn mathematical concepts was one of the factors that influenced pupils' maths success at primary school in Saudi Arabia. This could be explained by the fact they were intrinsically motivated, that is, driven by fun or the thrill of a challenge, and not because the motivation originated externally in the form of pressures and/or rewards (Ryan & Deci, 2000). In short, when pupils have a high level of intrinsic motivation, this can impact their academic achievement positively. Indeed, Xiao and Sun (2021) found that students with the highest instrumental motivation levels and the lowest math anxiety presented the highest achievement and levels of persistence in maths. Broussard and Garrison (2004) also reported that there was a positive relationship between children's levels of mastery motivation and their maths grades.

Most of the teachers were in agreement about the important role that families play in their children's achievement. They indicated that parents who took an interest in their child's education,

cooperated with the teacher and encouraged positive behaviour in their child saw that their child's outcome was positively affected. However, parents who did the opposite often observed a negative impact on their child's results. This finding supports the evidence from quantitative studies in the Saudi setting, which concluded that, according to maths teachers, poor follow-up from the parent was one of the key issues that they faced (Alharbi & Almatham, 2013; Aldosary & Alrawis, 2018). This finding is also consistent with Almalki's (2018) quantitative results, which showed that from Saudi primary teachers' viewpoint, parents following up on their children played an important role, as it helped them to increase their achievement.

Another factor highlighted was teachers' beliefs and pedagogical practices and how these communicated growth or fixed mindset messages to pupils, with the interviews revealing that the teachers had mixed mindsets. That is, they sometimes used practices that might foster a fixed intelligence mindset in maths, while at other times they acted in a way that could develop a growth intelligence mindset. Furthermore, occasionally they used methods that may send mixed mindsets messages to their pupils, as teachers described some practices that were clearly linked to a fixed mindset. For example, a minority of the teachers mentioned that they associated high scores in maths to geniuses or excellent pupils, thereby providing feedback consistent with the belief that a pupil was either talented at maths or not. Some teachers also explained that some pupils lacked the confidence to answer questions, specifically in front of their classmates, which, in turn, negatively affected their level of performance in maths. Thus, many of them sought to increase a struggling pupil's self-confidence by, for example, deliberately giving the pupil an easy question to answer, or giving priority to a pupil when s/he raised his/her hand to participate. Teachers might carry out these practices to encourage their pupils to participate, and thus increase their self-confidence, however, continuously conducting these practices may encourage pupils to avoid struggle and failure, and this is likely to communicate fixed mindset messages to them, according to the MTMF (Sun, 2018). Indeed, Rattan, Good, et al. (2012) found that instructors who endorsed a fixed (vs. growth) intelligence mindset comforted their pupils about their low maths' capacity and employed practices that did not encourage pupils' engagement in maths. This finding is also consistent with a study by Sun (2019), who found that some maths teachers asked their students to follow the procedures and did not encourage them to develop their own strategies, thus conveying a fixed mindset message to students, according to the MTMF.

An additional factor discussed by teachers was how they announced their pupils' results, which differed greatly. Some of them highlighted that they gave each pupil's results to them

separately or asked them whether or not they wanted their result to be announced, while others reported that they revealed the results of either every pupil or only the outstanding pupils to the whole class. They also displayed the best pupils' answers/work on the classroom wall. However, these practices might send messages that may diminish the resolve of poorly achieving pupils, and thus cause them to lose their confidence in their abilities and not even try to make an effort to improve and learn, as well as lead pupils to develop more of a fixed mindset. This result is in line with those of Sun (2018), who found that teachers who publicly recognised their pupils who had repeatedly performed well inadvertently delivered a fixed mindset message to the others regarding their capability in maths, as this list appeared to be fixed, indicating that specific lower-achieving pupils had little chance of featuring on it.

Furthermore, teachers reported that pupils as having fixed abilities, it often negatively influenced their performance in maths. They went on to say that intelligence is often a factor that helps pupils to achieve in maths, while having low abilities or suffering from learning disabilities in maths is likely to impair pupils' performance in maths. This belief, endorsed by some teachers, is associated with having a fixed mindset regarding intelligence, and can affect teachers' practices and the feedback they give pupils regarding their performance. This may manifest as the belief that they cannot develop their abilities and/or they may spend time trying to comfort their pupils about their low abilities. This, however, can lead their pupils to develop a more fixed mindset about their abilities in maths, which in turn may affect their achievement. Indeed, associating maths ability with an innate or fixed characteristic, according to the MTMF, communicates a fixed mindset message to pupils (Sun, 2018). This finding is consistent with Sun (2018), who highlighted one example of a teacher who participated in her research. That particular teacher only expected a few students to be able to keep up with the pace of the advanced class, thus possibly conveying a fixed mindset message to those students.

In contrast to the teachers demonstrating fixed mindset behaviours, some teachers emphasised the importance of effort and how they encouraged their students to try again when they made errors in their work. They also described how they motivated their pupils by giving them an example of a successful person who had initially struggled. This type of practice might motivate pupils to improve themselves and learn, which is consistent with a growth mindset. This finding is in line with those reported by Sun (2018, 2019), who found that some maths teachers respected and valued pupils' mistakes, linked them with learning and also delved into their mistakes, which according to the MTMF, could convey a growth mindset message to pupils. This finding is also

consistent with a study by Sun (2019), who found that some maths teachers who value the importance of struggle influence their pupils to adopt growth mindset practices, according to the MTMF.

Teachers also commented on how they provided additional opportunities to attempt to solve a problem and supported their pupils to master new maths skills and improve their performance, whether during the class by re-explaining any incomprehensible points with pupils or by providing them with private tuition. These results are in accordance with Sun's (2018, 2019) findings, which indicated that teachers who frequently provided students with extra help and multiple opportunities to resubmit the material were more likely to communicate a growth mindset message to pupils concerning their maths ability.

Consistently challenging pupils, for example, by giving them difficult problems to solve or creating competition among them, whether in or outside the classroom, was one of the practices that most of the teachers stated they used in their teaching. This type of practice reflects the implementation of a growth mindset maths practice, because, according to the MTMF, when teachers consider it worthwhile for pupils to take risks in maths and support them to do so, as well as encourage pupils to develop their own ideas and test them, it delivers growth mindset messages to pupils (Sun, 2018).

Teachers also stated that they provided practices that were aligned with delivering a growth mindset message to pupils. For example, teachers talked more about growth mindset comments that they made to their pupils in the classroom, which included conveying the belief that they could succeed in maths through effort and hard work. These comments are examples of explicit messages about mindsets related to maths that can influence pupils' determination to learn and potentially impact their performance. However, since teachers also provided some general and non-specific comments to students, their practice could be classified as also conveying a mixed mindset. Indeed, Sun's (2019) findings reported that although teachers used explicit growth mindset messages with their students, including statements such as 'each student can improve and succeed', according to the MTMF, this could have delivered mixed mindset messages to pupils, because such messages were, in fact, frequently neutral in nature.

However, although teachers mentioned a number of practices that they used that are clearly linked to a growth or fixed mindset, there are other practices that teachers described that might communicate mixed mindsets messages to their pupils. For example, there was a large consensus

that using auxiliary methods in the class and with pupils helped them in their learning and to improve. The most common methods used by teachers interviewed were peer teaching, peer evaluation and collaborative learning, all of which involved dividing the pupils in a class into mixed-ability groups, with each member taking on a role changed periodically. This finding is consistent with the results of Alkhamaiseh (2012), whose participants (teachers at primary and middle schools in the KSA) asserted the importance of using a cooperative learning strategy in their teaching. Although these strategies can sometimes be effective, specifically with underachieving pupils, teachers need to be cautious, because their actions might send mixed messages to their pupils, causing pupils to develop either more of a growth or fixed mindset. For example, when a teacher gives fixed roles to their pupils, gives the underachieving pupil an easy role or asks an excellent pupil to teach their classmates, these actions can send a message to underachieving pupils that they have a limited ability and are unable to help others. This result supports Sun's (2018, 2019) results, which found that teachers who divided students into heterogeneous groups conveyed mixed mindsets messages to their students. Conversely, Francome and Hewitt (2020) demonstrated that both teachers and students from schools that had mixed-maths attainment classes were more likely to hold a stronger growth mindset than those in classes divided into sets.

Indeed, all of the teachers agreed that praise and rewards had a useful and effective role, helping them to motivate a pupil to achieve further progress, especially since they had previously seen the impact of this on pupils' achievement. They commented that they provided their pupils with general praise, praised their pupils' abilities and the processes that they used, as well as thanked them, and gave rewards in different situations. According to the MTMF, praise that focusses on effort and specific processes that pupils make can convey growth mindset messages (Sun, 2018). However, since providing general praise and thanks is common, it has become meaningless to some extent, therefore it is unlikely to help pupils to improve their performance. Additionally, according to the MTMF, praising pupils for certain things such as their results, speed of answering, giving the right answer or for following the steps accurately are considered ways of communicating fixed mindset messages (Sun, 2018). This is because, praise for intelligence tends not to teach pupils that they are intelligent; instead, it often teaches them to focus on their ability instead of the impact of their effort on how well they do (Mueller & Dweck, 1998), thus causing them to develop more of a fixed mindset. Indeed, across six studies, Mueller and Dweck (1998) found that pupils who received praised for their intelligence after succeeding were found to care more about performance goals than learning goals and were more likely to adopt a fixed mindset compared to children praised for effort. Therefore, since teachers involved in this study used different types of praise with their

pupils, this was classified as sending mixed mindset massages. These findings are also in agreement with Sun's (2019) results, who found maths teachers using praise in the event of their pupils' processes and outcomes sent mixed mindset messages to their students, according to the MTMF. Regarding rewards, these results also correspond with the findings of Stipek et al. (2001), who demonstrated that fixed-minded maths teachers view grades and extrinsic rewards as useful strategies that motivate students to make an effort and engage in activities.

Finally, it is clear from the above that teachers sometimes reported using practices that deliver fixed mindset messages, and at other times they employed actions that convey either a growth mindset or mixed mindset messages to their pupils. Accordingly, a crucial implication for practice arising from this study is that the MOE has to intensify its efforts to increase pupils' motivation to learn by focusing on teachers' motivational instructional practice, as this has been shown to affect their pupils' motivation. Therefore, professional development programmes for teachers should include training courses that help them to motivate pupils, by covering subjects related to the impact of their beliefs, such as the implicit theory of intelligence, on their instructional practice, and how they can translate these beliefs into their instructional practice. This might help them to recognise the impact of teachers' intelligence mindset, feedback and pedagogical practices on pupils' mindset and results, as well as learn the growth mindset practices that need to be emphasised and the fixed mindset practices that need to be addressed.

The MOE should also consider increasing teachers' awareness about the link between implicit theories of intelligence and theories about pupil's motivation by providing motivational practices and messages to pupils, while at the same time stressing that the promotion of one of the intelligence mindsets may play a key role in enhancing a growth or fixed mindset in pupils. For example, giving feedback such as "You are a brilliant student" (P.100) is considered a value-neutral statements, since it has no specific meaning (Hildrew, 2018). To clarify, teachers should be made aware of that fact that although these common phrases are not detrimental, it is valuable to think about what is implied and how the comment could be extended to have a greater meaning; for example, "You have demonstrated excellent skill in applying what you have learned." (Hildrew, 2018, p.100). Furthermore, in terms of failure, adults' feedback should focus on the pupils' potential to progress regardless of the challenges and setbacks they face. That is, instead of criticising students' poor ability, it would be beneficial for adults to use phrases such, "I can't do this. . . *yet!*" (P. 1853, Haimovitz & Dweck, 2017).

However, changing the language used in the classroom is only the first step in implementing a growth mindset culture, that is to say, teachers and leaders not only have to change the way they communicate with students about their effort and work, but they also have to work to genuinely adopt a growth mindset approach in their classrooms (Hildrew, 2018). The behaviours, attitudes and actions that teachers and leaders value and reward have to support the motivational messages they give, otherwise their words lose their meaning and are viewed by students as insincere (Hildrew, 2018). In short, they have to believe that mistakes aid learning and high achievement should only be rewarded when it shows an improvement in effort and attitude (Hildrew, 2018). Teachers also have to be aware that rather than trying to increase students' self-confidence by assigning them easy work that they can complete without any effort or mistakes, they can cultivate the values that are at the core of mathematical and scientific contributions such as the love of a challenge, the love of hard work and the desire to accept and learn from the inevitable mistakes that are made (Dweck, 2008). This method is more likely to foster a growth mindset in pupils, which in turn, could improve their achievement.

Consequently, a growth mindset can be learned through interventions, and teachers can use key characteristics of a growth mindset in their pedagogical approach to improve pupils' motivation and achievement. Indeed, several studies have demonstrated that growth mindset interventions encourage students in the intervention group (compared to students in the control group) to adopt more of a growth mindset and/or improve their maths achievement (e.g., Lee et al., 2021; Peterson, 2018). This also has to be employed by supervisors, whose job is to observe and evaluate the performance of teachers in their classroom, in order to improve their skills and knowledge, too.

Furthermore, given that a poor school environment emerged as another issue from these findings, the MOE has to take action to provide all of the facilities and resources that are necessary to create positive learning environments, and thus increase pupils' motivation to learn. In addition, they should also find solutions to address the negative elements affecting pupils' outcomes in terms of school buildings, the school environment and education policy.

4.7 Strengths, limitations and future directions

A key strength of the present study is that this is the first study to explore the views of Saudi teachers concerning their pupils' success and failure in maths and the role of teachers' intelligence mindset on that, thus addressing the gap in the literature in terms of Saudi studies. Another strength of this study is the fact it aimed to address the gap in the literature by designing the study and

developing the interview questions based on the recent hypothesised model from a previous article by Haimovitz and Dweck (2017). The article recommended exploring how adults' mindsets, motivational methods and responses/practices with their children might impact their children's mindsets.

However, a number of important limitations need to be considered. Firstly, although there are several types of schools such as international education schools, private general education school, private religious education schools, private special education schools (e.g., a school that includes programmes that provides additional help and material in different subjects such as maths and science for gifted pupils and/or for those with learning disabilities), state general education schools, state religious education schools, and state special education schools in Saudi Arabia, this study only included teachers from state primary schools. Other types of schools such as private primary schools and international primary schools may provide a better educational environment that helps teachers spread the spirit of a growth mindset and easily deliver this type of mindset to their pupils. They might also have a greater ability to focus on pupils compared to state school teachers, especially since they have additional materials and resources, as well as the fact that the number of pupils in their classrooms is lower compared to state schools. Indeed, Almaayouf's (2015) results found that according to student counsellors in schools located in Alahsa, KSA, there were significant differences in the school climate between public and private schools, with more favourable conditions in private schools in terms of the school administration system, the human relations, the school environment and the work regulations and systems, in general.

Secondly, this study only included teachers from upper primary schools, specifically teachers who taught the 5th and 6th grades and did not investigate the view of teachers at lower primary schools, who may have a different point of view that, in turn, may affect the mindsets of their pupils and contribute to shaping their pupils' perspectives about the fixedness or malleability of their abilities.

The findings from this research provide other possible avenues for future research. For example, teachers who participated in this research commented on how the beliefs, behaviours and the practices of other teachers, principals, parents, and the pupils themselves can impact pupils' outcomes at school. Consequently, it would be beneficial to explore parents' and children's points of view about success, failure and intelligence, and their response/practice orientations in the case of success and failure. Moreover, future research should employ interviews with teachers from different types of school and working at different educational levels, as it would add another

viewpoint regarding teachers' beliefs and practices, which could be useful for further understanding the factors that can affect students' mindset and outcomes. Further research is also needed to better understand how teachers' different genders and years of experience might influence their mindset and pedagogical practices.

4.8 Conclusion

To conclude, the five main themes that emerged from the data highlighted the factors that might negatively impact pupils' maths achievement, specifically: large class size; overworked teachers; a school's lack of supplies, materials and resources; a lack of family follow up; pupil's lack of confidence; pupil's poor foundation in maths; negative feelings toward maths and teachers and pupil's poor maths abilities. Moreover, it is also evident that teachers have educational practices that may convey mixed mindsets messages to their pupils. To illustrate, teachers described some pedagogical practices that they used that might send growth intelligence mindset messages to their pupil, including emphasising the importance of pupils' mistakes when learning, providing extra help and many opportunities for resubmitting and challenging pupils. However, teachers also employed other practices that may deliver fixed intelligence mindset messages to their pupils such as providing praise related to pupils' attributes and outcome, not giving specific feedback, comforting underachieving pupils about their poor maths' abilities, and only announcing the results of outstanding pupils. Therefore, these results suggest areas to be developed for future practice and recommendations for future research.

Chapter 5 Study 3: How can adults' responses to children's failures in maths at primary schools in Riyadh influence these children's beliefs about their maths abilities?

The analysis of the qualitative study identified five main themes reflecting teachers' mindsets and reactions to their pupils' successes and failures. Two of these themes represented two factors that previous studies in the literature review (Chapter 1) had shown might impact children's intelligence mindsets and, in turn, their academic achievement. Therefore, the researcher of this current thesis selected these two factors as the focus for further exploration in this research, in order to identify if they are linked to children's belief about their abilities in maths or not. This was done by conducting an additional study. One of the two themes was related to teachers' beliefs about parents and parent-school engagement. Teachers described how parents who were interested in their child's learning and encouraged positive behaviour in their child had a beneficial impact on their child's motivation and achievement, while parents who did the opposite, frequently negatively affected their child's motivation and achievement. That is, the results of the qualitative study highlighted the role of parents' practices and behaviours on their child's motivation and achievement. In addition, the literature review in Chapter 1 also showed that some studies have found a correlation between parents' mindsets and their practices and behaviours (see Section 1.7). Therefore, the following study included mothers to gain a better understanding as to whether mothers' mindsets and their response orientations are linked to their children's growth or fixed intelligence mindset or not.

The second theme focused on in this next study was the teachers' beliefs about classroom teaching strategies and behaviour. This theme explores the theory that maths teachers' beliefs and practices can impact pupils' motivation and achievement, which is supported by studies in the literature review in Chapter 1 (see Section 1.7). The results of some studies have shown that teachers' mindsets correlate with their pupil's mindsets (e.g., Gutshall, 2016; Mesler et al., 2021). Thus, to develop a deeper and clearer understanding of the relationships between teachers' beliefs and response orientations to their pupils and their pupils' intelligence mindset, compared to their mothers, teachers were included in the next study.

Consequently, although the hypothesised model developed by Haimovitz and Dweck (2017; see Figure 1 in Section 1.7) was tested for the first time in Study 2 using a qualitative method, further investigations of this hypothesised model by employing a quantitative method was still needed. Therefore, a quantitative approach was chosen in order to identify if any relationships exist

between the variables present in the model among the three samples, namely: teachers, pupils and their mothers. This was considered particularly important, because to the best of the researcher's knowledge, there had been no previous study in non-Western countries, specifically in Saudi Arabia, that had examined the correlations between the mindsets and practices of parents and/or teachers and the intelligence mindsets of their children. It is also important to note that the next study to be presented investigated the relation between mothers and their children's growth or fixed intelligence mindsets in Saudi Arabia for the first time (see Section 2.2).

This chapter begins with the introduction of the study, followed by the research methodology of the study. Subsequently, the results and discussion are presented. Then, the strengths, limitations, and future directions are highlighted. Finally, the conclusion is provided.

5.1 Abstract

Recent studies into the roles of mindsets in learning have shown that adults' beliefs influence their practices, which in turn impact their children's mindsets, and this, consequently, affects school achievement. Accordingly, this study was designed to empirically test a hypothesised model, developed by Haimovitz and Dweck (2017), regarding how adults promote children's growth and fixed mindsets. The present study aimed to reveal the impact of adults' intelligence and failure mindsets on their response orientations to a child's maths failure scenario and how these, in turn, might influence their children's intelligence mindsets in mathematics. Online surveys provided quantitative data from 168 participants: 56 children aged 10 to 12 years old, as well as their mothers and maths teachers in Riyadh, Saudi Arabia. The findings revealed that across these three groups, only the mothers' mindset shaped a child's mindset, while the mindset of the maths teachers did not. A positive statistically significant relationship was found between mothers' failure mindset and their response orientation to a maths failure scenario. Additionally, a negative statistically significant relationship was found between mothers' learning orientation and their children's intelligence mindset. These results indicated that mothers who believe that failure is debilitating were more likely to react with a performance orientation response. Additionally, mothers who reported strong beliefs towards learning-oriented reactions had children who were more likely to endorse more of a growth mindset of maths intelligence. As a result of these investigations, the implications within the Saudi context are discussed, and suggestions are identified for future research.

Keywords: Intelligence and failure mindsets, Response orientations, Adults, Children, Maths.

5.2 Introduction

Until 2019, students in the KSA performed poorly in maths assessments and this was evident in both the national and international assessment results (see Section 2.6). Thus, a great deal of effort still needs to be made by the MOE, as well as administrators, principals and teachers, parents and researchers to improve students' performance, in order to achieve the goals of the Saudi Vision 2030, which aims to make education in KSA equal that in developed countries in the world by 2030 (see Section 2.4). The subject of motivational factors thought to influence academic achievement has been explored in several studies by researchers. One of the factors studied has been implicit theories of intelligence, the holding of which has been shown to have an impact on children's motivation and learning in school (Haimovitz & Dweck, 2016, 2017; Beyaztaş et al., 2017).

In implicit theories of intelligence, also known as intelligence mindsets, individuals who endorse an entity theory of intelligence, also known as a fixed mindset, take the view that intelligence is stable and unchangeable (Dweck et al., 1995; Haimovitz & Dweck, 2016). Those who have this notion believe that while individuals can learn new things, their core intelligence does not change (Dweck et al., 1995). In contrast, individuals who endorse incremental theory, also known as a growth mindset, have the view that intelligence may be developed through effort, the application of useful strategies and instruction (Dweck et al., 1995; Haimovitz & Dweck, 2016).

As mentioned above, some research has shown that the psychology of students, specifically their academic mindset, plays an important role in academic achievement (Rattan et al., 2015), however, other studies have concluded that this relationship does not exist. For example, some studies have reported a positive association between students' growth mindset and their academic achievement/GPA (e.g., Diseth et al., 2014; Paunesku et al., 2015; Tarbetsky et al., 2016), whereas other research has shown a negative association between students' fixed mindset and their academic achievement/attainment/GPA (e.g., Diseth et al., 2014; De Castella & Byrne, 2015; Mouratidis, et al., 2017; Diaconu-Gherasim et al., 2019). Yet, in other research, no associations have been found (e.g., Kornilova et al., 2009; Zhu et al., 2020, Study 4).

Although many studies have focused on exploring the correlations between both types of intelligence mindset (i.e., growth and fixed) and general academic achievement or GPA, others have tried to investigate these correlations in a specific area such as mathematics. Yet again, studies have provided mixed evidence. Some of these studies have reported a positive relationship between growth intelligence mindset and achievement in maths (e.g., Bostwick et al., 2017; Su et al., 2021:

Rahardi & Dartanto, 2021), and a negative correlation between fixed mindset about intelligence and performance and participants' academic achievement/performance in maths (e.g., Stipek & Gralinski, 1996; Warren et al., 2019). However, these associations have not always been identified (e.g., Ayeni, 2021; Li & Bates, 2019, Study 4).

Due to the fact a great deal of empirical evidence has shown that a growth mindset has a positive relationship with achievement, Yeager and Dweck (2012) highlighted that children must develop mindsets that help them to view setbacks as things they might take on and overcome over time with the aid of new strategies, effort, learning, help from others and patience, rather than as a result of self-esteem boosting or trait labelling. A growth mindset can be transferred from adults, including teachers, to children. This is particularly the case with teachers, since they play a key role in encouraging students to become active and self-motivated learners by developing classroom conditions that encourage them to do so (Deemer, 2004). Indeed, some studies have found that there is a positive association between teachers' mindsets and their students' mindsets in elementary and middle schools (e.g., Gutshall, 2016; Mesler et al., 2021).

According to Haimovitz and Dweck (2016), parents can also help their children to stay motivated and successful in their learning by encouraging them to view their abilities and intelligence as things that can be improved. Indeed, Song et al. (2022) found that parents who hold a growth intelligence mindset about the potential of their children, have children who tend to be more persistent and develop better reading skills (but not maths skills) compared to children whose parents endorse a fixed mindset. Accordingly, recent studies have aimed to explore the relationship between parents' mindsets and their children's mindsets. Overall, evidence from these studies has been mixed. For example, Matthes and Stoeger (2018) found that there was a positive association between parents' growth mindset and their children's (aged 9 to 12 years old) growth mindset. Moreover, Hayden's (2019) results reported that among students aged 11 to 18 years old, there was a positive relationship between students' own intelligence mindset and their perceptions of their parents' intelligence mindset; nevertheless, this relationship was not found between older students' (aged 13 and 18 years old) views and their perceptions of their parents' beliefs about intelligence mindset. Barba (2019) also found that there was no relationship between parents' maths mindset and their children's (aged 14 to 18 years old) maths mindset.

Some studies have not been able to show a link between parents' intelligence mindset and children's intelligence mindset in the event of children's experiences of succeeding or failing, which may be because of the ways that adults react to them during these events. That is, "adults' theories

of *how to motivate children*—how to make them feel good, how to give them confidence, how to motivate future learning" (p.1855) may clearer to children than their theories of intelligence (Haimovitz & Dweck, 2017). To clarify, parents' implicit theories of intelligence are not evident and visible to their children and, sometimes, do not manifest in parental reactions/responses (Haimovitz & Dweck, 2017). As a result, the above motivational theories may more greatly influence adults' behaviour toward children and, in turn, determine whether children develop a growth or fixed intelligence mindset (Haimovitz & Dweck, 2017).

One of these motivation theories is that parents' implicit theories of failure, which might be more obvious to their children, are reflected in parents' responses, such as their concerns and behaviour when their children face a setback, and impact children's view of intelligence mindsets (Haimovitz & Dweck, 2016). Failure mindsets, or implicit theories of failure, indicates that individuals may view failure as either enhancing or debilitating learning (Haimovitz & Dweck, 2016). That is to say, individuals who endorse an enhancing failure mindset believe that failure can be a positive experience that helps and motivates them to learn and grow, while individuals who endorse a debilitating failure mindset believe that failure is a demotivating experience that prevents learning and them from being productive (Haimovitz & Dweck, 2016).

Interestingly, Haimovitz and Dweck (2017) indicated that adults' intelligence mindsets and their motivation theories might not be well matched. Indeed, several studies have provided mixed evidence concerning the relationship between an individual's intelligence mindset and their failure mindset. For example, some studies have reported that there was no significant correlation between the intelligence mindset of both teachers and parents (Doedens-Plant, 2018) or even simply parents (Haimovitz & Dweck, 2016, Study 3a) and their failure mindset. Tao et al. (2022) also found that among university students, there was no significant impact of students' failure-is-debilitating mindset at the baseline on students' fixed intelligence mindset at follow-up. In contrast, other studies have found that parents' failure mindsets were positively related to their own intelligence mindsets (e.g., Haimovitz & Dweck, 2016, Study 1; Li, 2020; Jarsky, 2020). In terms of children, Li's (2020) results also demonstrated that there was a significant association between children's (aged 7 years 8 months to 11 years 4) failure-is-enhancing mindset and their growth intelligence mindset.

Since some studies had previously shown that parent intelligence mindsets did not correlate with their children's intelligence mindsets, several studies later aimed to establish the association between teacher or parents self-reported failure mindsets or their children's perceptions of their parents' failure mindsets and their children's/pupil's intelligence mindsets. However, the evidence

has been mixed. For example, over two studies, Haimovitz and Dweck (2016, study 1 and study 3b) found that children's (aged 9 to 12 years old) intelligence mindsets were not significantly associated with their parents' intelligence mindsets, but with their parents' failure mindsets and/or the children's perceptions of their parents' failure mindsets. This indicates that parents who viewed failure as a factor that debilitates learning had children who were significantly more likely to view intelligence as a fixed ability (Haimovitz & Dweck, 2016). A further study conducted by Li (2020) reported that there was a significant positive correlation between children's (aged 7 years 8 months to 11 years 4) growth intelligence mindset and their perceptions of parents' failure-is-enhancing mindsets. Li (2020) also showed that there was a significant positive correlation between pupil's perceptions of their teachers' failure mindsets and their pupil's intelligence mindsets. That is, children who believed that their teachers viewed failure as enhancing experience were more likely to believe that intelligence can be improved.

In contrast to the above earlier findings, Hayden (2019) found that among students aged 11 to 18 years old there was no correlation between adolescents' (aged 12 to 18 years old) view about intelligence and their perceptions of their parents' view about failure, which indicated a change in students' beliefs after the age of 11. Moreover, Haimovitz and Dweck (2016) reported that the results of Study 1 showed that there was no significant direct relationship between parents' reports about their view of failure and their children's (aged 9 to 12 years old) reports about their view of intelligence when controlling for children's perceptions of parent's performance-versus-learning orientation. However, there was an indirect association between them, which was mediated by children's perceptions of parent's performance-versus-learning orientation. This indicates that parents who viewed failure as debilitating learning had children who viewed their parents as endorsing more performance-oriented reactions, which consequently led their children to believe that their intelligence could not be developed (Haimovitz & Dweck, 2016). In the results of Study 2 and Study 4, they also reported that parents who held a debilitating view of failure (cf. parents who hold an enhancing view of failure) were more likely to respond to the child-failure scenario with more performance-oriented responses than learning-oriented responses. The performance-oriented response reflects parents' concerns regarding the performance and their child's lack of ability, specifically, "pitying their children, doubting their ability, comforting them for not having enough ability" (Haimovitz & Dweck, 2016, p. 864). This orientation is also known as person-oriented practice (Haimovitz & Dweck, 2017). However, learning-oriented responses represent parents' support for the learning and improvement of their child (Haimovitz & Dweck, 2016). This manifests in the form of "discussing what their children could learn from the experience and how they might

improve in the future" (Haimovitz & Dweck, 2016, p. 864). This orientation is also referred to as process-oriented practice (Haimovitz & Dweck, 2017).

It has also been argued that adults' intelligence mindset might be linked to their learning and/or performance orientations, which in turn influences children's mindsets. Thus, some studies have aimed to investigate the correlation between adults' intelligence mindset and their learning and/or performance orientations. For example, a study conducted by Park et al. (2016) showed that teachers who held a fixed mindset reported higher performance-oriented instructional practices that focus on achieving good scores and demonstrating competence than teachers who held a higher growth mindset. In contrast, it was found that teachers who held a higher growth mindset were more likely to adopt mastery-oriented instructional practices, which focused on learning and working hard. They also found that teachers' theories of intelligence did not predict their pupils' motivational frameworks (i.e., measured the fixedness of intelligence and academic abilities, and preferred easy tasks), however, their theories were associated with both their performance- and mastery-oriented instructional practices, yet only performance-oriented ones were related to the improvement of pupils' motivational frameworks. This, in turn, correlated with their maths achievement, indicating that the more teachers use performance-oriented instructional practices, the more pupils held a fixed mindset at the end of the academic year, even after controlling for pupils' beginning-of-year motivational frameworks (Park et al., 2016). In contrast, over two studies, Haimovitz and Dweck (2016, study 1 and study 2) found that parents' intelligence mindsets were not significantly associated with their children's (aged 9 to 12 years old) perceptions of their parents' performance-versus-learning orientation, with their own self-reporting of being performance-oriented or with their learning-oriented responses to their child's failure scenario. Moreover, Li (2020) found that there were no significant correlations between children's (aged 7 years 8 months to 11 years 4) intelligence mindsets and their perceptions of their parents' learning versus performance orientation.

Based on many of the studies above, Haimovitz and Dweck (2017) developed a hypothesised model (see Figure 1 in Section 1.7) to determine how adults promote children's growth and fixed mindsets. This model assumed that adults' implicit theories of intelligence and/or failure might be related to their responses, which in turn impacts whether their children foster more of a growth or fixed intelligence mindset. Although a number of previous studies have explored some of the relationships presented in the model, such as the associations between mindsets and response orientations, to the best of the researcher's knowledge, none of the relationships suggested in the

model have previously been investigated outside western culture. Moreover, this is the first study to empirically test the entire model by examining the associations between adults and their children. It is also the first study to look at these relationships in a non-Western cultural context (Saudi Arabia), as well as the first study to examine these relationships using more than one population of adults (both mothers and teachers).

The present study also has the feature of adding a new path to Haimovitz and Dweck's (2017) model, as it explored similar concepts among adults (see Figure 4) and children, in order to compare the outcome across both types of adults: teachers and mothers and their children. Consequently, this study intends to fill the gap in the literature, specifically in the Saudi context (see Section 2.2), by including both teachers' and parents' factors, such as their practices and beliefs about intelligence and failure, which can shape children's implicit theories of intelligence, in order to gain a better understanding of how children's beliefs that lead to a growth or fixed mindset are formed.

This study presented participants with a failure scenario, since all of the emotions or behaviours/reactions that can influence children to determine whether they can improve their ability (or not) can be discerned from their experience of a failure (Haimovitz & Dweck, 2016). It is also important to note that although Haimovitz and Dweck (2016) investigated the impact of age and gender on beliefs and responses among both the adults and children who participated in four studies, they found that that participant's age was only shown to have an effect on the results of one study (i.e., Study 2). However, when they tried to control for the participant's age in their subsequent analyses of that study, they did not find any differences in their results. Doedens-Plant (2018) also found that pupils' age and gender had no significant influence on their view of both intelligence and failure mindsets. Moreover, Li (2020) found that including specific control variables, namely children's age and gender, did not change the results in terms of their failure beliefs. Therefore, this study did not consider whether participants' age or gender affected their beliefs and/or responses in the analyses.

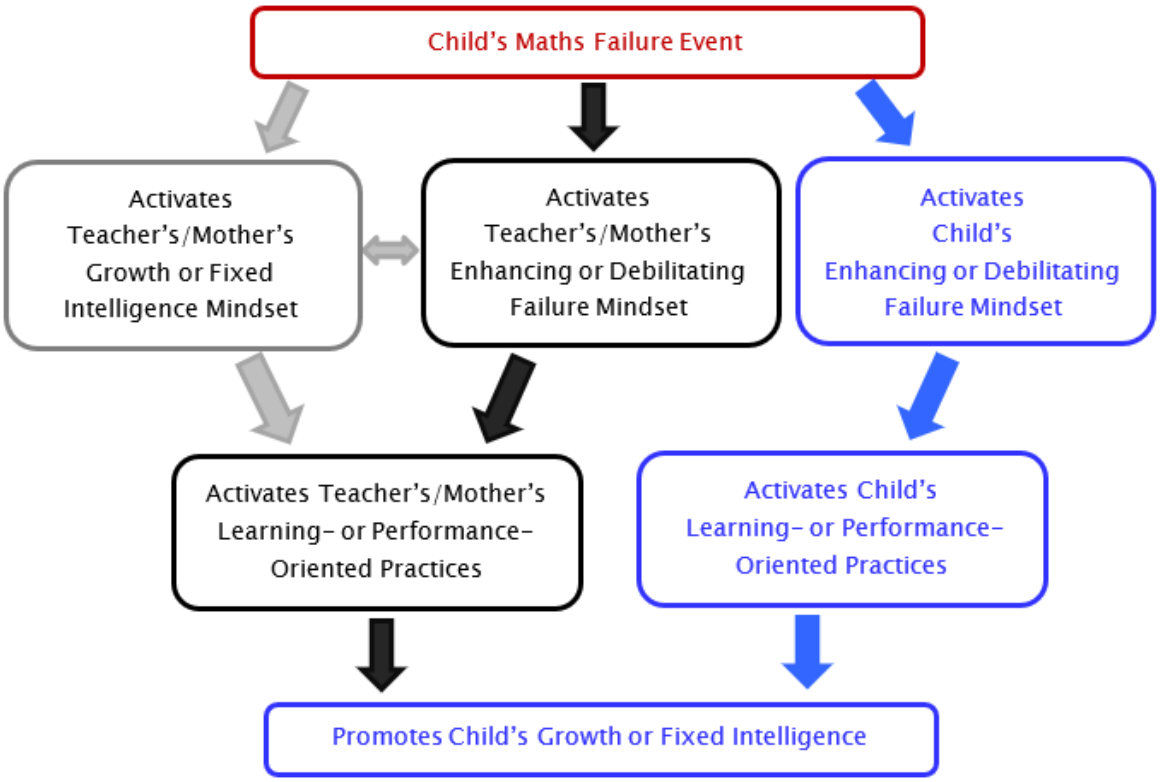
In short, this study aimed to address the following research questions:

1) Do the relationships suggested in the model created by Haimovitz and Dweck (2017; i.e., shown in Figure 1 in Section 1.7) hold true when this model is statistically implemented for primary maths teachers and mothers?

2) Comparing the relationships shown in Haimovitz and Dweck's model (2017; i.e., shown in Figure 1 in Section 1.7) and an expanded version of the Haimovitz and Dweck model (i.e., shown in Figure 4), do the additional relationships included in the expanded version improve upon our understanding of what promotes a growth or fixed intelligence mindset in children (aged 10 and 11 years old) beyond that obtained by only considering the relationships in Haimovitz and Dweck's model (2017)?
    a. Does any improvement hold true when considering primary maths teachers and/or mothers?

Figure 4

Hypothesised model for how adults and children together promote children's growth and fixed mindsets



5.3 Methodology

5.3.1 Research Design and Variables

In order to identify if the relationships exist between variables presented in Figure 4 in Section 5.2, a quantitative-correlational and cross-sectional survey research design was used. In a cross-sectional study, a population is captured as a snapshot at a single point in time, in order to examine the variable(s) of interest (Cohen et al., 2017). The following three variables are used with all participants in the current study: the intelligence mindset (growth or fixed), the failure mindset (enhancing or debilitating), and the orientation of the response (learning or performance). This study featured a scenario and questionnaires to measure these variables (and statistically estimate the relationships) presented in Figure 4 among the three samples (i.e., teachers, pupils and their mothers).

5.3.2 Participants

The sample included 5th and 6th grade pupils (aged 10 and 11 years) in Riyadh, Saudi Arabia, during the 2020/2021 academic year, plus these pupils' mothers and their maths teachers. Inclusion criteria required that the teachers who participated in this study were teaching maths to pupils in 2019/2020. This ensured that the teachers knew their pupils well, since they had both attended the school and studied face to face in the first semester of the academic year for four months, and the beginning of the second semester for seven weeks (a total of five months and three weeks) before in-person education was suspended in 2019/2020 (i.e., on 9th March 2020) due to the Covid-19 crisis. It is also important to note that the data from the participants started to be collected during the final weeks of exams at the end of the first semester of the 2020/2021 academic year. Moreover, due to the Covid-19 crisis during the 2020/2021 academic year, the MOE in Saudi Arabia asked all teachers to only attend school once a week. Consequently, due to the fact both teachers and mothers faced additional burdens during that academic year, it led some of them to decline to take part in this research.

A total of 78 schools were invited to take part via letters to the head teachers, and 58 of them gave their consent for the research to take place at their school. In total, 58 pupils, their teachers and their mothers were then invited to take part in this study (one triad per school), However, while 58 teachers agreed to participate, consent was achieved from only 57 mothers (for them and their child). Of these 57 mothers and 57 pupils, data were collected from all except one

pupil (failure to complete all of the items on the intelligence mindset scale). Therefore, the final sample included a total of 56 pupils plus their mothers and maths teachers, making a total of 168 participants. Again, each pupil, their mother and their teacher were from a single school, with a total of 56 schools, covering 42 out of 191 neighbourhoods/districts in Riyadh, Saudi Arabia.

With regard to pupil demographics, a total of 29 girls (51.8%) and 27 boys (48.2%) participated, with 32 pupils from the 5th grade (55.4%) and 25 pupils from the 6th grade (44.6%). All of the pupils identified their age as being between 9 and 12 years old (*M*= 3.11, *SD*= .652). To clarify, nine of them were 10 years old (16.1%), 32 pupils were 11 years old (57.1%), and 15 pupils were 12 years old (26.8%).

In terms of the mothers' demographics, three of them had only completed their primary education, three had only finished their middle education, a total of 15 had completed high school, five had a diploma, a total of 26 had a bachelor's degree, two had a master's degree, while only one mother had a doctorate. One mother did not indicate her level of education. In addition, seven mothers did not indicate either their date of birth or age, and the mothers ages ranged between 29 and 53 years old (*M*= 39.22, *SD*= 5.665).

Regarding teacher demographics, there were 29 female (51.8%) and 27 male (48.2%) teachers. In terms of education, 14 of them had a diploma, 35 had a bachelor's degree, six had a master's degree, while one teacher had a doctorate. A total of 50 teachers had a degree in maths, whereas six teachers had studied a different subject at university/college that was unrelated to mathematics. Six teachers did not indicate either their date of birth or age, and teachers' ages ranged between 28 and 62 years old, with a mean (*M*) of 41.10 and standard deviation (*SD*) of 6.338.

5.3.3 Ethical considerations

Ethical approval of the current study was obtained from the Faculty Ethics Committee (i.e., Faculty of Environmental and Life Sciences) at the University of Southampton, UK (ERGO II study ID number: 60757; see Appendix D1). Then, a permission letter was obtained from the MOE in Riyadh, Saudi Arabia to conduct the questionnaires among participants at girls' and boys' primary schools located in Riyadh city (see Appendix D2).

Additionally, a unique personal identification code was given to each participant, which was clearly indicated in their letter and was used during the data collection process to keep the identity of the participants confidential and to link each pupil with their mother and maths teacher.

Consequently, they were only referred to by their code, because no identifying information (e.g., participants' names) was collected. The unique personal identification code started with the letter 'T' for teachers, 'M' for mothers and 'P' for pupils, and each was followed by a specific number, ranging from 1 to 58. To link each teacher with their pupil and their mother, the mother and pupil of the teacher had the same number as the teacher but a different letter. For example, in the case of the teacher who had 'T1' as their unique personal identification code, the mother (of their pupil) had 'M1' as their unique personal identification code, and their child/pupil had 'P1' as their unique personal identification code.

Each participant was asked to tick the consent statement(s) as a requirement before they could start to complete the questionnaires, as participation was completely voluntary in this study. However, in the mother's questionnaire, mothers were also asked to complete the mother consent statement for their child in the consent section before they started to complete the questionnaire. All of the data were kept strictly confidential by storing them securely in electronic data files on a password-protected computer.

5.3.4 Procedure

Once ethical approval had been obtained from the University of Southampton, the researcher conducted a back-translation method to translate the three questionnaires from English into Arabic. The process of translation and adaptation of instruments, as outlined by the World Health Organisation (The process of translation, n.d.), were followed. That is to say, firstly, the three questionnaires were translated from English into Arabic by the researcher. Next, the Arabic translations of the questionnaires were compared with the English questionnaires by two bilingual professional translators. Following that, the Arabic versions of the questionnaires were translated into English by a further professional bilingual translator. Then, the two English versions, the original and the back-translated version, were checked to ensure that both of the two English versions did not differ in meaning by a British PhD student at the School of Psychology at the University of Southampton and a British English teacher.

The MOE in Riyadh, Saudi Arabia was then contacted and provided with all of the required documents, in order to obtain a permission letter to administer the questionnaires among participants at primary schools in Riyadh. Once the permission letter from the MOE had been received, several procedures were followed. Firstly, schools were randomly selected from a list of all the schools located in Riyadh city (using a random number generator) after requesting the names

and contact details of all of the primary schools for boys and girls in Riyadh from the MOE. Following that, the head at each school was contacted via the school phone number to explain the research aim to them and to find out their preferred method for sending all of the required documents, namely, the permission letter from the MOE, the three questionnaires and a letter for the head of the school that explained, in brief, the aim of the research (see Appendix D3). Some schools received the documents via their school email, while others received the documents in a text message to the school number through the school's official WhatsApp application, as requested. However, some schools were visited by the researcher in cases when there was a problem making contact over the phone and/or they had not replied to the email which had been sent to them, and thus, a sealed envelope that included all the documents as hard copies was given to them in person.

Once the heads of schools had given consent for the research to take place in their school, the eligible maths teachers at each school were asked by the heads of the schools if they were happy to participate or not in the study. Then, the teachers who consented to participate in this study received the letter assigned to them via their email, or as a text message to their mobile number via WhatsApp if they preferred (see Appendix D4). When the teachers had completed the questionnaire, they (or sometimes the pupil counsellor at the school) were asked to contact the mother and their child and ask them if they were happy to take part in this study or not. This was done by asking either the teacher or the pupil counsellor at the school about the total number of pupils on the teacher class list of the academic year 2019/2020, and then three pupils were selected at random. Following that, the teachers or the pupil counsellor were asked to recruit the mother of the first pupil chosen at random, and if she or their child did not wish to take part in this research, they were asked to recruit the mother of the second pupil selected at random, and so on.

Subsequently, the mothers who had consented to participate in this study received the letter assigned to them via a text message to their mobile number via WhatsApp (see Appendix D5). Once the mother had filled out the questionnaire, she was asked to open the letter assigned to their child to read it, and then open the link for their child to fill out the questionnaire if s/he wanted to be involved in this research (see Appendix D6). Each participant who participated in the current study received a letter assigned to them that explained the research aim in brief, provided them with a unique personal identification code, as well as included the link and barcode, which contained the information sheet, consent statement, the questionnaire, and the debriefing statement (see Appendices D7, D8, D9, D10, D11 and D12). Participants were allowed to complete the questionnaires at a time convenient to them.

5.3.5 Measures

To measure the concepts shown in Figure 4 (see Section 5.2), all of the participants (i.e., pupils and their mothers and teachers) completed online questionnaires in Arabic using Version 2020 of the Qualtrics software (i.e., a web-based survey tool), which began with a small set of demographic questions. The teachers' questionnaire included questions regarding their gender, age range, level of education and whether their degree was in the mathematics field or not, while the mothers' questionnaire contained questions concerning their age range and level of education, and lastly, the pupil questionnaire included questions related to their age and grade at the time of completion (see Appendices D13, D14 and D15).

Following the brief demographic questions, all of the participants read a hypothetical educational scenario concerning a child's/pupil's experience of failure in maths and then were asked to fill in a questionnaire that included 12 items measuring participants' response orientations. This scenario reflected an event in which the child failed, as shown in Figure 4, and participants' responses to it measured their maths' response orientations (learning and performance). After answering questions regarding their response orientations, participants were asked to complete two further questionnaires that included questions measuring two concepts presented in Figure 4: the maths' failure mindset concept (enhancing and debilitating mindsets; measured via six items for adults and four items for children) and the maths' intelligence mindset concept (fixed mindset only, measured via three items). Accordingly, there were a total of 21 statements included on the teachers' and mothers' questionnaires, and 19 statements on the pupils' questionnaire.

It is crucial to note that all three original scales (i.e., response orientations, failure mindset and intelligence mindset) have been adapted to reflect their beliefs about studying maths. This was done by adding the word "maths" to most of the items. An example of an original item from the intelligence mindset scale is "Your intelligence is something about you that you can't change very much", which was being modified to "Your maths intelligence is something about you that you can't change very much". It is also important to note that the original intelligence mindsets scale asks participants to indicate their level of agreement on a 6-point Likert scale with response options, namely: strongly agree, agree, mostly agree, mostly disagree, disagree and strongly disagree (Dweck et al., 1995). However, the original scales of failure mindsets and response orientations ask the participants to indicate their level of agreement on a 6-point Likert scale items, with response options starting from 1 (strongly disagree) to 6 (strongly agree; Haimovitz & Dweck, 2016). Therefore, since the failure mindsets scale and response orientations scale used in the current study

asked participants to indicate their level of agreement with the statements on a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree), the responses of intelligence mindsets scale were amended so as to be the same as the other two scales and to avoid confusing the participants. However, in the current study, following Lou and Noels (2017), participants were asked to indicate their level of agreement with the statements in all three questionnaires on a 6-point Likert scale, with response options starting from 1 (Strongly Disagree) to 6 (Strongly Agree), namely: strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree and strongly agree. These response options were used, since it is clearer and easier for participants, particularly children, to understand.

5.3.5.1 Maths Failure Scenario and Maths Responses Orientation

As mentioned above (see Section 5.3.5), all of the participants read a hypothetical educational scenario regarding a child's/pupil's experience of failure in maths. This led them to imagine that their child/pupil or s/he had obtained a "fail" in the final maths exam at the end of the first semester of the academic year. The scenario was adopted from Blackwell (2002) and Haimovitz and Dweck (2016). However, a few amendments were made to the scenario, in order to suit the Saudi education system. These amendments included using pupils from the 5th or 6th grades instead of the 4th or 11th grades. Further changes included: the term "first quiz" being modified to "the final exam at the end of the first semester of the academic year"; the score that the pupil obtained in the scenario; and the method used to inform both the mother and child (see Appendices D13, D14 and D15).

A similar scenario was provided to all of the participants, however, the teachers' scenario described their situation from the perspective of their pupil failing, while the mothers' scenario described their situation from the perspective of their child failing, and the children's scenario involved the pupil imagining their own failure in a maths exam. For example, the following scenario was presented to the pupils:

"Now, we would like you to read a scenario. While reading, imagine you are this [5th or 6th grade] pupil and that this really happened to you; try to picture how you would feel and what you would think and do if it happened.

You start a new maths class at the beginning of your [5th or 6th grade] year. You like maths and your teacher and think you know the subject pretty well, so you study a medium amount for the exam at the end of the first semester. Afterwards, your parents asked you about the exam and you said that

you think it went okay, even though there were some questions that were confusing. Then, you open the Noor program to see your report for the first semester (or you received your report from the school) and you find that you only got a score of 9 out of 30 in the maths exam - that's an F in maths."

Participants' orientation responses to the scenario were measured via a response orientation scale developed by Haimovitz and Dweck (2016). This scale included 12 items divided into two constructs/subscales: learning-oriented responses, which included 6 items (e.g., "I'd think about what I learned from doing poorly in the maths exam.") and performance-oriented responses, which also included 6 items (e.g., "I'd probably find myself dwelling on my performance in maths."; see Appendices D13, D14 and D15).

A similar scale was provided for all of the participants, however, the teachers' statements showed their reactions to their pupil in the event of them failing (e.g., "I'd feel sorry for my pupil."), while the mothers' statements revealed their responses to their child in the event of them failing (e.g., "I'd feel sorry for my child."), and the children's statements presented their reactions in the event of them failing (e.g., "I'd feel sorry for myself."). Following Haimovitz and Dweck (2016), a composite variable was created to reverse-score six items that referred to learning-oriented responses (i.e., items 7 to 12). Then, the average of the responses to all of the items (i.e., 12 items representing both learning orientation and performance orientation) was calculated. Therefore, a higher mean score indicated a stronger agreement with performance (vs. learning) orientation.

5.3.5.2 Maths Failure Mindset

The maths failure mindset scale created by Haimovitz and Dweck (2016) was employed to assess participants' beliefs about failure as either enhancing or debilitating learning. Six items were used for the questionnaires for adults, with three of them representing the idea that failure enhances learning (e.g., "Experiencing failure in maths facilitates learning and growth.") and the other three items indicating that failure hinders learning (e.g., "Experiencing failure in maths inhibits learning and growth."). However, only four items were used with children; two of them representing that notion that failure enhances learning, and the other two items indicating that failure hinders learning. The original items on the children's questionnaire were modified from asking them about their perceptions of their parents' view of failure to asking them to indicate their self-reported beliefs about failure, for example, "My parents think failure hurts my learning." was replaced with "I think failure in maths hurts my learning." (see Appendix D15). Following Haimovitz and Dweck (2016), a composite variable was created to reverse-score three items (i.e., the negative items: 1 to

3 on the adult's questionnaire, and items 3 and 4 on the pupil's questionnaire) that showed failure is an enhancing mindset. Then, the average of the responses to all of the items (i.e., the six/four items representing both enhancing and debilitating failure mindsets) was calculated using a computed variable. Consequently, a higher mean score indicated a more debilitating/negative (vs. enhancing/positive) view of failure.

5.3.5.3 Maths Intelligence Mindset

As mentioned above, the maths intelligence mindset shown in Figure 4 was measured using the fixed intelligence mindset scale developed by Dweck et al. (1995) to assess the participants' belief about the malleability of intelligence. Although Dweck's (2000) book presented six items on the children's scale and eight items on the adults' scale, only the three items that refer to a fixed mindset (the other three items represent a growth intelligence mindset) were used for both the children and adults in this study. This is due to the fact that implicit theory is a construct with a single unified theme, as rephrasing the same notion may cause participants, specifically children, to become confused and bored (Dweck et al., 1995; Dweck, 2000). A similar scale was provided to all of the other participants, however, the teachers' statements asked questions regarding their perception about their pupil's maths intelligence (e.g., "Your pupil's maths intelligence is something about her/him that s/he can't change very much."), while the mothers' statements asked questions concerning their view about their child's maths intelligence (e.g., "Your child's maths intelligence is something about her/him that s/he can't change very much."), and the children's statements asked questions regarding their beliefs about maths intelligence (e.g., "Your maths intelligence is something about you that you can't change very much."; see Appendices D13, D14 and D15). Following Dweck et al. (1995), a total score of the responses to all three of the items was averaged by calculating a mean score using a computed variable. This was done in order to classify participants into two categories: fixed and growth intelligence mindset. Following Haimovitz and Dweck (2016), a higher mean score indicated a strong agreement with a fixed (vs. growth) view of intelligence.

5.3.6 Analytic Approach

In order to prepare the data collected from the pupils, mothers, and teachers for analysis (56 triads in total), the data were first imported from Qualtrics into Microsoft Excel, and then the data documents were cleaned up. Following that, the data was imported into IBM SPSS Statistics (Version 27) and the scores for the negative items on the response orientation scale and failure mindset scale

were reverse coded. After that, the SPSS dataset showed that there were no missing values in the mothers' data, while there were missing values in the data from three participants, specifically the teachers and pupils, as shown in Table 3 of descriptive statistics. Missing data were replaced using multiple imputation in SPSS, and then, since the data were ordinal, the median of the estimated values from 1 to 5 was calculated and used in the subsequent statistical analysis. In addition, descriptive statistics and Cronbach's alpha reliability coefficients were estimated via SPSS. Moreover, McDonald's omega reliability coefficients were run for all of the questionnaires using Jeffreys's Amazing Statistics Program (JASP, Version 0.15).

In order to answer the research questions, Pearson correlations were conducted to identify the relationship between the variables measured by this study – all of which were continuous and treated as normally distributed following the central limit theory (see Altman & Bland, 1995; Pallant, 2003; Elliott & Woodward, 2007; Kwak & Kim, 2017). Moreover, to describe and evaluate the strength of these correlations, Cohen's (1992) effect size interpretations/labels were used: r=.10 to .29, which represented a small correlation, r=.30 to .49, which represented a moderate correlation, and r=0.50 or above, which represented a larger/strong correlation.

Table 3

Descriptive statistics for all variables measured in the current study

Variables		*N*	*MV (NP)*	*SR*	*Min*	*Max*	*M*	*SD*
Mothers' group	MRO	56	0	12-72	2.67	4.58	3.40	.36
	MPO	56	0	6-36	3.00	6.00	4.82	.78
	MLO	56	0	6-36	1.17	4.83	1.98	.83
	MFM	56	0	6-36	2.00	6.00	4.43	1.18
	MIM	56	0	3-18	1.00	6.00	3.20	1.67
Teachers' group	MRO	56	0	12-72	2.33	4.25	3.26	.43
	MPO	56	0	6-36	1.83	6.00	4.57	.89
	MLO	56	0	6-36	1.00	6.00	1.95	.87
	MFM	56	2 (1)	6-36	1.00	6.00	4.20	1.20
	MIM	56	2 (1)	3-18	1.00	4.67	2.42	1.17
Pupils' group	MRO	56	0	12-72	2.33	4.42	3.33	.44
	MPO	56	0	6-36	1.83	6.00	4.41	.97
	MLO	56	0	6-36	1.00	5.83	2.26	.91
	MFM	56	3 (1)	6-24	1.00	6.00	4.22	1.20
	MIM	56	0	3-18	1.00	6.00	3.15	1.46

Note. MRO= Maths Responses Orientation; MPO= Maths Performance-Oriented Responses; MLO= Maths Learning-Oriented Responses; MFM= Maths Failure Mindset; MIM= Maths Intelligence Mindset; MV= Missing value (number of participants with missing data); Min= Minimum score of mean; Max= Maximum score of mean; M= Mean; SD=Standard deviation; SR=Score range.

5.3.7 Reliability Analyses

The reliability of the measures was assessed using two types of reliability coefficients: Cronbach's alpha (α) and McDonald's omega (ω). In the current study, both types of reliability coefficients reported adequate levels of reliability for all of the measures (see Table 4). However, according to the differences between the two types of statistics, only the McDonald's omega values were interpreted. This is because the coefficient Cronbach's alpha has recently faced criticism for indicating scale reliability (e.g., Cronbach & Shavelson, 2004). Indeed, the reporting of McDonald's omega instead of alpha is now encouraged (see Trizano-Hermosilla & Alvarado, 2016; Dunn et al., 2014; Hayes & Coutts, 2020).

As presented in Table 4, McDonald's omega values ranged from .61 to .72 for the performance-oriented responses subscale and ranged from .61 to .79 for the learning-oriented

responses subscale. Additionally, the values for failure mindset scale ranged from .74 to .80, while the values for the intelligence mindset scale ranged from .78 to .94. According to Hair et al. (2016), reliability values ranging from .60 to < .70 are considered to be moderate, and values ranging from .70 to < .80 are considered to be good, values ranging from .80 to < .90 are considered to be very good, values ranging from .90 to < .95 are considered to be excellent, while values of ≥ .95 are considered to be too high.

5.4 Results

5.4.1 Do the relationships suggested in the model created by Haimovitz and Dweck (2017; i.e., shown in Figure 1 in Section 1.7) hold true when this model is statistically implemented for primary maths teachers and mothers?

The results of the Pearson correlations coefficients (*r*) are presented in Table 5. These results indicated that in maths, only the mothers' path was observed. It was found that there was a small positive statistically significant correlation between mothers' failure mindset and their response orientation ($r(56)= .29$, $p= .030$). This indicated that mothers who believed that failure is more harmful and debilitating and does not enhance learning were more likely to react with worry and concern regarding their children's poor performance outcomes, rather than support their children's learning and progress. It was also found that there was a negative statistically significant moderate association between mothers' learning orientation and their children's intelligence mindset ($r(56)= -.35$, $p= .008$), indicating that mothers who reported strong beliefs towards learning-oriented reactions had children who were more likely to endorse more of a growth (vs. fixed) view of intelligence mindset. For the remaining associations presented in Figure 1 and statistically estimated in this paper, there were no statistically significant correlations, notably none among the teachers' group/path (see Table 5). Therefore, it is clear that, in the current study, the relationships suggested in Figure 1 only hold true for the mothers but not the teachers (see Figure 5 for results summary and Figure 6 for mothers' path with their children).

Table 4

The reliability of the scales in the current study and other studies

Variables	N of P [a]	N of items	α [b]						ω [f] - [g]		
			Current study			Haimovitz and Dweck's study (2016)		Dweck et al.'s study (1995)	Current study		
			Mothers	Teachers	Pupils	Parents	Pupils	College students	Mothers	Teachers	Pupils
Performance Orientation	56	6	.59	.70	.64	.79	-	-	.61	.72	.69
Learning Orientation	56	6	.77	.81	.66	.78	-	-	.76	.79	.61
Intelligence Mindset	56	3	.92	.76	.73	-	-	.94 to .98 [e]	.94	.78	.81
Failure Mindset	56	6	.80	.82	-	.78 to .88 [c]	-	-	.76	.80	-
	56	4	-	-	.63	-	.77 [d]	-	-	-	.74

Note. [a] *P= participants;* [b] α= Cronbach's alpha; [c] Over three studies; [d] Pupils' Perceptions of their parents; [e] Over six studies; [f] ω= McDonald's omega; [g] Results not available in any other studies.

Table 5

Bivariate Pearson Correlation Matrix for all variables measured in the current study

Variables	*N*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mother reports																
1. MRO	56	-														
2. MPO	56		-													
3. MLO	56			-												
4. MFM	56	.29*	.17	.10	-											
5. MIM	56	-.10	.13	-.20	-.09	-										
Teacher reports																
6. MRO	56						-									
7. MPO	56							-								
8. MLO	56								-							
9. MFM	56						.10	.12	-.03	-						
10. MIM	56						-.07	-.23	.17	.15	-					
Pupil reports																
11. MRO	56											-				
12. MPO	56												-			
13. MLO	56													-		
14. MFM	56											.05	-.08	.13	-	
15. MIM	56	-.16	.23	-.35**			-.17	-.13	-.04			-.02	.19	-.23	-.17	-

Note. MRO= Maths Responses Orientation; MPO= Maths Performance Orientation; MLO= Maths Learning Orientation; MFM= Maths Failure Mindset; MIM= Maths Intelligence Mindset; *p < 0.05.; **p < 0.01.

5.4.2 Comparing the relationships shown in Haimovitz and Dweck's model (2017; i.e., shown in Figure 1 in Section 1.7) and an expanded version of the Haimovitz and Dweck model (i.e., shown in Figure 4 in Section 5.2), do the additional relationships included in the expanded version improve upon our understanding of what promotes a growth or fixed intelligence mindset in children (aged 10 and 11 years old) beyond that obtained by only considering the relationships in Haimovitz and Dweck's model (2017)?

a. Does any improvement hold true when considering primary maths teachers and/or mothers?

These questions were tested by estimated through Pearson correlation coefficient (*r*) among pupil variables. The results presented in Table 5 reveal that, in maths, there were no statistically significant correlations between the pupil variables. Thus, the additional relationships included in Figure 4 did not help to improve upon our understanding of what promotes a growth or fixed mindset in children beyond that obtained by only considering the relationships in Figure 1 (see also Figure 5 for results summary).

Figure 5

How adults promote children's growth and fixed mindsets (Haimovitz & Dweck, 2017) – correlations for adults were only significant for 56 mothers (cf. teachers' and children's paths) and their children (10-11 years old) in Riyadh, Saudi Arabia

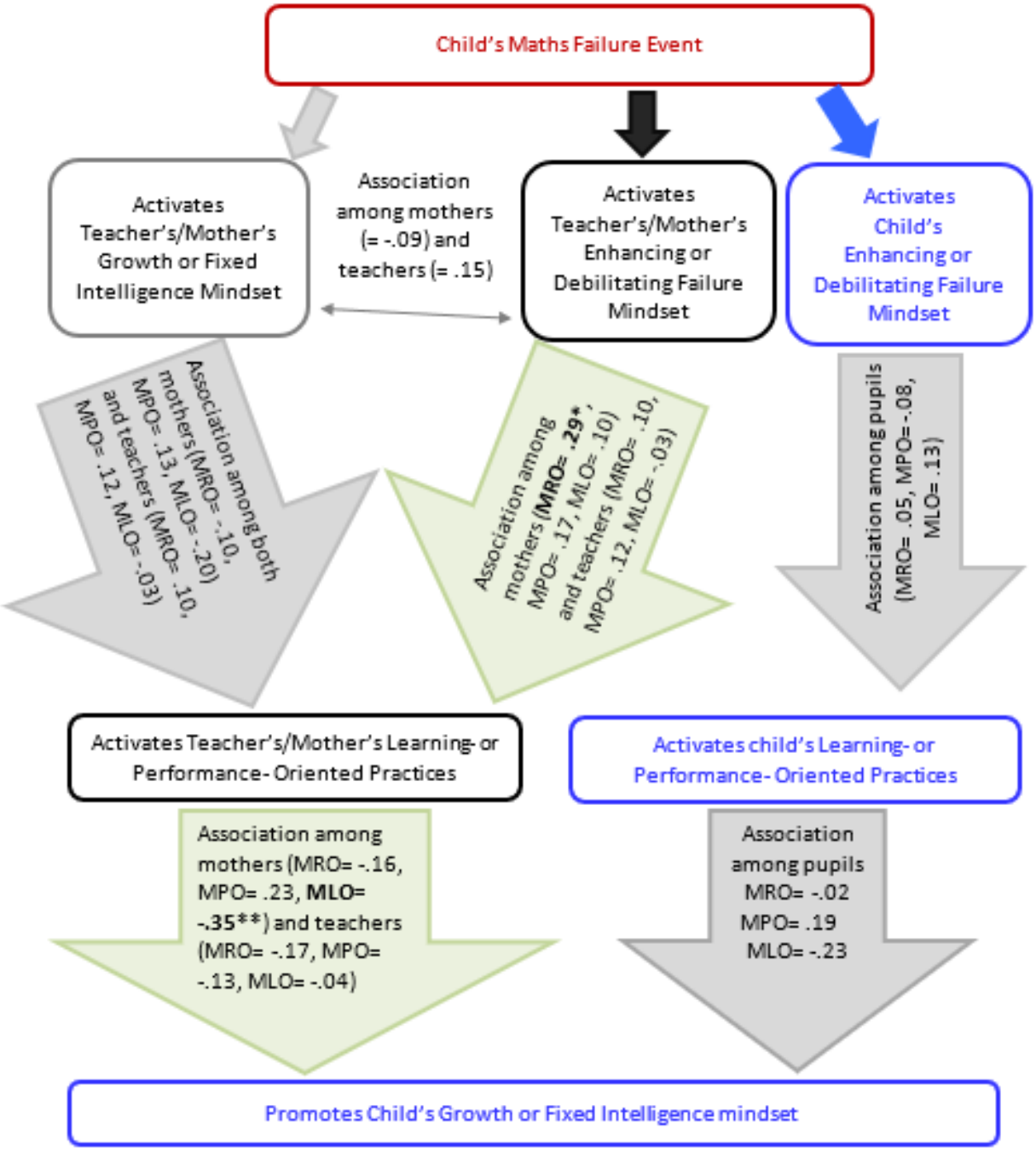
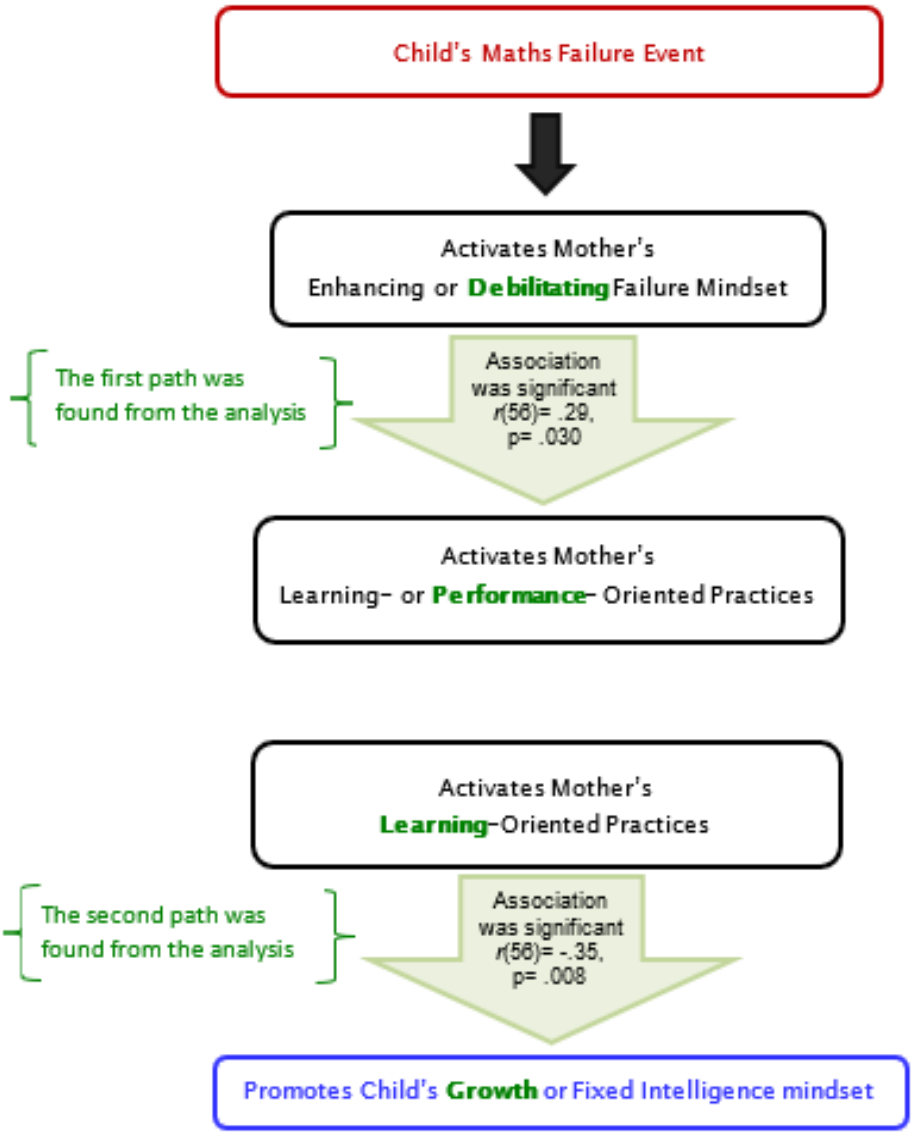


Figure 6

How mothers promote children's intelligence mindsets (Haimovitz & Dweck, 2017) – correlations for only significant for 56 mothers and their children (10-11 years old) in Riyadh, Saudi Arabia



5.5 Discussion

This study aimed to investigate if the relationships suggested in the model by Haimovitz and Dweck (2017), which was developed to explain how adults promote growth or fixed intelligence mindset in children, hold true in Saudi primary populations when investigating both children's teachers and mothers. Moreover, it explored if additional relationships related to children's beliefs (supplementing Haimovitz & Dweck, 2017; compare Figures 1 and 4) improve upon our understanding of what fosters a growth or fixed intelligence mindset in children. Generally, the results of the current study partially validate the model developed by Haimovitz and Dweck (2017), as well as support the motivational framework of implicit theories of intelligence and failure.

With respect to the first research question, the results showed four sets of findings. Firstly, it was found that there was no statistically significant association between intelligence mindset and failure mindset among mothers and teachers. This finding is consistent with that of Haimovitz and Dweck (2016, Study 3a) and Doedens-Plant (2018), who found no significant correlation between teachers' and/or parents' intelligence mindset and their failure mindset. However, this result is inconsistent with those in other studies by Haimovitz and Dweck (2016, Study 1), Jarsky (2020) and Li (2020), who found that there is a positive relationship between parents' failure mindsets and their intelligence mindsets.

Secondly, no statistically significant associations between mothers' or teachers' maths intelligence mindset and their maths responses orientations to a failure scenario were found in this study. These findings are in line with those reported by Haimovitz and Dweck (2016), who, across two studies (i.e., Study 1 and Study 2), found that parents' intelligence mindsets were not significantly related to their children's perceptions of their parents' performance-versus-learning orientation, or even with their self-reported performance-oriented or learning-oriented responses in their child's failure scenario. However, these findings are in contrast to Park et al.'s (2016) results, which presented a positive correlation between teachers who hold a fixed mindset and their performance-oriented instructional practices, and between teachers who hold a growth mindset and their mastery-oriented instructional practices.

Thirdly, in terms of a maths failure mindset, considering the association between adults' failure mindset and their performance orientation only or their learning orientation only, these were found to be unrelated significantly. Surprisingly, the results also revealed that there was a small positive association between adults' failure mindset and their response orientation to a failure

scenario, but it was only statistically significant for mothers (not teachers). This indicated that mothers who believe that failure is a debilitating experience were more likely to react with concern regarding the poor performance and results of their children. In addition, they were less likely to react by supporting their child's learning. This finding is in agreement with the results of Study 1 and Study 2 by Haimovitz and Dweck (2016), both of which demonstrated that parents who endorse a debilitating (cf. enhancing) view of failure had children who were more likely to see their parents react with performance-oriented practices (vs. learning-oriented practices). Furthermore, parents themselves were more likely to respond to the child-failure scenario with performance-oriented responses.

The first three results in this study might be explained by the fact that adults' perceptions regarding intelligence may not be directly linked to their theories about children's motivation, and so their related behaviours may not be consistent with these (Haimovitz & Dweck, 2017). However, that is not to suggest that adults' intelligence theories do not influence their behaviours, and thus in turn, the mindsets of their children in some cases (Haimovitz & Dweck, 2017). In other words, a mother's failure mindset appears to manifest in a visible way in terms of parental concerns and behaviours. This means that their worry and behaviours reflecting this are more evident to their children than the manifestations of their more abstract views concerning the nature of intelligence, which do not often present themselves clearly in their parental behaviours/responses (Haimovitz & Dweck, 2016). In terms of teachers' results, a possible explanation for why there is no obvious associations between teachers (compared to mothers) and their pupils in this study might be because those teachers may find it difficult to translate their beliefs into practices that pupils can observe in the classrooms, especially when those beliefs reflect a view that failure is helpful for their improvement (Doedens-Plant, 2018).

Fourthly, no statistically significant relationships between mothers' or teachers' response orientations to a failure scenario and their children's intelligence mindset were found in the current study. However, there was only a negative statistically significant relationship between mothers' maths learning orientation (not performance orientation) and their child's intelligence mindset, indicating that mothers who reported strong beliefs regarding learning-oriented responses had children who were more likely to hold a more growth (vs. fixed) view of intelligence mindset. This finding is partly consistent with Li's (2020) result, which showed that there were no significant associations between children's intelligence mindsets and their perceptions of parents' learning versus performance orientation. However, this finding is in contrast to those of Haimovitz and

Dweck (2016) and Park et al. (2016) who did find a link between parents' performance-oriented practices and children's fixed mindset. This indicates that parents and/or teachers who react with more performance-oriented responses had children who were more likely to believe that their intelligence is fixed.

The fourth result in this study may be explained by the fact that parents' reactions to their children's poor outcomes or failures may be the most visible and salient response for their children in the face of setbacks and failure, to the point where children may absorb their parents' attitude toward failure (Tao et al., 2022). As a result, how children perceive their parents' failure mindsets can have a significant impact on the beliefs they form regarding failure and intelligence throughout their time in education (Tao et al., 2022). Another possible alternative explanation related to teachers' findings in this study might be that this study involved teachers and pupils in maths classes during the 2019/2020 academic year, however, participants' measures were first collected at the end of the first semester of the 2020/2021 academic year, thus, the influence of former teachers from the previous academic year (i.e., 2019/2020) may have faded during their following year (i.e., 2020/2021) because pupils might have had different/new teachers. This may especially be true given the fact that education was suspended and schools were closed after around seven weeks into the second semester of the 2019/2020 academic year due to the Covid-19 crisis. Consequently, all of the pupils moved to the next grade earlier than usual, which certainly affected the interaction between them and their teachers, and thus, reduced the impact their teachers had on them.

With respect to the second research question, the results demonstrated three sets of findings. Firstly, the results revealed that in maths, pupils' failure mindset was not associated with their response orientation to a failure scenario, nor with their performance orientation or with their learning orientation. Secondly, the findings demonstrated that pupils' response orientation, whether performance orientation or learning orientation, were not statistically significantly related to their intelligence mindset. Thirdly, the results of this study also showed that pupils' failure mindset was not statistically significantly correlated with their intelligence mindset. This finding is in line with Tao et al.'s (2022) result, which found that students' failure-is-debilitating mindset did not affect their fixed intelligence mindset. However, this result is inconsistent with those of Li's (2020) results, which presented a significant association between children who view failure as enhancing and have a growth intelligence mindset. That is, there was a significant prediction between children's belief that intelligence can be grown and their view that failure is enhancing experience.

A possible explanation for the lack of statistically significant correlations between pupils' intelligence mindsets and their other variables may be due to the fact that there are other external motivational processes and factors which might be more closely related to the pupils' beliefs about intelligence than their other own beliefs. As discussed earlier, it might be parental responses to their child's poor or failing outcomes that may be the most tangible and salient to their children, and therefore make it possible for their children to internalise their parents' practices towards failure in the event of struggling challenges and failing performance in a way that can play a significant role in determining how these children view failure and intelligence during their schooling (Tao et al., 2022).

Finally, it is necessary for parents to recognise the importance of fostering a growth mindset in their children from an early stage, in order to build their motivation, as this could help to improve their children's achievement in maths. An increase in pupils' motivation is likely to not only be reflected by an improvement in pupils' maths assessments results at school (see Section 1.6), but will also benefit them in the future, specifically at the end of their secondary education when they have to pass at least one of two assessments to pursue their higher education at the university in the KSA. These two assessments are the General Aptitude Test and the Academic Achievement Test for Scientific Specialisations, which both includes a maths section (KSA ETEC, n.d.-a, n.d.-c). Therefore, the present results have important implications in the context of family settings. That is because the results of this study suggest that mothers' beliefs and practices play a key role in influencing their children's mindsets, and thus, parental awareness regarding the effect of their beliefs, messages and behaviours on their children should be brought to the awareness of schools and the Saudi MOE, as well as parents. However, it is possible that teaching parents to develop a growth mindset and then expecting them to convey this to their children is not enough (Haimovitz & Dweck, 2016). Thus, providing parent-support programmes that focus on parents' failure mindsets and that highlight how a child's failure could be useful, as well as ways in which a child's setbacks can be responded to by parents in order to keep children motivated may also be beneficial (Haimovitz & Dweck, 2016).

Furthermore, teaching students in Saudi Arabia after the Covid-19 crisis has changed, as it no longer only based around face-to-face teaching, but also incorporates distance learning. Consequently, parents across all SES have had to learn how to use educational technologies and applications to help their children complete their education. Therefore, another possible implication of the findings regarding mothers is that it may be useful to provide online courses, workshops and/or activities for them to access in their spare time, in order to educate them and increase their

awareness of how to deal with the challenges their children face in their learning. However, it is important that these courses guide parents to place more emphasis on the value of mistakes and failure when interacting with their children, that is, helping them understand that making mistakes might be a way to learn and a crucial time for brain development, so their children appreciate making mistakes as providing a learning opportunity to improve their academic performance (Su et al., 2021). Moreover, it would be helpful/useful for the MOE in the KSA to urge schools to encourage parents to take advantage of the free online tools available to them. For example, some of these tools include the "Project for Education Research That Scales" website, PERTS.net, which is an online resource that provides free educational materials to support a growth mindset framework, and the "Mindset Work" website, mindsetworks.com (Brougham & Kashubeck-West, 2018), which also provide free resources for learners of different ages and educational stages to develop a growth mindset (Mindset Works, Inc., n.d.). These would be beneficial for parents, especially those who work, because their working hours may be at the same time as their children's school hours. Moreover, the benefit of these tools is not only limited to mothers, but it may also benefit fathers who are responsible for educating their children.

5.6 Strengths, limitations and future directions

A key strength of the present study was that it builds on the previous research conducted by Haimovitz and Dweck (2016), and to the best of the researcher's knowledge, this study is the first to test the hypothesised model regarding how adults promote children's growth and fixed mindsets (Haimovitz & Dweck, 2017). The second strength of this study is that it is the first to look at these relationships in a non-Western cultural context. A third strength is that it investigated the impact of both teachers and mothers on children's beliefs. A fourth strength is that it also considered the relationships between children's beliefs and academic abilities – not just the beliefs of adults. A fifth strength is that this study takes into account the recommendations of Dweck et al. (1995) and Dweck (2000), as it avoided using a binary measure of intelligence mindset and only used three items of the fixed intelligence mindset (not growth mindset; see Section 5.3.5.3). Utilising growth mindset items demonstrated that the items are very compelling, thus increasing social desirability bias (see Hong et al., 1999).

However, a number of important limitations need to be considered. Firstly, only teachers who taught pupils in one academic year (i.e., 2019/2020) were surveyed, and teachers of the following year (2020/2021) were not included. This is a limitation of this study because the teachers

from the 2020/2021 year may have had an impact on the pupils' mindsets, yet this is not accounted for in this study. Additionally, the current study only included mothers, so future studies should seek to incorporate data from further sources such as pupils' fathers, their peers and other teachers in the same academic year.

Secondly, only pupils in their fifth and sixth grades were included in this study, and accordingly, more research is needed to develop a deeper understanding of the relationships between the three concepts within different age groups and at different levels of education.

Thirdly, the sample only included pupils drawn from public schools, thus, future research could target pupils from different types of schools such as private schools, international schools and special education schools.

Fourthly, the present study narrowed its focus to only include pupils' experiences of studying mathematics. Consequently, it is not possible to generalise the findings to other academic subjects. Hence, it would be interesting to investigate these concepts and their associations in different academic subjects.

Fifthly, surveying adults and children at one point in the year only provides a snapshot of the relationships investigated in this paper and does not allow for any exploration of any potential changes in a teacher's or parent's influence on his/her pupil/child over the school year. Therefore, it would be beneficial to conduct longitudinal research to follow children's beliefs at the beginning, periodically throughout the academic year, and again at the end of the academic year, to fully determine how adults impact their children's beliefs.

Finally, this study focused on family and school contexts and took place in a single country (Saudi Arabia), and therefore, it is suggested that the association of these factors requires further investigation in different countries and cultures.

5.7 Conclusion

This study set out to investigate the influence of teachers' and mothers' implicit theories of intelligence and failure on their response orientations to a maths failure scenario, and how these beliefs and practices, in turn, may affect children's implicit theories of intelligence in mathematics. This is the first study to examine the associations between these three concepts among teachers, mothers, and children, and the first to do so both in Saudi Arabia and in a non-Western Culture. The

current study suggests that it is the mindsets and responses of mothers, not teachers, that influence children's beliefs about their maths abilities. These findings contribute to our understanding of how children's intelligence mindset in maths is and can be shaped, and thus provides a basis for further research.

Chapter 6 Discussion

This chapter begins with key findings of the thesis. Then, the thesis's strengths, limitations, and directions for future research are provided. Finally, the implications and conclusion of the thesis are given.

6.1 Discussion of the main findings

The MOE cooperates with the ETEC to provide national assessments, as well as participate in international assessments, in order to evaluate the educational level of students in the KSA compared to students from other countries. However, to date, all of these assessments have shown that students are below average in maths (see Section 2.6). Maths is considered a core subject at all stages of education in the KSA. Moreover, students at the secondary education stage who intend to continue their education in higher education institutions have to pass "the General Aptitude Test" (KSA ETEC, n.d.-c). Furthermore, if they would like to continue their studies in scientific fields, they also have to pass a second assessment called "the Academic Achievement Test for Scientific Specialisations" (KSA ETEC, n.d.-a). Both of these tests contain a maths part (KSA ETEC, n.d.-a, n.d.-c). Therefore, in line with the Saudi Vision 2030 and the objectives of the MOE, which seeks to develop educational quality in order to improve students' knowledge and skills (see Section 2.4), there is an urgent need to look for the possible causes of students' poor outcomes in maths and find solutions for them. Students' level of motivation and beliefs about their abilities in maths might be two of the main factors that impact students' results in maths.

In the past, many studies identified a positive correlation between learners' intelligence mindsets and their motivation, learning and academic achievement (see Section 1.6). Therefore, later research aimed to explore the factors that can shape and affect the intelligence mindsets of learners. Some of these studies investigated how teachers' mindsets impact their students' mindsets and achievement, while others explored the impact of parents on their children (see Section 1.7). However, to the best of the researcher's knowledge, none of these studies ever took place in Saudi Arabia. Thus, to address this gap, this thesis aimed to extend the literature by first investigating the correlation between teachers' mindsets and their students' mindsets in primary and secondary schools. Then, it sought to explore the role played by teachers and mothers in shaping their pupil's and children's intelligence mindsets related to mathematics in primary schools in Saudi Arabia. Accordingly, in order to achieve the goals of the current thesis, three different types of methods

were used across three papers, specifically: a systematic review, a qualitative study and a quantitative study.

It's important to keep in mind that this thesis was designed to test Haimovitz and Dweck's (2017) hypothesised model using both qualitative and quantitative methods. This model suggested that adults' implicit theories of intelligence and their beliefs regarding how to motivate children are evident in adults' responses and practices towards their children's successes or failures, and thus, foster children to hold either more growth or fixed mindsets. That is, children may come to conclusions about their potential to improve their mathematical skills and abilities as a result of adults' reactions to them. Consequently, adults' beliefs and/or practices reported by them will be linked to the practices and beliefs mentioned in the literature that could lead to them either delivering a growth mindset, conveying a fixed mindset, or communicating a mixed mindset to children. Although few studies have been conducted in this area, the studies that are available give us an idea of the influence adults' theories have on their responses and reactions, and thus, cause children to endorse more of a growth or fixed mindset.

Study 1 in this thesis, presented in Chapter 3, was a systematic review that aimed to investigate the association between qualified maths teachers' baseline intelligence mindsets and their students' maths achievement in primary and secondary schools. A search was made using five databases and the seven studies identified were featured in the systematic review. Overall, the evidence from these studies was mixed. A positive relationship between qualified maths teachers' growth intelligence mindset and students' higher scores in maths achievement in three studies (i.e., Schullo & Alperson, 1998; Hubacz, 2013; Bostwick et al., 2020) included in that review was found. The results of this review are in agreement with those of Zhang et al.'s (2017) review, which reported that teachers' mindsets, whether as a cause or a mediator, were associated with their students' academic achievement. Moreover, the findings from this review were also consistent with those of Cunningham and Farmer (2016), who demonstrated that teachers' beliefs collectively included self-efficacy, collective-efficacy, intrinsic motivation, extrinsic motivation, and growth mindsets were associated with students' overall academic achievement. These results are also in line with Star et al. (2014), who found that students who participated in a growth mindset intervention group guided by their teachers improved their achievement in maths. Similarly, Anderson et al. (2018) and Bonne and Johnston (2016) reported that, compared to pupils in the control group, pupils whose teachers had previously received a professional development intervention, including the growth mindset concept, increased their achievement in maths.

A possible explanation for the above result might be that teachers who believe that intelligence can be grown and developed are likely to deliver this view to their pupils and support their progress, despite prior failures or successes (Balzer, 2014). Moreover, teachers who hold a growth mindset might translate their belief through positive practices and master the material they are teaching, and this may reflect positively in their students' achievement in mathematics (Bostwick, 2020). This result may also be explained by the fact that the relationships between teachers' mindset and their students' academic achievement might represent the "theory of action" highlighted by Sun (2019). This theory explains that maths teachers' mindset might be reflected in their educational practices with their students, leading to the possibility of them conveying mindset messages to their students about their ability (Sun, 2019). Subsequently, this impacts their beliefs concerning their ability, that is, if it is changeable or unchangeable, which in turn, influences their academic achievement (Sun, 2019). Indeed, many studies in the literature consider the role of teachers' and students' mindset on their students/own academic achievement in maths (see Sections 1.6 and 1.7).

Yet, in contrast to the three studies showing a positive correlation between teacher's intelligence mindset and student achievement reported in the review, four studies (Gadeyne et al., 2006; Balzer, 2014; Jones, 2016; Chiarelli, 2018) showed no significant relationships between maths teachers' intelligence mindsets and students' achievement in maths. Nevertheless, Balzer (2014) observed a significant positive relationship between maths teachers' growth intelligence mindset and students' yearly progress in maths, specifically among students who were economically disadvantaged. The above finding is in agreement with Star et al.'s (2014) results, who reported that although they did find that students achieved better results in maths as a consequence of an intervention led by their teacher, they uncovered no relationship between students' maths test scores and their teachers' mindsets concerning their maths ability. In addition, this result is consistent with those of Dommett et al. (2013), Tecker (2017) and Orosz et al. (2017), who all found that students' maths achievement did not increase as a result of attending an intervention designed for both students and their teachers. These findings are also in line with those of Seals (2018) and Rienzo et al. (2015), who reported that pupils whose teachers attended a growth mindset intervention did not improve their achievement in maths. A possible explanation for this might be that the effects of this on students' achievement may take longer to manifest (Dommett et al., 2013).

The results of Study 1 (i.e., the systematic review) led to further investigations to gain a detailed understanding of the role of maths teachers' intelligence mindsets and practices on their students' maths achievement by employing a qualitative study, which is presented in Chapter 4. This study aimed to explore the views of 30 primary school maths teachers regarding their beliefs and classroom reactions to their pupils' maths achievement and failure in Riyadh, Saudi Arabia. According to the teachers' views, five main themes were formulated from the analysis: teacher beliefs about (1) the impact of national policy on maths education, (2) the importance of the school's ethos and provision of adequate resources, (3) classroom teaching strategies and behaviours (4) teachers' beliefs about their pupils, and (5) parents and parent-school engagement.

Teachers were pleased with the Ministry's updates to the curriculum and the inclusion of real-life examples and exercises to develop higher-order thinking skills, as they expressed the belief that they motivate pupils to interact more with the material. Moreover, this new way of presenting the lessons in the textbook is considered to be interesting for pupils. A possible explanation for this might be that linking mathematics lessons to real life, such as giving mathematical problems related to their lives (e.g., buying and/or selling maths problems) with different levels of challenge may make it easier for pupils to understand mathematics concepts and motivate them more to turn to solve these problems in the practical exercises section of their textbook, which thus reflected positively on students' achievement.

On the other hand, teachers reported several factors that had a detrimental impact on the effectiveness of their teaching and certain pupils' learning, which included having: a large number of pupils with different levels of abilities in one classroom and only 45 minutes a day to teach them, a large number of classes to teach every week, a lack of supplies, materials and resources at their schools. These findings are supported by other previous studies which found that these three factors might be the issues that negatively affected their capability to teach the maths curriculum to their pupils (e.g., Alharbi & Almatham, 2013; Ali & Abdulhakim, 2013; Alaomry et al., 2013; Ezz Aldeen & Subahi, 2014; Hassan & Hamid, 2014; Rayyani, 2018). Indeed, Alsubaie and Alghamdi (2020) reported that in the KSA, schools often lack equipped laboratories and had large class sizes, which led students to perform poorly in international maths exams such as the TIMSS exam in 2015.

A possible explanation for the above results might be the fact that a large number of state primary schools in the KSA are either rented, on loan or old. That is, these schools may not be adapted to suit the number of pupils or their educational needs in terms of the resources and equipment needed to improve their learning, which could significantly contribute to the poor

academic achievement of pupils. Indeed, in terms of primary schools in Riyadh in the academic year 2018-2019, there was one boy's school on loan and 153 rented boys' schools, while there were 2 girls' schools on loan and 117 rented girls' schools (see Appendix C14 for more details). For example, Alghamedi (2010) compared Saudi schools' characteristics to those in China and Singapore, whose pupils performed well on the TIMSS test in 2007 and found that schools in these two countries were larger and more modern than those in Saudi Arabia.

Teachers reported that pupils' achievement was positively impacted by their school's motivation methods used by leadership teams such as providing motivational incentives and prizes. This finding is consistent with Almalki's (2018) results, which reported that according to the Saudi primary teachers who participated in the study, the encouragement from their school's leadership team was one of the factors that positively encouraged and motivated pupils, and thus, improved their achievement in maths. A possible explanation for this is that the use of extrinsic motivation by school administrators, for example, honouring and/or awarding pupils in front of their classmates, might have a positive psychological effect on pupils and motivate them to do better. This was confirmed by Alsilami (2020), who found a positive association between students' level of motivation and their GPA in maths.

Moreover, the majority of the teachers emphasised the significance of the pupils' mathematical foundation and stated that a strong foundation had a beneficial impact on pupils' achievement, whereas a poor foundation was considered a factor that led pupils to perform poorly in maths. Additionally, the majority of interviewees stressed the importance of pupils' feelings in their academic learning. To clarify, they said that pupils' love or hate of maths or the teacher was a factor that impacted pupils' achievement. These views are consistent with the findings of previous quantitative studies, which reported that, from maths teachers' viewpoints, one of the key issues that might negatively affect pupils' maths performance in the KSA is their negative attitudes towards maths and/or their belief that maths is a difficult subject (Ali & Abdulhakim, 2013; Alsaedi, 2015; Shahadah & Alkaramiti, 2016; Aldosary & Alrawis, 2018). These findings are consistent with teachers' beliefs that pupils who love maths will work hard to succeed, but pupils who detest maths will not even attempt to do well. Indeed, in a Saudi context, it was a positive relationship between boy students' attitudes towards maths and their achievement in maths (Albabtain, 1991).

It was also reported by the interviewers that self-motivation affected pupils' attainment. Teachers claimed that pupils with high levels of intrinsic motivation were more likely to succeed in maths, whereas those with low levels of intrinsic motivation typically performed poorly. This result is

in keeping with Alaomry et al.'s (2013) quantitative findings, which reported that a large percentage of maths teachers agreed that the motivation of students to learn mathematical concepts was one of the key issues that impacted pupils' success in maths at the primary stage in the KSA. This result may be explained by the fact that intrinsic motivation refers to behaviour which is driven by fun or the thrill of a challenge, and not due to extrinsic motivation such as pressures or rewards (Ryan & Deci, 2000). Therefore, pupils' maths achievement might be positively affected if they have a high level of intrinsic motivation. Indeed, Xiao and Sun (2021) reported that students with the highest instrumental motivation levels and the lowest math anxiety showed the highest achievement and levels of persistence in maths. Moreover, Broussard and Garrison (2004) found that there was a positive association between children's levels of mastery motivation and their maths grades.

A further factor reported was the positive influence of parents who took an interest in their child's learning, worked with their child's teacher and encouraged their child to behave excellently, as the majority of teachers stated this had a beneficial impact on the child's achievement. Teachers also commented that parents who did the opposite, on the other hand, frequently witnessed a detrimental impact on the child's performance. These results reflect those of quantitative studies in the Saudi context, which showed that poor follow-up from the families was one of the greatest challenges that maths teachers faced, according to their view (Alharbi & Almatham, 2013; Aldosary & Alrawis, 2018). In addition, this finding is in keeping with Almalki's (2018) quantitative results, which found that parents following up on their children played a key role, as it helped them to improve their achievement according to Saudi primary teachers' point of view.

Teachers also described the educational practices they utilised in their classroom, which would appear to provide mixed mindsets messages to their pupils. To illustrate, they employed practices that promoted a growth intelligence mindset in math at times, but also acted in ways that might foster a fixed intelligence mindset at other times. Additionally, some of their practices that they used sometimes might deliver mixed mindsets messages to their pupils. Teachers mentioned practices they used in their classroom with their pupils which were more likely to foster a fixed mindset in them, according to the mindset literature. For example, they explained that they linked high scores in maths to the achievements of geniuses or excellent pupils. They also mentioned that they sought to increase the confidence of pupils who had low self-confidence in themselves by giving them an easy question to answer or giving a pupil who raised their hand to participate first priority. According to the MTMF, teachers may use these practices in order to motivate pupils to participate and so boost their self-confidence but doing so repeatedly may encourage pupils to avoid

difficulty and failure, sending them messages that are indicative of fixed mindsets (Sun, 2018). Rattan, Good, et al. (2012) provided evidence that showed that instructors who adopted a fixed (vs. growth) intelligence mindset comforted their pupils about their poor maths capacity and utilised practices that did not encourage pupils' engagement. This finding is also in agreement with a study by Sun (2019), who reported that math teachers urged their pupils to follow the procedures instead of letting them come up with their own procedures, sending a message to students that represented fixed mindset feedback, according to the MTMF.

A further practice described by teachers was related to their methods of announcing pupils' marks, which were varied. While some of them reported that they handed each pupil their results separately or asked pupils if they would like their marks to be announced or not, others mentioned that they either announced the results of all their pupils or solely pupils who obtained average or excellent results. Moreover, they said that they displayed the best pupils' activities on the classroom wall. However, by doing this, teachers may cause pupils performing poorly to lose confidence in their abilities, which in turn could result in them putting in less effort to learn and improve their abilities, ultimately causing them to develop more of a fixed mindset about their maths abilities. These findings are in agreement with Sun's (2018) results, which reported that some teachers publicly recognised their pupils who had consistently performed well, and thus, inadvertently conveyed a fixed mindset message to the pupils concerning their ability in maths, because it appeared that those pupils performing poorly would not be included on the list.

Some teachers believe that pupils' fixed abilities can impact their performance in maths. They claimed that while having low skills or learning difficulties in maths is likely to hinder pupils' performance in maths, having high levels of abilities, such as intelligence, assists pupils to achieve in math. This belief may be evident in teachers' practices and their feedback, which could result in some of their pupils believing that they cannot improve their abilities, thus negatively affecting their motivation and education. Indeed, according to the MTMF, teaching pupils that their maths ability is an innate or fixed ability delivers a fixed mindset message to them (Sun, 2018). A similar finding was presented by Sun (2018) who found that one example of a teacher who assumed that only a small number of students would be able to keep up with the pace of the advanced class, which may have transmitted a fixed mindset message to those students.

Contrary to the above teaching practices that might be sending fixed mindset messages and instruction to their pupils, some teachers highlighted the value of effort and how they pushed their pupils by providing an example of a successful person who had initially struggled. They also urged

their pupils to try again when they made mistakes in their task. This kind of instruction may inspire pupils to grow and learn, which is aligned with a growth mindset. This finding is consistent with those mentioned by Sun (2018, 2019), who found that some maths teachers who acknowledged and accepted their students' mistakes, connected them to learning, and explored them helped their students, as, according to the MTMF, this might send a growth mindset message to students. These results are in agreement with Sun's (2019) findings which showed that teachers who valued the importance of struggle were promoting growth mindset, from the viewpoint of the MTMF.

Another practice described by teachers and classified according to the literature as delivering growth mindset messages is giving pupils more chances to try to address a problem and helping them to learn new skills to achieve something, whether by reviewing any difficult concepts with pupils in a class or by giving them private classes. Similar to these practices used by teachers who participated in this study, it was also shown by Sun (2018, 2019) that teachers who frequently gave students extra help and several chances to submit the work again were more likely to convey a growth mindset to students regarding their mathematical capability. One of the strategies that teachers in this study also claimed they utilised in their instruction was consistently challenging pupils. That is, they gave their pupils different levels of difficult problems to solve or incited competition among them, whether in or outside the classroom. According to the MTMF, when teachers support pupils to take risks in maths and consider it worthwhile, as well as encourage pupils to improve their ideas and test them, it helps to foster a growth mindset among pupils (Sun, 2018).

Teachers also mentioned the language that reflected explicit mindset messages. However, since some of these messages were neutral, this means that teachers delivered mixed mindset messages to their pupils. This finding is in line with Sun's (2019) results, which found that although teachers employed some explicit growth mindset messages with their students, these messages were essentially neutral in content and did not present a multi-dimensional perspective of maths, and thus they ultimately delivered mixed mindset messages to pupils, according to the MTMF.

Regarding practices that might communicate a growth mindset to pupils, as shown in the mindset literature, the majority of teachers described that they employed different types of auxiliary methods to help their pupils with their learning and progress. Peer teaching and evaluation and collaborative learning, that is, dividing pupils into mixed-ability groups and assigning a specific role to each member that changes periodically, were strategies that were frequently employed by the majority of teachers interviewed. These results are in accordance with Alkhamaiseh's (2012) study,

as the teachers at primary and middle schools in the KSA involved in their study also emphasised the importance of using a cooperative learning strategy in their teaching. However, teachers should be cautious because this approach may give their students mixed mindset instructions and messages, which could encourage either a more fixed or growth mindset to develop. Although these educational methods can occasionally be effective, particularly with pupils who perform poorly, they should still be used with caution. Evidence of this was shown in Sun's (2018, 2019) studies, which reported that teachers who divided students into heterogeneous groups may have sent mixed mindsets messages to their students, according to the MTMF. On the contrary, Francome and Hewitt (2020) found that both teachers and students from schools that had mixed-maths attainment classes were more likely to endorse a stronger growth mindset than those from classes divided into sets.

Since teachers had previously witnessed the effects of praise and rewards on pupils' performance, all of them strongly believed that these two practices played a valuable and effective role in motivating a pupil to make additional progress. Teachers stated that they thanked and rewarded their pupils in various circumstances, as well as gave either general praise, praised their abilities or praised the methods and strategies that they used. They clarified that they sometimes gave learning praise, including praising pupils' effort and hard work, while at other times they provided performance praise such as praising pupils' correct answers. However, giving general thanks and praise has largely lost its meaning and is therefore unlikely to help pupils perform better. Indeed, the MTMF have stated that praising pupils in specific situations, including for achieving good results, answering quickly, providing the correct answer or for following the steps accurately, do, in fact, convey fixed mindset messages (Sun, 2018). This is due to the fact that praise for intelligence seems to teach pupils to infer their ability from their performance rather than their effort (Mueller & Dweck, 1998), which contributes to the development of a fixed mindset. Mueller and Dweck (1998) provided evidence from six studies that pupils who had their intelligence recognised/praised after they had succeeded cared more about performance goals than learning goals and were more likely to develop a fixed mindset than pupils who had their effort praised. Therefore, based on the MTMF, when teachers praise both their students' processes and outcomes it may communicate mixed mindset messages to their students (Sun, 2019). In terms of rewards, Stipek et al. (2001) found that fixed-minded maths teachers viewed scores and extrinsic rewards as useful strategies to motivate students to make an effort and participate in activities.

Therefore, the findings reported in Study 2 showed the importance of the role of teachers' and parents' beliefs and practices on their pupils'/child's learning and beliefs. It also highlighted the

role of pupil factors on their learning. Accordingly, this led to an additional exploration of the associations between adults' intelligence and failure mindsets, practices and responses and their children's tendency to adopt more of a growth or fixed mindset using a quantitative study, which is presented in Chapter 5. This study aimed to investigate if the associations proposed in the model developed by Haimovitz and Dweck (2017) explain how adults promote a growth or fixed intelligence mindset in children, and if this holds true in the primary school population in the KSA. Thus, the study included both the children's teachers and mothers (56 triads in total). In addition, it explored if the expanded version, which includes additional associations related to children's beliefs (supplementing Haimovitz & Dweck, 2017; compare Figures 1 and 4), improves upon our understanding of what fosters a growth or fixed maths intelligence mindset in children.

With regard to adults' relationships, among all of the associations suggested in Figure 1, surprisingly, the results showed that only two significant relationships were observed between mothers (not teachers) and their children (see Figures 5 and 6). Firstly, no significant relationships between intelligence mindset and failure mindset among both mothers and teachers was found. This study supports evidence from Haimovitz and Dweck (2016, Study 3a) and Doedens-Plant (2018), who also reported no significant relationship between teachers' and/or parents' failure mindset and their intelligence mindset. Nevertheless, this result is in contrast with those of three other studies, specifically by Haimovitz and Dweck (2016, Study 1), Li (2020) and Jarsky (2020), which demonstrated that there is positive association between parents' failure mindsets and their intelligence mindsets.

Furthermore, the result from this study showed that there was no statistically significant relationship between mothers' or teachers' maths intelligence mindset and their maths response orientations to a maths failure scenario. These findings support those from two studies by Haimovitz and Dweck (2016, Study 1 and Study 2), whose results showed that parents' intelligence mindsets did not significantly correlate with their children's perceptions of their parents' performance-versus-learning orientation or even with their self-reported performance-oriented or learning-oriented responses in a scenario describing their child's failure. Yet, these results are inconsistent with Park et al.'s (2016) findings, which found a positive association between teachers who adopted a fixed mindset and their performance-oriented instructional practices, as well as between teachers who adopted a growth mindset and their mastery-oriented instructional practices.

The current study also found that there were no significant associations between mothers' or teachers' failure mindset and either solely their performance orientation or solely their learning

orientation. What is surprising is that this study found a small positive relationship between mothers' (not teachers) failure mindset and their response orientation to a failure scenario. That is, mothers who viewed failure as a debilitating experience were more likely to respond with concern about their child's poor achievement results and less likely to respond by supporting their child's learning. This result is in the line with the results of two studies by Haimovitz and Dweck (2016, Study 1 and Study 2), which both reported that parents who adopted a debilitating (cf. enhancing) view of failure had children who were more likely to see their parents react with performance-oriented practices (vs. learning-oriented practices), or self-reported they were more likely to hold performance-oriented practices relative to learning-oriented practices.

Moreover, this study found that there were no significant correlations between adults' (mothers and teachers) response orientations to a failure scenario and their children's intelligence mindset. Yet, there was a negative significant association between mothers' (not teachers') maths learning orientation (not performance orientation) and their children's intelligence mindset. That is, mothers who reported strong beliefs concerning learning-oriented responses had children who were more likely to believe that intelligence can be developed. This result is partly in accordance with an earlier study by Li (2020), who found that there were no significant relationships between children's intelligence mindsets and their perceptions of parents' learning versus performance orientation. Nevertheless, this finding is inconsistent with those of Haimovitz and Dweck (2016) and Park et al. (2016), who reported a relationship between parents' performance-oriented practices and children's fixed mindsets. That is, parents who responded with more performance-oriented responses and teachers who responded with more performance-oriented instructional practices had children who were more likely to hold a fixed intelligence mindset.

All of the results given above from the quantitative study can be attributed to the fact that, in some cases, parents' failure mindsets (compared to intelligence mindsets) were often reflected in their reactions and responses, and this was generally evident to their children (Haimovitz & Dweck, 2016). Another possible explanation for this is that parental responses to their child's poor performance or failure may be the most tangible and salient evidence for a child of their parent's attitude to this (Tao et al., 2022). Consequently, students may internalise their parents' attitude towards failure (Tao et al., 2022). Thus, how children regard their parents' failure attitudes can play a significant role in shaping how they view failure and intelligence as they progress through their education (Tao et al., 2022). In addition, a possible reason for the absence of any significant relationship between maths teacher variables (compared to the mother variable) and their pupils in

this study could perhaps be due to teachers finding it difficult to show their views in a visible way through their reactions to and practices with their pupils, particularly when those views convey the message that failure is useful for their improvement (Doedens-Plant, 2018).

Additionally, it seems possible that since the teachers who took part in this study were the participating pupils' former maths teachers from the previous academic year (i.e., 2019/2020), their influence had possibly waned during the following year (i.e., 2020/2021). This is particularly true given that, because of the Covid-19 pandemic, education was interrupted, and schools were closed after around seven weeks into the second semester of the 2019/2020 academic year. As a result, all of the students moved up to the next stage earlier than usual, and this influenced the interaction between teachers and their pupils, in short, by reducing the impact those teachers had.

The results of the current study also revealed that among the relationships between pupils' variables suggested in Figure 4, no significant associations were found between them. That is, pupils' response orientations, performance orientation or learning orientation were not found to be related to their failure mindsets or their intelligence mindsets. This result is consistent with Tao et al.'s (2022) finding, which showed that students' failure-is-debilitating mindset did not impact their fixed mindset regarding intelligence. Nevertheless, this result is in contrast to Li's (2020) findings, which showed that children who believed that failure enhanced learning were significantly more likely to believe that intelligence can be grown and developed. The possible explanation for this may be that children at this stage of their education were unlikely to have experienced challenging situations and/or failure in their education. Therefore, their views about failure remain unformed and they lack the strategies to manage and respond to these experiences. This is particularly the case for pupils studying in primary schools in Saudi Arabia, as until recently, continuous evaluation was the only form of assessment (see Section 2.5). Consequently, if a pupil did not pass on the first attempt, they had several opportunities to succeed later, thus they were unlikely to experience failure or see their classmates fail. As a result, some individuals were not concerned about studying for and/or failing an exam and did not move to the next grade, because they were aware that they would have another chance to try again. Another possible explanation for this result is the fact that there are other external motivational methods and factors that may be more closely associated to and shape pupils' beliefs concerning intelligence than their beliefs about themselves. Indeed, as previously mentioned, parental reactions to their children's poor or failing results might be the most tangible and salient evidence of this for their children, making it possible for their children to internalise their parents' practises towards failure in the event of a challenge and/or poor performance in a way that can play

a significant role in determining how these children view failure and intelligence during their schooling (Tao et al., 2022).

Overall, the findings of the current thesis partially validate Haimovitz and Dweck's (2017) model, as well as the motivational framework of implicit theories of intelligence and failure. To sum up, the results of the current thesis demonstrated that the practices and teaching methods that teachers used in their classroom in Saudi Arabia can send growth, fixed or mixed mindsets to their pupils about their ability in maths. The findings also provided evidence that mothers' motivational theories (i.e., failure mindsets) related to their responses and reactions can cause their children to adopt either a more growth or fixed mindset about their ability in maths.

6.2 Strengths, limitations and future directions

The present thesis contains a number of strengths. The first strength is that the current thesis includes three cohorts, specifically, children and their mothers and teachers, who all featured in the third quantitative study. This is unusual, since there are few studies that have measured the effectiveness of both teachers and parents together, with most either focusing on teachers or parents. In addition, the samples of both the qualitative and quantitative studies were randomly selected and covered different areas and a large number of schools and neighbourhoods in the city of Riyadh, Saudi Arabia, which increased the external validity of the findings. That is, the qualitative study included 24 primary schools and the quantitative study included 56 primary schools, making a total of 80 state primary schools in Riyadh, Saudi Arabia included in the study.

The second strength of this thesis is that it includes both genders, both within the teacher sample and pupil sample. In Saudi Arabia, males and females attend and teach at gender segregated schools, and therefore many of the studies conducted in Saudi Arabia have included a sample only featuring one gender. Consequently, the researcher of this thesis sought to include both genders for both teachers (i.e., in the quantitative and qualitative studies) and pupils (i.e., in the qualitative study).

The third strength of this thesis is that both of the empirical studies were designed to test Haimovitz and Dweck's (2017) hypothesised model using two types of methods. Specifically, it took a qualitative approach by including interviews and used a quantitative method by including questionnaires. Moreover, to the best of the researcher's knowledge, this thesis is the first that has aimed to test Haimovitz and Dweck's (2017) model in order to investigate how adults promote

children's growth and fixed mindsets. Furthermore, an additional path was added to the present thesis, to ensure it explored the associations between the three concepts presented in the model among the pupil sample.

The fourth and final strength is that both the empirical studies in the current thesis were conducted in Riyadh, Saudi Arabia, while the majority of the previous studies on intelligence, failure mindsets and response orientations to failure have been conducted in Western cultural contexts such as the *USA* and European countries. Thus, obtaining data in the Saudi context has helped to address the gap in the literature.

Although the thesis has a number of strengths, several limitations need to be acknowledged. Firstly, the systematic review in the current thesis did not apply a meta-analysis of the studies included, as a range of measures had been used to assess achievement in mathematics, thus making it difficult to do so.

Secondly, the qualitative and quantitative studies were only conducted at state/public schools. Therefore, further studies need to be carried out in a variety of different types of schools, including private schools, international schools and special education schools. This is needed for a number of reasons. For example, private and international schools tend to have a better learning environment and provide more facilities (e.g., laboratories), which in turn are likely to have a more positive impact on pupils' motivation.

Thirdly, the two empirical studies conducted in Saudi Arabia in this thesis included teachers who taught the 5th and 6th grades in upper primary schools, thus, exploring the view of teachers teaching lower primary schools is recommended, since they may play a greater role in shaping the mindsets of pupils. In addition, more research is required to gain a better understanding of the associations between the three concepts at various different ages and educational stages.

Fourthly, the current thesis focused on understanding an individual's intelligence and failure mindsets and response orientations to failure within a specific domain, namely, maths. Therefore, it would be beneficial for any future studies investigating these three concepts to focus on different academic domains.

Fifthly, the two empirical studies presented in this thesis were conducted in Riyadh, Saudi Arabia, so further investigation into different cultures is strongly recommended, particularly as it has been argued that culture might greatly shape an individual's mindset (see Section 1.3.1.1).

Sixthly, the quantitative study only included teachers who had taught pupils in the year previous to the application, therefore an exploration of the beliefs of teachers educating pupils in the year of application would be useful, in order to discover their current impact on pupils' mindsets. It is also suggested that the influence of other factors, such as the influence of their father, siblings and classmates, on pupils' adoption of a growth or fixed intelligence mindset in maths be investigated.

Finally, since the data collected for this thesis was taken at one point in time, it would be useful to employ a longitudinal investigation, from the beginning to the end of the academic year, to develop a better understanding of how teachers and mothers influence and shape their children to hold more of a growth or fixed intelligence mindset regarding their maths ability.

6.3 Implications

The findings of this thesis have a number of implications. Firstly, given the fact that only seven studies into the impact of teachers' intelligence mindsets on their pupils' maths achievement have been conducted (all of which are included in the systematic review), as well as the fact the results of those studies are conflicting, it is clearly necessary for more studies on this relationship to be carried out in the future, to better understand it. In addition, the lack of any study on this relationship in non-Western countries, including Saudi Arabia, further supports the need to measure this relationship in different cultures.

Secondly, since all of the outcomes of previous maths assessments showed that students in the KSA obtained scores under the average in maths compared to their peers in other countries (see Section 2.6), the MOE should look for possible reasons, in order to address this issue and to achieve their goals related to the Saudi Vision 2030 (see Section 2.4). Teachers' beliefs and classroom practices might be one of the factors the affect students' mindset and achievement. Indeed, the qualitative analysis revealed that teachers sometimes act in a way that reflects fixed intelligence mindset practices to their pupils, at other times they behave in a way that conveys messages of a growth intelligence mindset, whilst sometimes they use practices that deliver mixed intelligence mindset messages to their pupils. These findings highlight the need for the Saudi MOE to pay more attention to increasing pupils' motivation by raising teachers' awareness of the impact of their beliefs, practices and responses to the failure and success of their pupils, and how this might impact their motivation to learn and the extent to which they believe in the possibility of developing their abilities.

Finally, the results of the quantitative analysis in this thesis demonstrate that mothers' mindsets and responses, and not maths teachers' mindsets and responses, have a significant relationship with their child maths intelligence mindset. Therefore, these findings imply that the effects of mothers' views, messages and responses to their children's motivation should be brought to the attention of schools and the Saudi MOE. However, it is important to note that teaching parents to cultivate a growth intelligence mindset and then expecting them to automatically pass it on to their children is not enough (Haimovitz & Dweck, 2016). Thus, providing a support programme aimed at focusing on parents' failure mindsets and motivational practices would teach them how failure can be useful and how to respond to their children's setbacks, in order to keep their children motivated and help them in their learning (Haimovitz & Dweck, 2016).

Given that the education system changed from how it was before Covid-19 (traditional face-to-face) to a total reliance on e-learning during the Covid-19 pandemic, a reliance which is still partially in effect now, the MOE should also assist parents in learning to use educational applications by providing programmes and courses. This would increase parents' awareness of the impact of their motivational beliefs and practices on their children's mindsets, which in turn may affect their children's level of achievement. The ministry's interest should not only be limited to mothers, however, as fathers should also be included. This is because some fathers are the ones who bear the responsibility of educating their children. In addition, schools in the KSA are divided by gender, so girls' schools are separate from boys' schools. Thus, taking care of boys in terms of communicating with their school and teachers and attending parental meetings is the responsibility of the fathers in many families. Thus, the role of fathers is no less important than the role of mothers.

6.4 Conclusion

To sum up, this thesis had two aims; the first was to review the literature to establish the effect of teachers' intelligence mindsets on their student's academic achievement in mathematics. The second aim was to test Haimovitz and Dweck's (2017) model via two empirical studies, using both qualitative and quantitative methods and by including three sample groups, namely children, their mothers and their teachers. Indeed, this thesis appears to be the first body of research that has attempted to examine Haimovitz and Dweck's (2017) model, to the best of the researcher's knowledge.

It has also helped to address the research gaps regarding the influence of adults' mindsets and practices on pupils' mindsets and motivation in a non-Western cultural context. The findings

revealed that the studies presented in the review provided mixed evidence regarding the impact of teachers' intelligence mindsets on their pupils' maths achievement. Moreover, from the analysis of the qualitative interviews, teachers' belief and practices are reflected in the following five themes that emerged: teacher beliefs about (1) the impact of national policy on maths education, (2) the importance of the school's ethos and provision of adequate resources, (3) classroom teaching strategies and behaviours (4) teachers' beliefs about their pupils, and (5) parents and parent-school engagement. Additionally, the quantitative evidence showed that children's perceptions about their maths intelligence ability are influenced by their mothers' beliefs and reactions, and not by their teachers. Thus, it is suggested that future studies include participants from different types of schools and age groups, as well as focus on different cultural settings and school subjects. Investigating the impact of other factors surrounding the pupils, such as the influence of other family members and their peers, is also recommended.

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مقارنة بالدول الأخرى من وجهة نظر المعلمين والمشرفين (الأسباب– الحلول والعلاج- أساليب التطوير) [Level of achievement students in Saudi Arabia in math and science according to the results of International Studies (TIMSS) compared to other countries from the point of view of teachers and supervisors (causes-solutions and remedy-development methods)]. *Journal of Education*, *35*(169.1), 327–372. https://jsrep.journals.ekb.eg/article_32150.html

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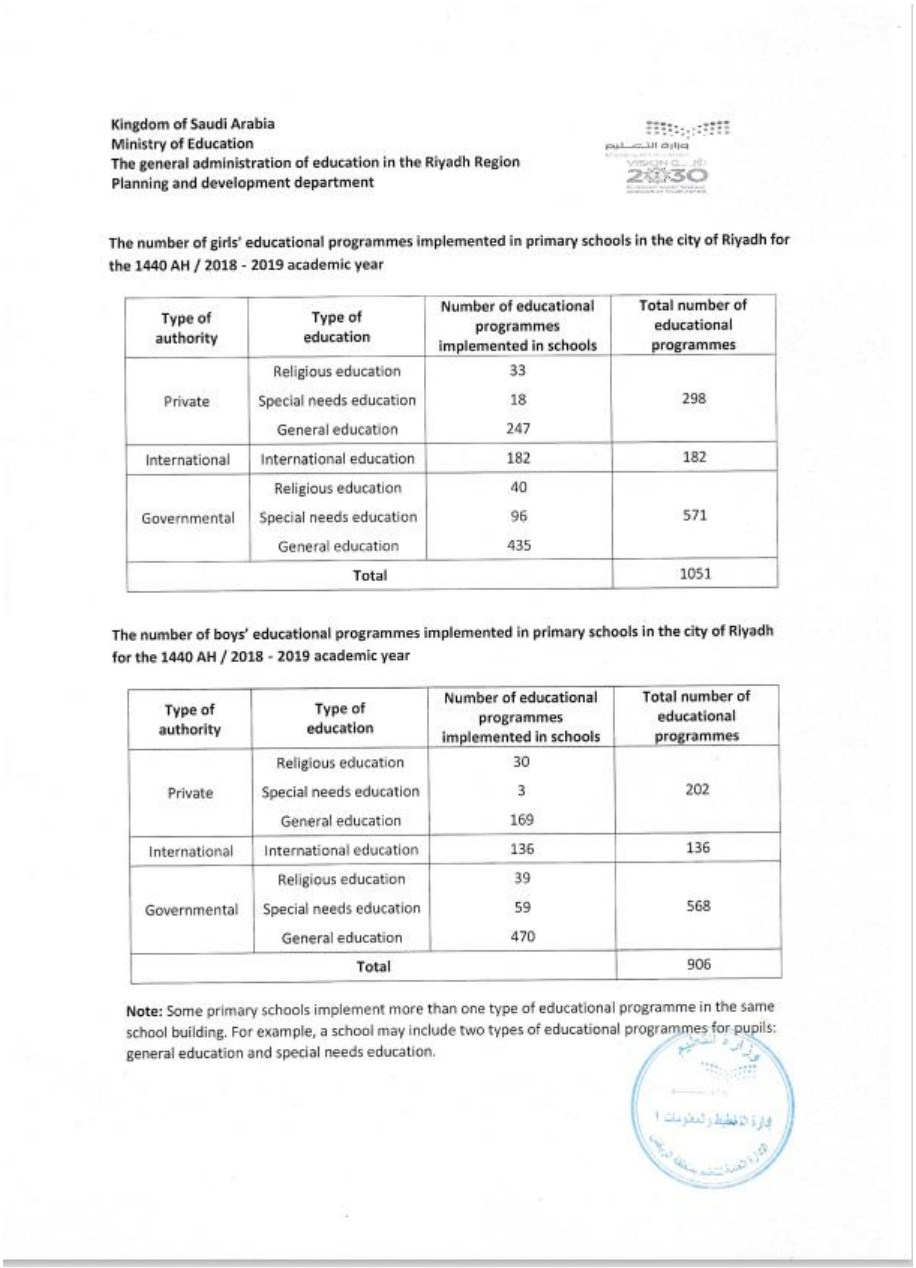
Appendix A Chapter 2: Mindsets and Education in the Kingdom of Saudi Arabia.

A1 The number of educational programmes implemented in primary schools in Riyadh, the KSA in 2018/2019.

Figure 7

The number of educational programmes implemented in primary schools in Riyadh, the KSA in 2018/2019



Kingdom of Saudi Arabia
Ministry of Education
The general administration of education in the Riyadh Region
Planning and development department

The number of girls' educational programmes implemented in primary schools in the city of Riyadh for the 1440 AH / 2018 - 2019 academic year

Type of authority	Type of education	Number of educational programmes implemented in schools	Total number of educational programmes
Private	Religious education	33	298
	Special needs education	18	
	General education	247	
International	International education	182	182
Governmental	Religious education	40	571
	Special needs education	96	
	General education	435	
Total			1051

The number of boys' educational programmes implemented in primary schools in the city of Riyadh for the 1440 AH / 2018 - 2019 academic year

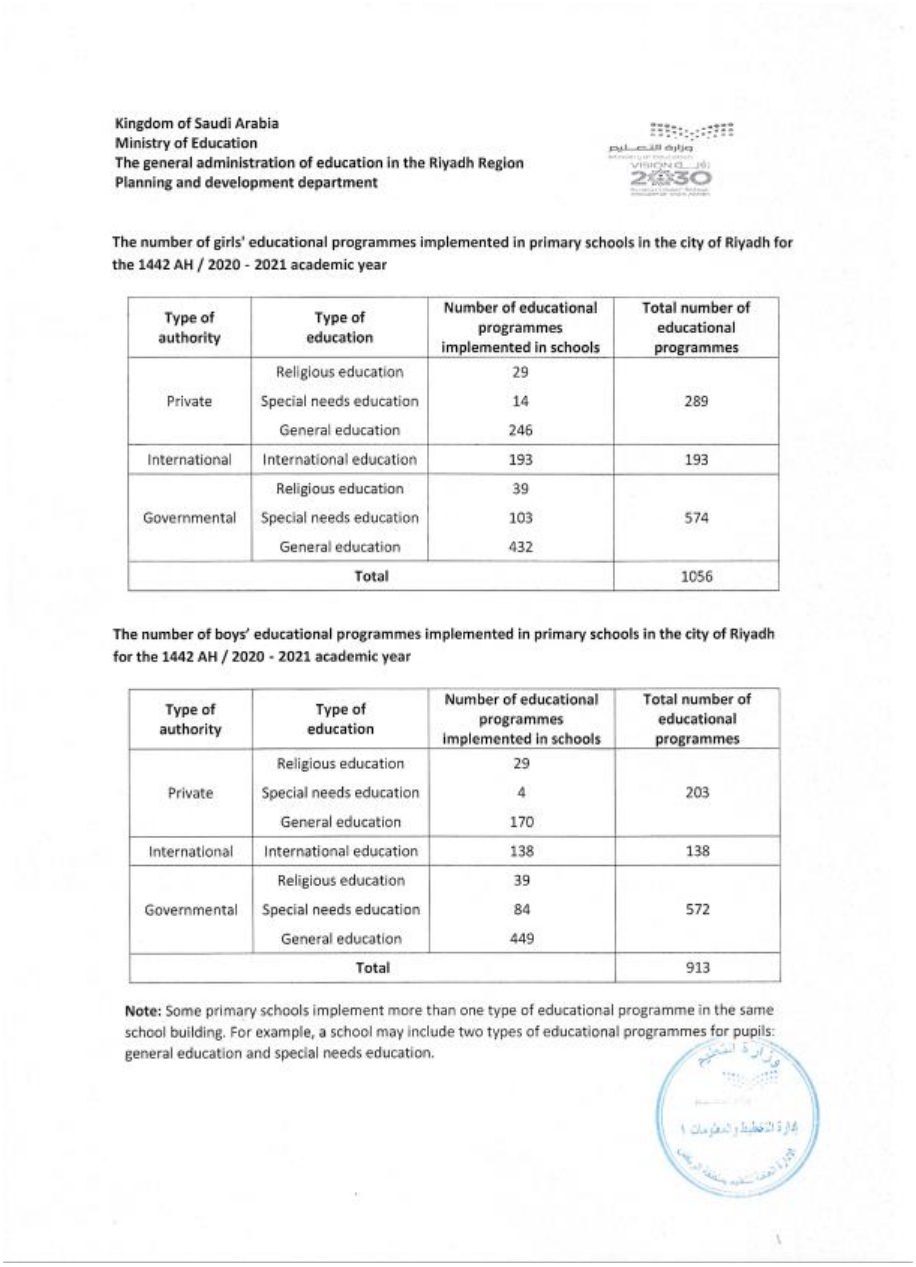
Type of authority	Type of education	Number of educational programmes implemented in schools	Total number of educational programmes
Private	Religious education	30	202
	Special needs education	3	
	General education	169	
International	International education	136	136
Governmental	Religious education	39	568
	Special needs education	59	
	General education	470	
Total			906

Note: Some primary schools implement more than one type of educational programme in the same school building. For example, a school may include two types of educational programmes for pupils: general education and special needs education.

A2 The number of educational programmes implemented in primary schools in Riyadh, the KSA in 2020/2021.

Figure 8

The number of educational programmes implemented in primary schools in Riyadh, the KSA in 2020/2021



Kingdom of Saudi Arabia
Ministry of Education
The general administration of education in the Riyadh Region
Planning and development department

The number of girls' educational programmes implemented in primary schools in the city of Riyadh for the 1442 AH / 2020 - 2021 academic year

Type of authority	Type of education	Number of educational programmes implemented in schools	Total number of educational programmes
Private	Religious education	29	289
	Special needs education	14	
	General education	246	
International	International education	193	193
Governmental	Religious education	39	574
	Special needs education	103	
	General education	432	
Total			1056

The number of boys' educational programmes implemented in primary schools in the city of Riyadh for the 1442 AH / 2020 - 2021 academic year

Type of authority	Type of education	Number of educational programmes implemented in schools	Total number of educational programmes
Private	Religious education	29	203
	Special needs education	4	
	General education	170	
International	International education	138	138
Governmental	Religious education	39	572
	Special needs education	84	
	General education	449	
Total			913

Note: Some primary schools implement more than one type of educational programme in the same school building. For example, a school may include two types of educational programmes for pupils: general education and special needs education.

Appendix B Study 1: A systematic literature review investigating the relationship between maths teachers' mindsets and students' maths achievement.

B1 The three studies excluded from the current systematic review

1. Khalkhali, V., Zolqadr, A., & Khalili, R. (2015). Examining the impact of teacher intelligence beliefs on students' self-handicapping and performance at mathematic lesson. *Education Sciences & Psychology*, *36*(4).
2. McKinney, E. E. (2018). *The Impact of Teacher Growth Mindset on Student Self-Efficacy and Math Performance for All Students and for English Learners* (Doctoral dissertation, The University of Texas at San Antonio).
3. Swire, K. (2020). An Exploration of Mathematical Mindset of Female Novice Early Childhood Teachers (Doctoral dissertation, Hood College).

Reasons for exclusion:

- The first study used a biography of a mathematician referred to as a teacher.
- The second study measured students' perception of their teachers' mindset, however, the teachers did not complete questionnaires regarding their own intelligence mindset.

Although the third study included measures of mindsets and achievement, it did not find that achievement can be used as a strong predictor of teacher mindset. Additionally, no questions were asked about the association between these two variables.

B2 Additional information on the seven studies identified by, and included in, the systematic review

Table 6

Additional information on the seven studies identified by, and included in, the systematic review

Author(s) and year	Title	Study aims	Teachers' years of teaching experience	Study measures
Schullo and Alperson (1998)	Low SES Algebra 1 Students and their Teachers: Individual and a Bi-directional Investigation of their Relationship and Implicit Beliefs of Ability with Final Grades.	This study aimed to investigate the relationship between teachers' and low SES students' mindsets regarding their Algebra 1 scores. In addition, it aimed to investigate the agreement and understanding of both the teacher and their student regarding intelligence and maths beliefs via a bi-directional instrument: the interpersonal perception method.	From 1 to 40 years	Measures of both teachers and students: - Implicit beliefs questionnaire included intelligence items and maths items. - Interpersonal Perception Method (IPM) Questionnaire. Additional students' measure: - Students' final scores of their Algebra 1 performance were collected.
Gadeyne et al. (2006)	Psychosocial Educational Effectiveness Criteria and their Relation to Teaching in Primary Education.	The purpose of this study was to investigate whether the differences in pupils' academic achievement and behavioural functioning were related to teachers' beliefs and the reported teaching behaviours and attitudes.	NR[a]	Teachers' measures: 1. Child Behavior Checklist. 2. Teaching attitudes questionnaires: - Teacher's Educational Orientation Questionnaire. - Appraisal of Impact on Pupils Questionnaire. - Implicit Theory of Intelligence Measure 3. Teaching behaviour: - Care for Pupils with Learning Problems Questionnaire. Students' measures: - Children's (pre-) academic achievement: Reading, spelling, and math tests.

Table 6 (continued)

Additional information on the seven studies identified by, and included in, the systematic review

Author(s) and year	Title	Study aims	Teachers' years of teaching experience	Study measures
Hubacz (2013)	How a Teacher's Sense of Self-Efficacy and Implicit Theory of Intelligence Relate to Student Achievement in Mathematics.	The goal of this study was to investigate the correlation between teachers' self-efficacy and mindsets and tenth-grade students' maths achievement. In addition, it explored how teachers' mindsets and students' maths achievement varied according to teachers' level of self-efficacy. Moreover, the relationship between students' mindsets and their achievement and teachers' mindsets was also investigated.	From less than one year to 40 years	Teachers' measures: - Teacher self-efficacy. - Teachers' implicit theories of intelligence. - Teacher gender and years of experience. Students' measures: - Students' achievement in maths. - Students' implicit theories of intelligence - Students' gender and SES. - Parental level of education.
Balzer (2014)	Relationship between Teachers' Beliefs and Student Achievement in Middle School Mathematics.	This study investigated the association between teachers' implicit theory of intelligence, goal orientation and their economically disadvantaged students' scores in mathematics tests and their progress in maths from one year to another.	From 7 to 12 years	Teachers' measures: - Theory of Intelligence Scale. - Patterns of Adaptive Learning Scale. Students' measures: - Economically disadvantaged student's math (State of Texas Assessment of Academic Readiness) scores. - The percentage of students who made yearly progress from the previous year in the state mathematics test for each maths teacher that participated.

Table 6 (continued)

Additional information on the seven studies identified by, and included in, the systematic review

Author(s) and year	Title	Study aims	Teachers' years of teaching experience	Study measures
Jones (2016)	A Quantitative Study: The Relationship Between School-Wide Instructional Practices, Teacher Beliefs, and Growth Mindset and Value-Added Student Growth in Elementary Mathematics for Grades 3–5.	This study examined the association between math teachers' instructional practices, beliefs and mindset and primary students' growth in maths, based on the value-added average growth index (AGI) from the Pennsylvanian System of School Assessment.	NR[a]	Teachers' measures: - Mathematics Instructional Practice Survey. - Mathematics Beliefs and Awareness Survey. - Theories of Intelligence Scale. Students' measures: The Average Growth Index (AGI).
Chiarelli (2018)	Correlating the Growth Mindset of Special Education Teachers and Student Growth.	This study examined the association between special education teachers' growth mindset and student achievement in the area of maths and reading.	From less than one year to over 25	Teachers' measure: - "What's Your Mindset" survey. Students' measures: - Northwest Evaluation Association's (NWEA) Measures of Academic Progress (MAP) Conditional Growth Index (CGI) score of the middle and the end of the year.

Table 6 (continued)

Additional information on the seven studies identified by, and included in, the systematic review

Author(s) and year	Title	Study aims	Teachers' years of teaching experience	Study measures
Bostwick et al. (2020)	Teacher, Classroom, and Student Growth Orientation in Mathematics: A Multilevel Examination of Growth Goals, Growth Mindset, Engagement, and Achievement.	This study investigated the correlation between the growth orientation and the maths outcomes of students, classroom and teachers by focusing on (a) the relationship between students' growth orientation and their outcomes; (b) the relationship between classroom growth orientation and classroom maths outcome; (c) the associations between teachers' growth orientation and classroom maths outcomes; (d) the interaction between growth orientation in the classroom and teachers and its relationship with classroom outcomes.	On average, teachers had 17.2 years of experience. A total of 84.6% of them had at least five years' teaching experience.	<u>Teachers' measures:</u> Teachers' growth orientation included: - Teachers' Implicit Beliefs in Intelligence Scale. - Teachers' self-based growth goals from the Personal Best Scale adapted to teaching. - Teachers' task-based growth goals - mastery approach items from the Achievement Goals Questionnaire adapted to teaching. - Teacher demographic factors which contain gender, seniority, years of teaching experience, and educational qualification. <u>Students' measures:</u> Student and classroom mathematics growth orientation included: - Growth mindset. - Self-based growth goals. - Task-based growth goals. - Students' engagement. - Student demographic factors and classroom composition, such as gender, age, language background, neighbourhood SES, and prior numeracy achievement. - Maths achievement test.

[a] NR = Not Reported.

B3 AXIS - Quality assessment tool

Table 7

AXIS - Quality assessment tool

	NO.	Items	Yes	No	Do not know / comment
Introduction	1	Were the aims/objectives of the study clear?			
Methods	2	Was the study design appropriate for the stated aim(s)?			
	3	Was the sample size justified?			
	4	Was the target/reference population clearly defined? (Is it clear who the research was about?)			
	5	Was the sample frame taken from an appropriate population base, so that it closely represented the target/reference population under investigation?			
	6	Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?			
	7	Were measures undertaken to address and categorise non-responders?			
	8	Were the risk factor and outcome variables measured appropriate to the aims of the study?			
	9	Were the risk factor and outcome variables measured correctly using instruments/ measurements that had been trialled, piloted or published previously?			
	10	Is it clear what was used to determined statistical significance and/or precision estimates? (e.g., p values, CIs)			
	11	Were the methods (including statistical methods) sufficiently described to enable them to be repeated?			

Table 7 (continued)

AXIS - Quality assessment tool

	NO.	Items	Yes	No	Do not know / comment
Results	12	Were the basic data adequately described?			
	13	Does the response rate raise concerns about non-response bias?			
	14	If appropriate, was information about non-responders described?			
	15	Were the results internally consistent?			
	16	Were the results for the analyses described in the methods presented?			
Discussion	17	Were the authors' discussions and conclusions justified by the results?			
	18	Were the limitations of the study discussed?			
Other	19	Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?			
	20	Was ethical approval or consent of participants attained?			
Total Score from 20 /					

B4 Results of the quality assessment tool for all of the correlational studies

Table 8

Results of the quality assessment tool for all of the correlational studies

	Items NO.	Schullo and Alperson (1998)	Gadeyne et al. (2006)	Hubacz (2013)	Balzer (2014)	Jones (2016)	Chiarelli (2018)	Bostwick et al. (2020)
Introduction	1	1	1	1	1	1	1	1
Methods	2	1	1	1	1	1	1	1
	3	0	1	1	1	1	1	0
	4	1	1	1	1	1	1	1
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	0	0	0	0	0	0	0
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
	11	1	1	1	1	1	1	1
Results	12	1	1	1	1	1	1	1
	13	0	0	0	0	0	0	0
	14	0	0	0	0	0	0	0
	15	1	1	1	1	1	1	1
	16	1	1	1	1	1	1	1

Table 8 (continued)

Results of the quality assessment tool for all of the correlational studies

	Items NO.	Schullo and Alperson (1998)	Gadeyne et al. (2006)	Hubacz (2013)	Balzer (2014)	Jones (2016)	Chiarelli (2018)	Bostwick et al. (2020)
Discussion	17	1	1	1	1	1	1	1
	18	0	1	1	1	1	1	1
Other	19	1	1	1	1	1	1	1
	20	0	1	0	1	1	1	1
Total Score from 20 /		14	17	16	17	17	17	16

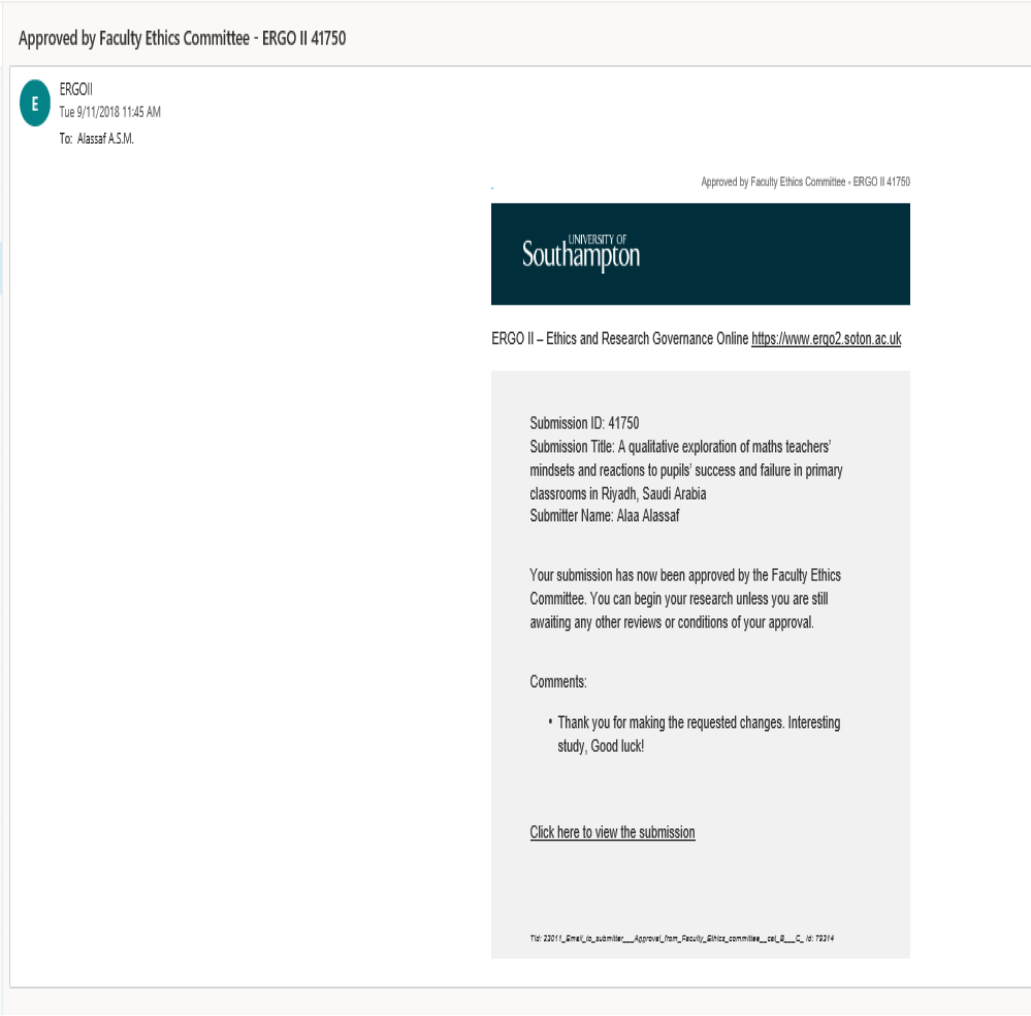
Appendix C Study 2: A qualitative exploration of maths teachers' mindsets and reactions to pupils' successes and failures in primary classrooms in Riyadh, Saudi Arabia

C1 The ethical approval from the Faculty Ethics Committee at the University of Southampton.

(ERGO II study ID number: 41750)

Figure 9

The ethical approval from the Faculty Ethics Committee at the University of Southampton



UNIVERSITY OF Southampton

C2 Head of education ministry letter (Version 1; 03/ 07/ 2018)

Study Title: A qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

Ergo number: 41750

Dear ……,

My name is Alaa Alassaf, and I am conducting a study as a part of my Ph.D. program in psychology school at the University of Southampton in the United Kingdom. The title of my study is a qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

The study involves interviewing maths teachers both female and male who teach grade five and/or six in state-funded primary classes in Riyadh, Saudi Araba. The study aims to understand how mindsets influence reactions of maths teachers to pupil academic success and failure. Teachers will be asked to take part in an interview which is divided into two parts. In the first part, they will be asked demographic questions and then they will be asked questions about how they manage success and failure in mathematics. The interview will take up to 45 minutes.

I am writing to you as the head of the ministry of education to provide you with details of this study and ask your permission for working with maths teachers in state-funded primary schools in Riyadh. Please find the attached document, which is the interview questions.

Yours faithfully,
Alaa Alassaf

If you have any questions please do not hesitate to contact me via my email address (asa1e16@soton.ac.uk) or you can contact my supervisor. Dr. Hanna Kovshoff, Associate Professor in Developmental Psychology, University of Southampton, UK (h.kovshoff@soton.ac.uk).

If you have a question about your or the participants rights please contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 3856, email fshs-rso@soton.ac.uk

UNIVERSITY OF Southampton

C3 Head of school letter (Version 1; 03/ 07/ 2018)

Study Title: A qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

Ergo number: 41750

Dear …….,

My name is Alaa Alassaf, and I am conducting a study as a part of my Ph.D. program in psychology school at the University of Southampton in the United Kingdom. The title of my study is a qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

The study involves interviewing maths teachers both female and male who teach grade five and/or six in state-funded primary classes in Riyadh, Saudi Araba. The study aims to understand how mindsets influence reactions of maths teachers to pupil academic success and failure. Teachers will be asked to take part in an interview which is divided into two parts. In the first part, they will be asked demographic questions and then they will be asked questions about how they manage success and failure in mathematics. The interview will take up to 45 minutes.

I am writing to you as the head of the ministry of education to provide you with details of this study and ask your permission for working with maths teachers in state-funded primary schools in Riyadh. Please find the attached document, which is the interview questions.

Yours faithfully,
Alaa Alassaf

If you have any questions please do not hesitate to contact me via my email address (asa1e16@soton.ac.uk) or you can contact my supervisor. Dr. Hanna Kovshoff, Associate Professor in Developmental Psychology, University of Southampton, UK (h.kovshoff@soton.ac.uk).

If you have a question about your or the participants rights please contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 3856, email fshs-rso@soton.ac.uk

C4 Letter (To Whom It May Concern)

September 19, 2018

To Whom It May Concern

I would like to confirm that Alaa Alassaf wants to conduct her study as a part of her PhD program in psychology school at the University of Southampton in the United Kingdom. The title of her study is a qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

The study involves interviewing maths teachers both female and male who teach grade five and/or six in state-funded primary classes in Riyadh, Saudi Arabia. Her study aims to understand how mindsets influence reactions of maths teachers to pupil academic success and failure.

I am writing to you to ask your permission to allow Alaa to work with maths teachers in state-funded primary schools in Riyadh. Thank you very much for your support with Alaa's research.

19سبتمبر 2018

إلى من يهمه الأمر

أود التأكيد على أن آلاء العساف ترغب في إجراء دراستها كجزء من برنامج الدكتوراه في قسم علم النفس في جامعة ساوثهامبتون في المملكة المتحدة. وعنوان دراستها هو الاستكشاف النوعي لعقليات معلمي /معلمات الرياضيات وردود أفعالهم تجاه نجاح التلاميذ /التلميذات وفشلهم في الفصول الدراسية الإبتدائية في مدينة الرياض بالمملكة العربية السعودية.

تتضمن الدراسة إجراء مقابلات مع معلمي ومعلمات الرياضيات الذين يُدرسون الصف الخامس و / أو الصف السادس في المدارس الابتدائية الحكومية في الرياض، المملكة العربية السعودية. وتهدف دراستها إلى فهم كيفية تأثير عقليات معلمي الرياضيات في ردود أفعالهم على النجاح والفشل الأكاديمي للتلاميذ.

أكتب لك لطلب السماح لـ آلاء بالتطبيق مع معلمي ومعلمات الرياضيات في المدراس الابتدائية الحكومية في الرياض. شكراً جزيلاً لدعمكم لبحث آلاء.

وتفضلوا بقبول فائق الاحترام،

Yours sincerely,

Dr. Hanna Kovshoff

Associate Professor in Developmental Psychology

Centre for Innovation in Mental Health - Developmental Laboratory

Tel: +44 (0) 23 8059 4593 |

Email: hk@soton.ac.uk

School of Psychology, University of Southampton, SO17 1BJ, UK.

C5 The official permission letter from the Ministry of Education in Saudi Arabia to conduct the study in primary schools.

Figure 10

The official permission letter from the Ministry of Education in Saudi Arabia to conduct the study in primary schools

المملكة العربية السعودية
وزارة التعليم
الإدارة العامة للتعليم بمنطقة الرياض
إدارة التخطيط والتطوير
Planning & Development

وزارة التعليم
Ministry of Education

الرقم: .....
التاريخ: ٢٢/١/١٤٤٠هـ
المشفوعات: .....

" إفادة "

الموضوع: الموافقة على تطبيق أدوات الدراسة في مدارس تابعة لإدارة التعليم بمنطقة الرياض

الاسم	الاء بنت صالح محمد العساف		
السجل المدني	[redacted]	العام الدراسي	١٤٣٩هـ - ١٤٤٠هـ
الجامعة	جامعة ساوثهامبتون- المملكة المتحدة	التخصص	علم النفس
الدرجة العلمية	دكتوراه	العينة	معلمي ومعلمات مادة الرياضيات
عنوان الدراسة	الاستكشاف النوعي لمقليات معلمي /معلمات الرياضيات وردود أفعالهم تجاه نجاح التلاميذ /التلميذات وفشلهم في الفصول الدراسية الابتدائية في مدينة الرياض بالمملكة العربية السعودية		
نوع الإفادة	الموافقة على تطبيق الدراسة في المدارس الحكومية الابتدائية للبنين والبنات التابعة للإدارة العامة للتعليم بمنطقة الرياض مع معلمي ومعلمات (الرياضيات) على ان تبدأ تطبيق ادواتها البحثية (المقابلة) بدء من تاريخ ١٤٤٠/١/٢٣ الموافق ٣/اكتوبر/٢٠١٨ خلال العام الدراسي (١٤٣٩هـ الى ١٤٤٠هـ) بحسب طلبها		

السلام عليكم ورحمة الله وبركاته وبعد،

بناء على قرار سعادة مدير عام التعليم بمنطقة الرياض رقم ٣٨٩٢٠٧٩٣ وتاريخ ١٤٣٨/٦/٢٣هـ بشأن تفويض الصلاحية لإدارة التخطيط والمعلومات لتسهيل مهمة الباحثين والباحثات، وحيث تقدمت إلينا الباحثة (الموضحة بياناتها أعلاه) بطلب إجراء دراستها خلال العام الدراسي ١٤٣٩هـ الى ١٤٤٠هـ وعليه نفيدكم أنه لا مانع من تطبيق الدراسة خلال مدة زمنية محددة بـ (٩٠) يوم خلال العام الدراسي الحالي ، على نطاق مدارس منطقة الرياض مع ملاحظة أن الباحثة تتحمل كامل المسؤولية المتعلقة بمختلف جوانب البحث ، ولا يعني سماح الإدارة العامة للتعليم موافقتها بالضرورة على مشكلة البحث أو على الطرق والأساليب المستخدمة في دراستها ومعالجتها وبناء على طلبها تم منحها الإفادة ،علماً أنه تم الاطلاع على أداة الدراسة (المقابلة).

شاكرين لكم حسن تعاونكم

إدارة التخطيط والمعلومات

وزارة التعليم
إدارة التخطيط والمعلومات ١

ص / للملحقة
ص / قسم الدراسات والبحوث
ل/ المراك

صفحة ١٤ من ١٨ تاريخ الإصدار : ١٤٣٦/٨/٥هـ الإصدار: ١.٠ رمز العملية ت ط 6 ع

C6 Interview Guidelines

Table 9

Interview Guidelines

		Themes	Questions	Prompts	Possible Probes		
					Detail-oriented	Elaboration	Clarification
Successes	1	**Pupil achievement event (Successes).**					
	2a	**Activates adult's intelligence mindset.**	What makes pupils succeed in maths? What made that particular pupil succeed in maths?	What are the factors that help pupils to success in maths?	- What sorts of words do you say? - What sorts of things do you do? - When do you say that? - When do you do that?	- That's helpful. Can you give me more details about that? - I'm beginning to get the picture: but some more examples might help, so could you please give me other examples?	- You said ….. What do you mean by ……? - Could you please clarify further?
	2b	**Activates adult's theory of how to motivate children.**	How do you motivate a pupil who succeeds to do even better? How did you motivate that pupil that you remember to do even better?	What do you do with a pupil who answers correctly in the exercises in the classroom or in her/his homework?			
	3	**Activates adult process- or person-oriented practices.**	What do you say to a pupil who succeeds in maths? What did you say to that pupil that you remember when they succeeded? What feedback did you give him or her about their performance in maths tests? Maths homework?	What do you say to a pupil who answers correctly in the exercises in the classroom or in her/his homework?			
	4	**Promotes pupil growth or fixed mindset.**	How do you ensure that the pupils in your classroom continue to succeed? How did you ensure that that pupil that you remember continued to succeed?				

Table 9 (continued)

Interview Guidelines

		Themes	Questions	Prompts	Possible Probes		
					Detail-oriented	Elaboration	Clarification
Failures	1	**Pupil achievement event (Failures).**					
	2a	**Activates adult's intelligence mindset.**	Why do you think some pupils fail in maths? Why do you think that pupil failed in maths?	What are the factors that lead pupils to fail in maths?	- What sorts of words do you say? - What sorts of things do you do? - When do you say that? - When do you do that?	- That's helpful. Can you give me more details about that? - I'm beginning to get the picture: but some more examples might help, so could you please give me other examples?	- You said ….. What do you mean by ……? - Could you please clarify further?
	2b	**Activates adult's theory of how to motivate children.**	How do you motivate a pupil who fails to do better? How did you try to motivate that pupil that you remember to do better?	What do you do with a pupil who answers incorrectly in the exercises in the classroom or in her/his homework?			
	3	**Activates adult process- or person-oriented practices.**	What do you say to a pupil who fails in maths? What did you say to that pupil that you remember when they failed? What feedback did you give them about their performance in maths tests? Maths homework?	What do you say to a pupil who answers incorrectly in the exercises in the classroom or in her/his homework?			
	4	**Promotes pupil growth or fixed mindset.**	How do you ensure that the pupils in your classroom stop failing? What did you do to ensure that that pupil you remember stopped failing?				

C7 Semi-structured interview with maths teachers in primary schools

(Version 1; 03/ 07/ 2018)

Study Title: A qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

Ergo number: 41750

My name is Alaa Alassaf. I am a Ph.D. student in Psychology at the University of Southampton in the United Kingdom. Thank you for agreeing to participate in my research study. My study centres around how maths teachers manage success and failure in maths. In this interview, first, you will be asked to give information about yourself, and then you will be asked questions about your reaction and activities concerning pupils' maths success and failure in your classrooms. Please remember there are no right or wrong answers. I also want to remind you that the interview will be recorded, and your answers will be kept confidential and will be used for research purposes only. No one, apart from the researchers, will hear the recordings or see the transcripts. Once the interview is complete, the recordings will be transcribed and through this process, all identifying information about yourself or your school will be removed. If you feel that you would like to withdraw from the interview at any point, you can, and I will not ask you for the reason that you wish to withdraw.

Shall we start the interview? Ok, first I would like to start by asking you information about yourself:

Can you please tell me what your age group is? □ From 22 to 29 years old □ From 30 to 39 years old □ From 40 to 49 years old

□ From 50 to 59 years old □ From 60 to 69 years old □ 70 years or older

Could you please tell me about your education, for instance what is your education degree? What is your education subject?

Can you please tell me about your current teaching, for example what age group do you teach? How many classes do you teach? How many pupils are there in each class?

Could you please tell me how many years of teaching experience you have? □ Less than 5 years □ From 6 to 10 years

□ From 11 to 20 years □ More than 20 years

Now, I would like to ask you questions about how you manage pupils' maths' success and failure in your classrooms. I would like to start by thinking about maths success. In your opinion,

1. What makes pupils succeed in maths? 2. Can you remember a particular pupil who was at the top of your class in maths last year? Please do not tell me their name but keep them in your mind. Do you have a pupil in mind? 3. What made that particular pupil succeed in maths?	What are the factors that help pupils to success in maths?	- What sorts of words do you say? - What sorts of things do you do? - When do you say that? - When do you do that? - That's helpful. Can you give me more details about that?
4. What do you say to a pupil who succeeds in maths? 5. What did you say to that pupil that you remember when they succeeded? 6. What feedback did you give them about their performance in maths tests? Maths homework?	What do you say to a pupil who answers correctly in the exercises in the classroom or in her/his homework?	- I'm beginning to get the picture: but some more examples might help, so could you please give me other examples? - You said ….. What do you mean by ……?
7. How do you motivate a pupil who succeeds to do even better? 8. How did you motivate that pupil that you remember to do even better? 9. How do you ensure that the pupils in your classroom continue to succeed? 10. How did you ensure that that pupil that you remember continued to succeed?	What do you do with a pupil who answers correctly in the exercises in the classroom or in her/his homework?	- Could you please clarify further?

Now, I will ask you questions about maths failures. In your opinion,

1. Why do you think some pupils fail in maths? 2. Now, I would like you to remember a pupil who performed at the bottom of the set in maths last year. Please do not tell me their name but keep them in your mind. Can you think of a pupil? 3. Why do you think that pupil failed in maths?	What are the factors that lead pupils to fail in maths?	- What sorts of words do you say? - What sorts of things do you do? - When do you say that? - When do you do that? - That's helpful. Can you give me more details about that?
4. What do you say to a pupil who fails in maths? 5. What did you say to that pupil that you remember when they failed? 6. What feedback did you give them about their performance in maths tests? Maths homework?	What do you say to a pupil who answers incorrectly in the exercises in the classroom or in her/his homework?	- I'm beginning to get the picture: but some more examples might help, so could you please give me other examples? - You said ….. What do you mean by ……? - Could you please clarify further?
7. How do you motivate a pupil who fails to do better? 8. How did you try to motivate that pupil that you remember to do better? 9. How do you ensure that the pupils in your classroom stop failing? 10. What did you do to ensure that that pupil you remember stopped failing?	What do you do with a pupil who answers incorrectly in the exercises in the classroom or in her/his homework?	

Thank you for your time. Do you have any questions that you would like to ask me?

UNIVERSITY OF Southampton

C8 Teacher Information Sheet

(Version 2; 01/ 08/ 2018)

Study Title: A qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

Researcher: Alaa Alassaf

ERGO number: 41750

Please read this information carefully before deciding to take part in this research. It is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

I am conducting this study as a part of my Ph.D. program in Psychology school at the University of Southampton in the United Kingdom. The purpose of this study is to understand how maths teachers manage maths success and failure of their pupils in their classrooms.

Why have I been asked to participate?

You have been chosen to participate in this research because you are a maths teacher of 5th grade and/or 6th grade in primary school in Riyadh.

What will happen to me if I take part?

If you decide to take part, you will be asked to answer a few demographic questions such as your age group, the number of pupils in your classes and your years of teaching experience. Then, you will be asked a number of questions regarding how you manage pupils' academic success and failure, and how you motivate your pupils in your classes. This interview will take approximately 45 minutes.

Are there any benefits in my taking part?

There will be no personal benefit to you. However, your participation in this research will contribute to better understanding of how maths teachers promote pupil academic success and maths achievement.

Are there any risks involved?

There are no risks involved you when you decide to participate in this study. Moreover, if you feel that you would like to withdraw from the interview at any point, you can, and I will not ask you for the reason that you wish to withdraw.

Will my participation be confidential?

The data will be used only for research purposes and no one will have access to the data except me and my research team. The research data will be stored in locked filing cabinets. In addition, the data from the audio recordings of the interviews also will be kept completely confidential, and it will be stored securely on a password protected computer and available only to the researcher and her team. As data is entered into our software, we will allocate each participant a number, this means that they will only be referred to by their number. A list of numbers and participant names will be kept by the researcher for the purposes of identifying data relating to them if required in the future, such as withdrawal of consent. Thus, a code number will be given to each participant during the transcription of the data from the interviews records to hide the real identity of the participants. Physical and electronic data also will be retained for a period of 10 years, after which they will be destroyed.

What should I do if I want to take part?

If you want to take part, please read the consent form and then initial all the statements and sign the form.

What happens if I change my mind?

The participation in this study is voluntary. Therefore, if you change your mind you have the right to withdraw from this research at any time. There are no repercussions for withdrawing. Your responses will be destroyed/deleted upon your withdrawal up until the point were data are analysed (15/ 10/ 2018).

What will happen to the results of the research?

The results of this research will be included in my thesis for the Ph.D. program in Psychology school at the University of Southampton in the United Kingdom. It may also be presented at conferences or published in academic journals. However, you, or your school, will not be identified in the research results. If you wish to receive a summary of the results, please contact me Alaa Alassaf at asa1e16@soton.ac.uk. The confidentiality data will be deposited in University repositories. Physical and electronic data will be retained for a period of 10 years, after which it will be destroyed.

Where can I get more information?

For more information on this study, please contact me Alaa Alassaf at asa1e16@soton.ac.uk

What happens if something goes wrong?

In case of concern or complaint, you can contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 3856, email fshs-rso@soton.ac.uk

Thank you for taking the time to read the information sheet and considering taking part in the research.

[01/ 08/ 2018] [Version 2] [Ethics/ Ergo number: 41750]

UNIVERSITY OF Southampton

C9 Teacher consent form

(Version 3; 28/ 08/ 2018)

Study title: A qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

Researcher name: Alaa Alassaf

ERGO number: 41750

Please initial the boxes (√) if you agree with the statements:

I have read and understood the information sheet (01/ 08/ 2018, Version 2) and have had the opportunity to ask questions about the study.	
I agree to take part in this research project and agree for my data to be used for the purpose of this study.	
I understand my participation is voluntary and I may withdraw for any reason without my rights being affected.	
I understand that if I withdraw from the study that it may not be possible to remove the data once my personal information is no longer linked to the data.	
I understand that I may be quoted directly in reports of the research but that I will not be directly identified (e.g., that my name will not be used).	
I agree to take part in the interview for the purposes set out in the teacher information sheet and understand that these will be recorded using audio.	

Name of participant (print name) ……

Signature of participant ……

Date ……

Name of the researcher (Alaa Alassaf)

Signature of researcher

Date: 28/ 08/ 2018

UNIVERSITY OF Southampton

C10 Teacher debriefing statement

Study Title: A qualitative exploration of maths teachers' mindsets and reactions to pupils' success and failure in primary classrooms in Riyadh, Saudi Arabia.

Debriefing Statement (Version 1, 03/ 07/ 2018)

Thank you for taking part in this study.

The aim of this study was to understand more about how maths teachers in promote pupils' maths achievement in Riyadh, Saudi Arabia. Your information from the interview will help our understanding of how maths teachers manage maths success and failure of their pupils.

Once again, let us remind you that the results of this study will not include any personal details such as your name or any other identifying characteristics, and that your details will be number coded. The study did not use deception.

If you have any questions or feel worried about anything we asked you during the interview, please let me know so we can talk about it. In addition, if you have any further questions about the study or if you wish to receive a summary of the study findings once the study has been completed, please contact me Alaa Alassaf at asa1e16@soton.ac.uk.

Thank you again for your participation.

Signature: _____ Date: _____

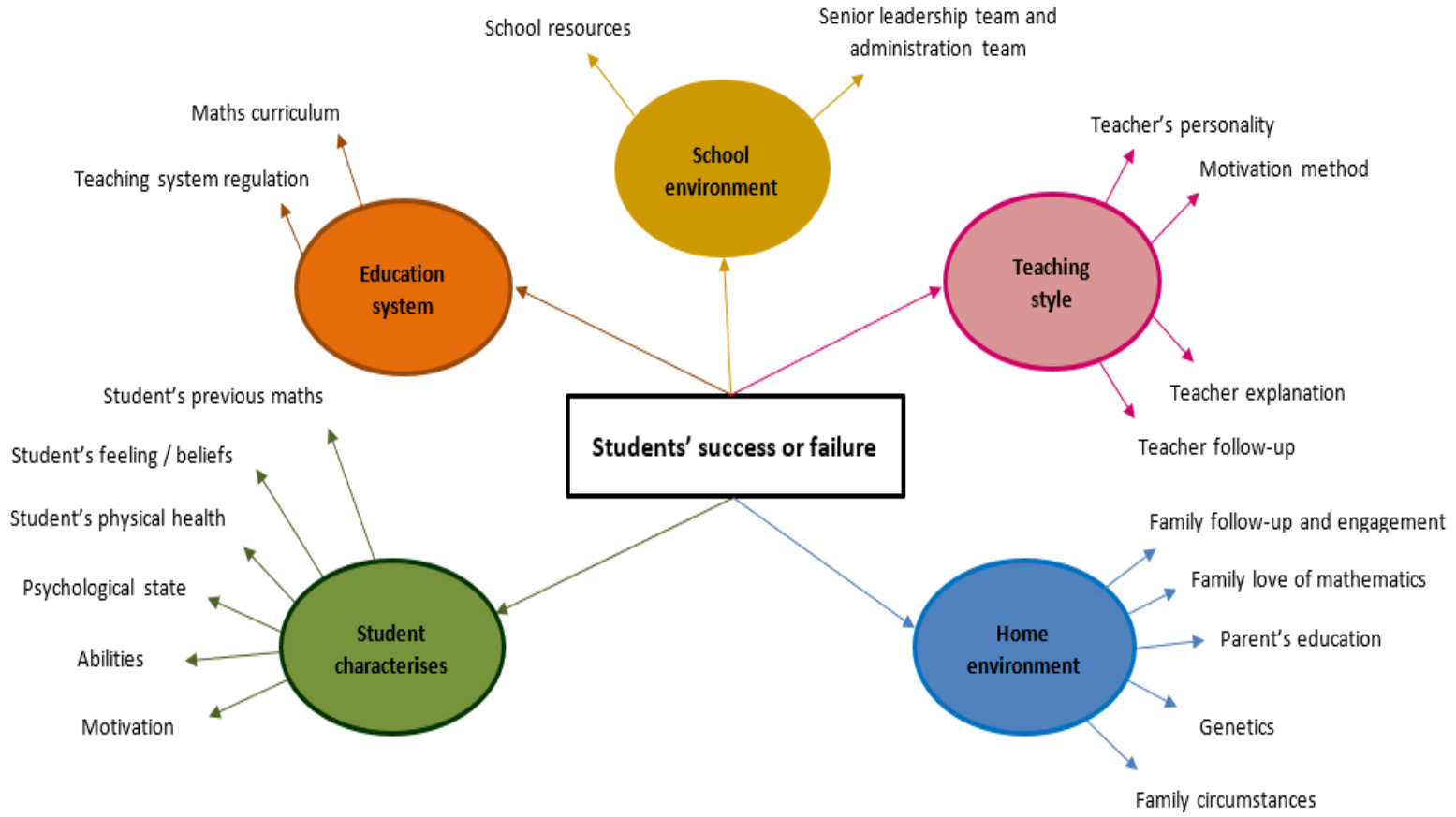
Name: _____

If you have questions about your rights as a participant in this study, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 3856, email fshs-rso@soton.ac.uk

C11 The first initial thematic map

Figure 11

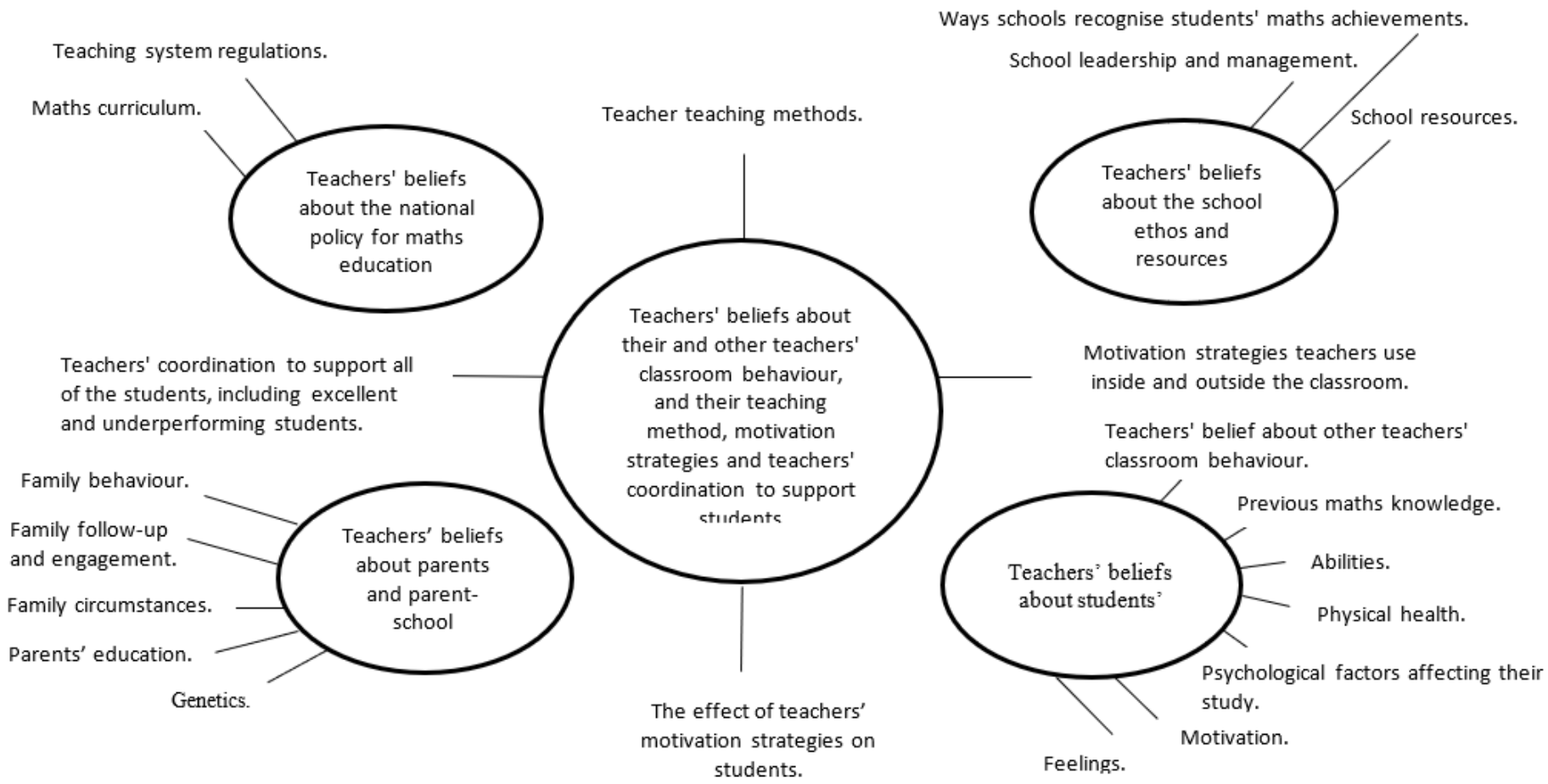
The first initial thematic map



C12 The second initial thematic map

Figure 12

The second initial thematic map



C13 The coding manual table featuring the teacher interview analysis

Present in Document Vol 2 of 2

C14 The ownership of primary school buildings in the city of Riyadh for the 2018 – 2019 and 2020 – 2021 academic years.

Figure 13

The ownership of primary school buildings in the city of Riyadh for the 2018 – 2019 and 2020 – 2021 academic years

Kingdom of Saudi Arabia
Ministry of Education
The general administration of education in the Riyadh Region
Planning and development department

The ownership of primary school buildings in the city of Riyadh for the 1440 AH / 2018 – 2019 academic year

Gender	Type of authority	Building ownership	Number of buildings	Total number of buildings
Girls' school buildings	Governmental	Loan Governmental Tenant	2 386 117	505
Boys' school buildings	Governmental	Loan Governmental Tenant	1 387 153	541

The ownership of primary school buildings in the city of Riyadh for the 1442 AH / 2020 – 2021 academic year

Gender	Type of authority	Building ownership	Number of buildings	Total number of buildings
Girls' school buildings	Governmental	Loan Governmental Tenant	2 410 112	524
Boys' school buildings	Governmental	Loan Governmental Tenant	1 392 153	546

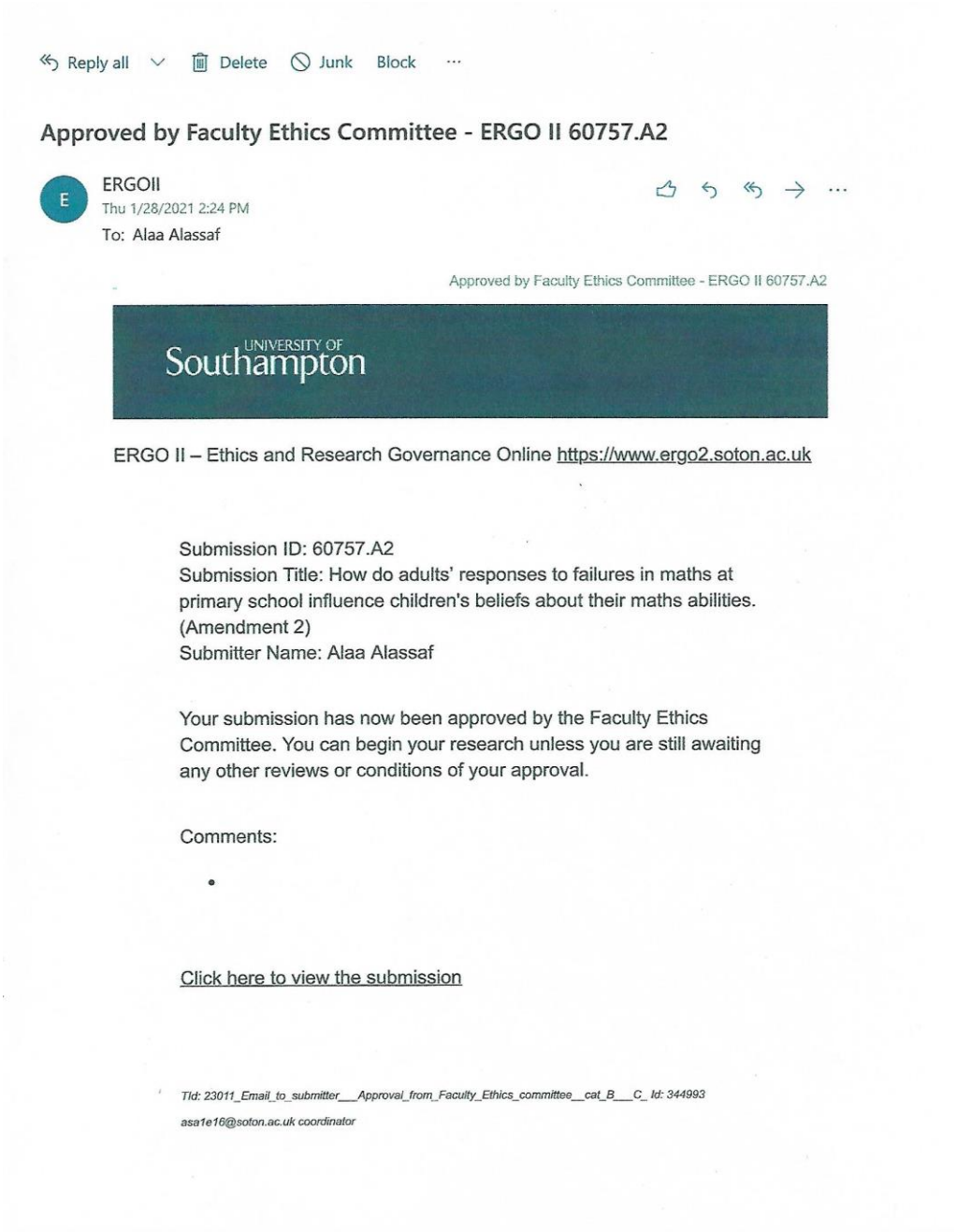
Appendix D Study 3: How do adults' responses to children's failures in maths at primary schools in Riyadh influence these children's beliefs about their maths abilities?

D1 The ethical approval from the Faculty Ethics Committee at the University of Southampton.

(ERGO II study ID number: 60757)

Figure 14

The ethical approval from the Faculty Ethics Committee at the University of Southampton



Reply all Delete Junk Block ···

Approved by Faculty Ethics Committee - ERGO II 60757.A2

E ERGOII
Thu 1/28/2021 2:24 PM
To: Alaa Alassaf

Approved by Faculty Ethics Committee - ERGO II 60757.A2

UNIVERSITY OF Southampton

ERGO II – Ethics and Research Governance Online https://www.ergo2.soton.ac.uk

Submission ID: 60757.A2
Submission Title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities. (Amendment 2)
Submitter Name: Alaa Alassaf

Your submission has now been approved by the Faculty Ethics Committee. You can begin your research unless you are still awaiting any other reviews or conditions of your approval.

Comments:

•

Click here to view the submission

TId: 23011_Email_to_submitter___Approval_from_Faculty_Ethics_committee__cat_B___C_ Id: 344993

asa1e16@soton.ac.uk coordinator

D2 The official permission letter from the Ministry of Education in Saudi Arabia to conduct the study in primary schools.

Figure 15

The official permission letter from the Ministry of Education in Saudi Arabia to conduct the study in primary schools

المملكة العربية السعودية
وزارة التعليم
الإدارة العامة للتعليم بمنطقة الرياض
إدارة التخطيط والتطوير

وزارة التعليم

الرقم .....
التاريخ: ١٥/ ٤/ ١٤٤٢هـ .
المشفوعات:.....

" إفادة "

بالموافقة على تطبيق أداة الدراسة في المدارس التابعة لإدارة التعليم بمنطقة الرياض

الاسم	آلاء بنت صالح محمد العساف		
السجل المدني	[redacted]	العام الدراسي	١٤٤١_١٤٤٢
الجامعة	جامعة ساوثهامبتون- المملكة المتحدة	التخصص	علم النفس
عينة الدراسة	معلم - معلمة/ طالب – طالبة – أمهات	الدرجة العلمية	دكتوراه
عنوان الدراسة	كيف تؤثر ردود أفعال البالغين تجاه الرسوب في الرياضيات في المرحلة الابتدائية على معتقدات الأطفال حول قدراتهم في الرياضيات.		
فترة التطبيق	بدءاً من تاريخ١٥/ ٤/ ١٤٤٢ بحسب طلبها ، ولمدة ٩٠يوماً خلال العام الدراسي (١٤٤١هـ-١٤٤٢هـ)		
نوع الإفادة	الموافقة على تطبيق أداتي الدراسة (استبانة المعلم – استبانة التلميذ) في المدارس التابعة للإدارة العامة للتعليم بمنطقة الرياض **الموافقة على تطبيق استبانة أمهات الطلاب بحسب مايسمح به النظام**		

لمن يهمه الأمر...

السلام عليكم ورحمة الله وبركاته وبعد،

بناءً على قرار سعادة مدير عام التعليم بمنطقة الرياض رقم ٣٨٩٢٠٧٩٣ وتاريخ ١٤٣٨/٦/٢٣هـ بشأن تفويض الصلاحية لإدارة التخطيط والتطوير لتسهيل مهمة الباحثين والباحثات.وحيث تقدمت الباحثة (الموضحة بياناتها أعلاه) بالطلب رقم(D-165244) وتاريخ (31/ 10/ ٢٠٢٠م) لإجراء دراستها بداية من التاريخ الموضح اعلاه خلال العام الدراسي الحالي 1441/ 1442هـ وعليه نفيدكم أنه لا مانع من تطبيق الدراسة خلال مدة زمنية محددة بـ (٩٠) يوماً خلال العام الدراسي الحالي، على نطاق مدارس منطقة الرياض، **مع ملاحظة أن الباحثة تتحمل مسؤولية جمع البيانات والحفاظ على سريتها لاستخدامها لأغراض البحث العلمي فقط ،** ولا يعني سماح الإدارة العامة للتعليم، موافقتها بالضرورة على مشكلة البحث أو على الطرق والأساليب المستخدمة في دراستها ومعالجتها.

وبناء على طلبها تم منحها الإفادة.

والله الموفق

إدارة التخطيط والتطوير

D3 Letter to the head of the school

Dear Head of the school,

My name is Alaa Alassaf, and I am conducting a research as a part of my Ph.D. program in psychology school at the University of Southampton in the United Kingdom. The title of my study is how do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

The research aims to investigate how adults' beliefs about and responses to children's failures in maths influences their children's beliefs about their abilities in maths, and how children respond to this. The data from this research is important for us because it will enhance our understanding and help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school. This research involves three online questionnaires which will be sent to both female and male maths teachers who taught pupils in year 4 or 5 (aged 9 and 10) at primary school in Riyadh during the last academic year 2019/2020, their pupils who will be in the 5th and 6th grade this academic year 2020/2021 and their mothers. Participants will be able to complete the questionnaires at a time convenient to them either at school or at home. The entire three questionnaires will take no longer than 10 minutes.

I am writing to you as the head of the school to ask your permission to allow me to conduct my research in your school. Thank you very much for supporting my research.

Yours faithfully,
Alaa Alassaf

If you have any further questions, please do not hesitate to contact me through my email address (asa1e16@soton.ac.uk) or you can contact my supervisor. Dr. Hanna Kovshoff, Associate Professor in Developmental Psychology, University of Southampton, UK (h.kovshoff@soton.ac.uk).

If you have a question about your or the participants rights please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

[23/ 09/ 2020] [Version 2] [Ergo number: 60757]

D4 Teacher letter

Research title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Dear Teacher,

I would like to invite you to take part in a study which we hope the results of which will support and help adults (mothers and teachers) to increase children's motivation which might help them to improve their maths' results at school. This research involves three online questionnaires, **which only include 21 statements and should take no longer than 10 minutes to complete.** More information about this research and the questionnaires can be found on the following barcode, please scan this barcode to complete the questionnaires:

Or you can go to the link below (or you can write it into your device) to complete the questionnaires:

Once you open the barcode or link (please open one of them), you will first read the information sheet, and then if you are happy to participate, **you have to click the consent statement** so you can move to the next step to fill in the questionnaires and finally you will be able to read the debriefing statement.

Your unique personal identification code, is: (e.g.: T1, T2 ...)

Note: You have to write the English letter above as a capital letter.

Please click the box below if you do not wish to take part in this research, and then return this letter to the researcher or reply to the email or text message that you received. ☐

Thank you for taking the time to read the letter and considering taking part in this research.

Yours faithfully,

Alaa Alassaf – PhD student

[20/ 08/ 2020] [Version 1] [Ergo number: 60757]

D5 Mother letter

Research title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Dear Mother,

I would like to invite you and your daughter/son to take part in a study which we hope the results of which will support and help adults (mothers and teachers) to increase children's motivation which might help them to improve their maths' results at school. This research involves three online questionnaires, **which only include 21 statements and should take no longer than 10 minutes to complete.** More information about this research and the questionnaires can be found using the following barcode, please scan this barcode to complete the questionnaires:

Or you can go to the link below (or you can write it into your device) to complete the questionnaires:

Once you open the barcode or link (please open one of them), you will first read the information sheet, and then if you are happy to participate, **you have to click the consent statements** so you can move onto the next step to fill in the questionnaires, and finally you will be able to read the debriefing statement.

Your unique personal identification code, is: (e.g.: M1, M2 ...)

Note: You have to write the English letter above as a capital letter.

Please click the box below if you do not wish to take part in this research, and then return this letter with your child to the researcher or reply to the email or text message that you received.

☐

Thank you for taking the time to read the letter and considering taking part in this research.

Yours faithfully,

Alaa Alassaf – PhD student

[20/ 08/ 2020] [Version 1] [Ergo number: 60757]

D6 Pupil letter

Research title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Dear Pupil,

I would like to invite you to take part in a study which we hope the results of which will support and help adults (mothers and teachers) to increase children's motivation which might help them to improve their maths' results at school. This research involves three online questionnaires, **which only include 19 statements and should take no longer than 10 minutes to complete.** Your mother has given permission for you to take part in this research, however, you can decide whether you would like to participate or not. More information about this research and the questionnaires can be found using the following barcode, which your mother (or your teacher, the social worker or one of the admission staff in your school) will scan this barcode to complete the questionnaires:

Or you or they can go to the link below (or write it into your or their device) to complete the questionnaires:

Once you open the barcode or link (please open one of them), you will first read the information sheet, and then if you are happy to participate, **you have to click the consent statement** so you can move onto the next step to fill in the questionnaires, and finally you will be able to read the debriefing statement.

Your unique personal identification code, is: (e.g.: P1, P2 ...)

Note: You have to write the English letter above as a capital letter.

Please click the box below if you do not wish to take part in this research, and then return this letter to the researcher or reply to the email or text message that your mother received. ☐

Thank you for taking the time to read the letter and considering taking part in this research.

Yours faithfully,

Alaa Alassaf – PhD student

[20/ 08/ 2020] [Version 1] [Ergo number: 60757]

D7 Teacher information sheet and consent statement

Study Title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Researcher: Alaa Alassaf
Supervisors: Dr. Hanna Kovshoff and Dr. James Hall
ERGO number: 60757

Dear Teacher,
You are being invited to take part in the above research study. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others, but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent statement.

What is the research about?
I am conducting this research as a part of my Ph.D. programme at the School of Psychology at the University of Southampton in the United Kingdom. This research is funded by Princess Nourah bint Abdulrahman University. The purpose of this research is to investigate how adults' beliefs and responses to failure in maths influence how children think and feel about their abilities in maths and how they respond to this.

Why have I been asked to participate?
Your school have been randomly chosen to participate in this research, and you have been chosen to participate in this research because you are a maths teacher who taught pupils in year 4 and/or 5 (aged 9 and 10) at a primary school in Riyadh during the last academic year 2019/2020. The research sample will contain three groups: up to 60 maths teachers (30 female and 30 male), up to 60 pupils (30 girls and 30 boys) and their mothers, with a total of 180 participants for all of the groups. Participants will be recruited from state-funded primary schools in Riyadh, Saudi Arabia.

What will happen to me if I take part?
If you decide to take part, you will be asked to fill in three online questionnaires at a time convenient for you. **These questionnaires should take no longer than 10 minutes to complete**. We will also ask you to recruit one random pupil from your class list of the last academic year. To do this, we will need to know how many pupils were on the class list, and we will generate a random number and ask you (or the social worker or one of the admission staff in your school) to recruit this pupil and their mother. If this mother or pupil does not wish to participate, we will give you another random number. Your pupil and their mother will also be asked to fill in three online questionnaires which should take no longer than 10 minutes to complete, at a time convenient for them at their school or home.

Are there any benefits in my taking part?
There will be no personal benefit to you. However, your participation in this research will contribute to a deeper understanding of how adults' (mothers and teachers) beliefs about and responses to their child's/pupils' failure in maths influences their child's/pupils' beliefs about their abilities in maths, and how children respond to this. The data from this research is important for us because it is enhancing our understanding and help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school.

Are there any risks involved?
There are no risks involved for you when you decide to participate in this research. Moreover, if you feel that you would like to withdraw from the questionnaire at any point, you can without penalty, and we will not ask you the reason that you wish to withdraw.

What data will be collected?
This research will only entail completing online questionnaires. A unique personal identification code will be given to each participant (you can find it written in your letter) to hide the real identity of the participants and to link each pupil with their mother and maths' teacher. This means that you will only be referred to by your code because no identifying information (e.g., participants' name) will be collected. However, you will be asked to answer a few demographic questions such as your date of birth and your level of education. Then, **you will be asked to fill in three questionnaires which only include 21 statements** regarding your beliefs about maths' intelligence ability and maths' failure and your responses to your pupil in a situation of failure in maths.

Will my participation be confidential?
The data will only be used for research purposes and no one will have access to the data except members of the research team. In addition, responsible members of the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may also require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

To remind you, no names will be required because each participant will be given a unique personal identification code, so all of the data is entirely confidential. Your participation and the information we collect about you during the course of the research will be kept strictly confidential. In addition, it will be stored securely in electronic data files on a password protected computer or on an encrypted memory device and it will only be available to the researcher and her team. Electronic data will be retained for a period of 10 years, after which they will be destroyed.

Do I have to take part?
No, it is entirely up to you to decide whether or not to take part, as participation is completely voluntary in this research. If you decide you want to take part, you will need to click "I consent" below the consent statement to show you have agreed to take part.

What happens if I change my mind?
You have the right to change your mind and withdraw at any time without giving a reason and without your participant rights being affected. If you wish to stop participating during the questionnaires, you can simply stop answering the questionnaires at any time without penalty. In addition, you can withdraw after filling in the questionnaires by contacting the researcher via her email (asa1e16@soton.ac.uk) to express that you wish to withdraw your consent, together with your personal identification code, which will result in the removal and deletion of your and your pupils' and their mothers data. This can be done at any point up until when the data will begin to be analysed on 08/03/2021.

What will happen to the results of the research?
The results of this research will be included in my thesis for my Ph.D. programme in Psychology school at the University of Southampton in the United Kingdom. It may also be presented at conferences or published in academic journals. However, your personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent. If you wish to receive a summary of the results, please contact me at asa1e16@soton.ac.uk

Where can I get more information?
For more information on this research, please contact me (Alaa Alassaf) at asa1e16@soton.ac.uk

What happens if there is a problem?
If you have a concern about any aspect of this research, you should speak to the researcher (Alaa Alassaf) who will do her best to answer your questions. You can send an email to the researcher at asa1e16@soton.ac.uk. If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

Data Protection Privacy Notice
The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

[06/ 01/ 2021] [Version 4]

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Thank you for taking the time to read the information sheet and considering taking part in this research.

Please click the box below to indicate that you agree with the consent statement:
I have read and understood the teacher information sheet and I agree to participate in this study. □

Please write your personal identification code as written in the letter which was sent to you:

[06/ 01/ 2021] [Version 4]

D8 Mother information sheet and consent statements

Study Title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Researcher: Alaa Alassaf
Supervisors: Dr. Hanna Kovshoff and Dr. James Hall
ERGO number: 60757

Dear Mother,
You are being invited to take part in the above research study. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others, but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent statement.

What is the research about?
I am conducting this research as a part of my Ph.D. programme at the School of Psychology at the University of Southampton in the United Kingdom. This research is funded by Princess Nourah bint Abdulrahman University. The purpose of this research is to investigate how adults' beliefs and responses to failure in maths influence how children think and feel about their abilities in maths and how they respond to this.

Why have I been asked to participate?
You have been randomly chosen from your child class to participate in this research because your daughter or son is in year 5 or 6 (aged 10 and 11) of a primary school in Riyadh. The research sample will contain three groups: up to 60 maths teachers (30 female and 30 male), up to 60 pupils (30 girls and 30 boys) and their mothers, with a total of 180 participants for all of the groups. Participants will be recruited from state-funded primary schools in Riyadh, Saudi Arabia.

What will happen to me if I take part?
If you decide to take part, you will be asked to fill in three online questionnaires at a time convenient for you. **These questionnaires should take no longer than 10 minutes to complete.** Your daughter/son and their maths teacher will also be asked to fill in three online questionnaires which should take no longer than 10 minutes to complete, at a time convenient for them at their school or home.

Are there any benefits in my taking part?
There will be no personal benefit to you. However, your participation in this research will contribute to a deeper understanding of how adults' (mothers and teachers) beliefs about and responses to their child's/pupils' failure in maths influences their child's/pupils' beliefs about their abilities in maths, and how children respond to this. The data from this research is important for us because it is enhancing our understanding and help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school.

Are there any risks involved?
There are no risks involved for you and your child when you decide to participate in this research. Moreover, if you feel that you would like to withdraw from the questionnaire at any point, you can without penalty, and we will not ask you the reason that you wish to withdraw.

What data will be collected?
This research will only entail completing online questionnaires. A unique personal identification code will be given to each participant (you can find it written in your letter) to hide the real identity of the participants and to link each pupil with their mother and maths' teacher. This means that you will only be referred to by your code because no identifying information (e.g., participants' name) will be collected. However, you will be asked to answer a few demographic questions such as your date of birth and your level of education. Then, **you will be asked to fill in three questionnaires which only include 21 statements** regarding your beliefs about maths' intelligence ability and maths' failure and your responses to your child in a situation of failure in maths.

Will my participation be confidential?
The data will only be used for research purposes and no one will have access to the data except members of the research team. In addition, responsible members of the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may also require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

To remind you, no names will be required because each participant will be given a unique personal identification code, so all of the data is entirely confidential. Your participation and the information we collect about you during the course of the research will be kept strictly confidential. In addition, it will be stored securely in electronic data files on a password protected computer or on an encrypted memory device and it will only be available to the researcher and her team. Electronic data will be retained for a period of 10 years, after which they will be destroyed.

Do I have to take part?
No, it is entirely up to you to decide whether or not to take part, as participation is completely voluntary in this research. If you decide you want to take part, you will need to click "I consent" below the consent statements to show you have agreed to take part.

What happens if I change my mind?
You and your child have the right to change your mind and withdraw at any time without giving a reason and without your participant rights being affected. If you or your child wish to stop participating during the questionnaires, you can both simply stop answering the questionnaires at any time without penalty. In addition, you and your child can withdraw after filling in the questionnaires by contacting the researcher via her email (asa1e16@soton.ac.uk) to express that you wish to withdraw your and your child's consent, together with your personal identification codes, which will result in the removal and deletion of your data. This can be done at any point up until when the data will begin to be analysed on 08/03/2021.

What will happen to the results of the research?
The results of this research will be included in my thesis for my Ph.D. programme in Psychology school at the University of Southampton in the United Kingdom. It may also be presented at conferences or published in academic journals. However, you and your child's personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent. If you wish to receive a summary of the results, please contact me at asa1e16@soton.ac.uk

Where can I get more information?
For more information on this research, please contact me (Alaa Alassaf) at asa1e16@soton.ac.uk

What happens if there is a problem?
If you have a concern about any aspect of this research, you should speak to the researcher (Alaa Alassaf) who will do her best to answer your questions. You can send an email to the researcher at asa1e16@soton.ac.uk. If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

Data Protection Privacy Notice
The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

[06/ 01/ 2021] [Version 4]

For the purposes of data protection law, the University of Southampton is the 'Data Controller' for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for 10 years after the study has finished after which time any link between you and your information will be removed.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University's data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University's Data Protection Officer (data.protection@soton.ac.uk).

Thank you for taking the time to read the information sheet and considering taking part in this research.

Please click the two boxes below to indicate that you agree with the consent statements:

I have read and understood the mother information sheet and I agree to participate in this study. □

I give consent for my daughter/son to take part in this research project and agree for her/his data to be used for the purpose of this study. □

Please write your personal identification code as written in the letter which was sent to you:

D9 Pupil information sheet and consent statement

Study Title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Researcher: Alaa Alassaf
Supervisors: Dr. Hanna Kovshoff and Dr. James Hall
ERGO number: 60757

Dear Pupil,
You are being invited to take part in the above research study. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research.

Why are we doing this research?
We are doing this research to investigate how adults' beliefs and responses to failure in maths influence how children think and feel about their abilities in maths and how they respond to this.

Why have I been asked to participate?
You have been randomly chosen from your class to participate in this research because you are a pupil in year 5 or 6 (aged 10 and 11) at a primary school in Riyadh. In addition, your mother and your maths' teacher who taught you in the last academic year 2019/2020 took part in this research.

How many participants will take part in this research?
The research sample will contain three groups: up to 60 maths teachers (30 female and 30 male), up to 60 pupils (30 girls and 30 boys) and their mothers, with a total of 180 participants for all of the groups. Participants will be recruited from state-funded primary schools in Riyadh, Saudi Arabia.

What will happen to me if I take part?
If you decide you want to take part, you will be asked to:

1. Click "I consent" below the consent statement to show you have agreed to take part.
2. Write your personal identification code as written in the letter which was sent to you.
3. Fill in three online questionnaires at a time convenient for you. These questionnaires should take no longer than 10 minutes to complete.

Are there any benefits in my taking part?
There will be no personal benefit to you. However, your participation in this research will contribute to a deeper understanding of how adults' (mothers and teachers) beliefs about and responses to their child's/pupils' failure in maths influences their child's/pupils' beliefs about their abilities in maths, and how children respond to this. The data from this research is important for us because it is enhancing our understanding and help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school.

Are there any risks involved?
There are no risks involved for you and your mother when you decide to participate in this research. Moreover, if you feel that you would like to withdraw from the questionnaire at any point, you can without penalty, and we will not ask you the reason that you wish to withdraw.

What data will be collected?
1. You will be asked to choose your age and your level of education.
2. You will be asked to fill in three online questionnaires which only include 19 statements regarding your beliefs about maths' intelligence ability and maths' failure and your responses in a situation of failure in maths.

Will my participation be confidential?
Yes, the data will only be used for research purposes and no one will have access to the data except members of the research team and responsible members of the University of Southampton.

Do I have to take part?
No, it is entirely up to you to decide whether or not to take part, as participation is completely voluntary in this research.

What happens if I change my mind?
You have the right to change your mind and withdraw at any time without giving a reason.
- If you wish to stop participating during the questionnaires, you can simply stop answering the questionnaires at any time without penalty.
- You and your mother can withdraw after filling in the questionnaires by contacting me (Alaa Alassaf) at asa1e16@soton.ac.uk before 08/03/2021 to tell me that you wish to withdraw your and your mother's consent, together with your personal identification codes, which will result in the removal and deletion of your data.

What will happen to the results of the research?
The results of this research will be included in my thesis for my Ph.D. programme in Psychology school at the University of Southampton in the United Kingdom. It may also be presented at conferences or published in academic journals. However, you and your mother's personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent. If you wish to receive a summary of the results, please contact me at asa1e16@soton.ac.uk

Where can I get more information?
For more information on this research, please contact me (Alaa Alassaf) at asa1e16@soton.ac.uk

What happens if there is a problem?
If you have a concern about any aspect of this research, you should speak or send an email to the researcher (Alaa Alassaf at asa1e16@soton.ac.uk.) who will do her best to answer your questions. If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

[06/ 01/ 2021] [Version 4]

Thank you for taking the time to read the information sheet and considering taking part in this research.

Please click the box below to indicate that you agree with the consent statement:

I have read and understood the pupil information sheet and I agree to participate in this study. □

Please write your personal identification code as written in the letter which was sent to you:

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D10 Teacher debriefing statement

Title of research: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Debriefing Statement (Version 1, date 20/ 08/ 2020)

ERGO ID: 60757

Dear Teacher,

Thank you very much for your help and participation in this research.

The aim of this research is to investigate how adults' beliefs about and responses to children's failures in maths influences their children's beliefs about their abilities in maths, and how children respond to this. It is expected that adults' beliefs about maths' intelligence and failure and their responses to their child/pupil in the case of failure in maths might impact their child/pupil beliefs about their maths' abilities, which in turn may influence their maths achievement. Thus, your data is important because it will help us to develop a deeper understanding of this issue in Saudi Arabia, and it will help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school.

Once again, let us remind you that the results of this research will not include any personal details such as your name or any other identifying characteristics, and that your details will be number coded. The research has not used deception. If you have any further questions about the research or if you wish to receive a summary of the research findings once the research has been completed, please contact me Alaa Alassaf at asa1e16@soton.ac.uk.

Thank you again for your participation. I appreciate it.

Name: Alaa Alassaf Signature: Alaa Date: 20/ 08/ 2020

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

UNIVERSITY OF Southampton

D11 Mother debriefing statement

Title of research: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Debriefing Statement (Version 1, date 20/ 08/ 2020)

ERGO ID: 60757

Dear Mother,

Thank you very much for your help and participation in this research.

The aim of this research is to investigate how adults' beliefs about and responses to children's failures in maths influences their children's beliefs about their abilities in maths, and how children respond to this. It is expected that adults' beliefs about maths' intelligence and failure and their responses to their child/pupil in the case of failure in maths might impact their child/pupil beliefs about their maths' abilities, which in turn may influence their maths achievement. Thus, your data is important because it will help us to develop a deeper understanding of this issue in Saudi Arabia, and it will help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school.

Once again, let us remind you that the results of this research will not include any personal details such as your name or any other identifying characteristics, and that your details will be number coded. The research has not used deception. If you have any further questions about the research or if you wish to receive a summary of the research findings once the research has been completed, please contact me Alaa Alassaf at asa1e16@soton.ac.uk.

Thank you again for your participation. I appreciate it.

Name: Alaa Alassaf Signature: Alaa Date: 20/ 08/ 2020

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

UNIVERSITY OF Southampton

D12 Pupil debriefing statement

Title of research: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Debriefing Statement (Version 1, date 20/ 08/ 2020)

ERGO ID: 60757

Dear Pupil,

Thank you very much for your help and participation in this research.

The aim of this research is to investigate how adults' beliefs about and responses to children's failures in maths influences their children's beliefs about their abilities in maths, and how children respond to this. It is expected that adults' beliefs about maths' intelligence and failure and their responses to their child/pupil in the case of failure in maths might impact their child/pupil beliefs about their maths' abilities, which in turn may influence their maths achievement. Thus, your data is important because it will help us to develop a deeper understanding of this issue in Saudi Arabia, and it will help us to support and help adults to increase children's motivation which might help them to improve their maths' results at school.

Once again, let us remind you that the results of this research will not include any personal details such as your name or any other identifying characteristics, and that your details will be number coded. The research has not used deception. If you have any further questions about the research or if you wish to receive a summary of the research findings once the research has been completed, please contact me Alaa Alassaf at asa1e16@soton.ac.uk.

Thank you again for your participation. I appreciate it.

Name: Alaa Alassaf Signature: Alaa Date: 20/ 08/ 2020

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk).

D13 Teacher questionnaires

Research title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Ergo number: 60757

Thank you for agreeing to take part in this research.

In this questionnaire, first, we want you to complete some demographic information, and then we want you to read a scenario. After that, we would like you to fill in three questionnaires.

Please remember:

- There are no right or wrong answers. We want to know what you think and feel.
- You do not need to spend much time on any one question – use your first instinct to decide on your answer.
- These questionnaires are anonymous and nobody outside of the research team will see your answers.

Please fill in the following demographic information about yourself:

1) What is your date of Birth? ___ ___/___ ___/___ ___ ___ ___

D D M M Y Y Y Y

2) What is your gender?

☐ Female

☐ Male

3) What is your level of education?

☐ Diploma's degree

☐ Bachelor's degree

☐ Master's degree

☐ Doctorate or above (e.g., Associate Professor)

4) Is your degree in the mathematics field?

☐ Yes

☐ No

Now, we would like you to read a scenario. While reading, imagine you are the teacher of this [5th or 6th grade] pupil and that this really happened to your pupil; try to picture how you would feel and what you would think and do if it happened.

One of your students in your classroom in [5th or 6th grade] s/he likes maths and you and thinks s/he knows the subject pretty well, so s/he studies a medium amount for the exam at the end of the first semester. After the exam, you see him/her and s/he said that s/he thinks it went okay, even though there were some questions that were confusing. Then, after correcting his/her exam paper at the end of the first semester you find that s/he only got a score of 9 out of 30 in the maths exam - that's an F in maths.

Response questionnaire

Please indicate how likely you would be to have each of the reactions below, which reflect your responses to your pupil in a situation of failure in maths. Make sure that your answer is in the correct box.

	Strongly disagree 1	**Moderately disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Moderately agree 5**	**Strongly agree 6**
1. I might worry (at least for a moment) that my pupil isn't good in maths.						
2. I'd consider whether my pupil had enough ability in maths.						
3. I'd feel sorry for my pupil.						
4. I might feel a bit bad about myself as a teacher.						
5. I'd probably find myself dwelling on his/her performance in maths.						
6. I'd try to comfort my pupil to tell her/him it's okay if s/he isn't the most talented in all subjects.						
7. I'd think my pupil just didn't study hard enough for the maths' exam.						
8. I'd think my pupil didn't go about studying in the						

right way for the maths exam.						
9. I'd encourage my pupil to tell me what s/he learned from doing poorly in the maths' exam.						
10. I'd discuss how s/he can use these kinds of mistakes to really master maths subject.						
11. I'd let my pupil know that this is a great opportunity to learn this maths material well.						
12. I'd discuss with my pupil whether it would be useful to ask their parents for help.						

Maths failure mindset questionnaire

Please indicate how much you agree or disagree with each statement below, which describe your beliefs about maths' failure. Make sure that your answer is in the correct box.

	Strongly disagree **1**	**Moderately disagree** **2**	**Slightly disagree** **3**	**Slightly agree** **4**	**Moderately agree** **5**	**Strongly agree** **6**
1. Experiencing failure in maths enhances performance and productivity.						
2. Experiencing failure in maths facilitates learning and growth.						
3. The effects of failure in maths are positive and should be utilized.						
4. Experiencing failure in maths debilitates performance and productivity.						
5. Experiencing failure in maths inhibits						

learning and growth.						
6. The effects of failure in maths are negative and should be avoided.						

Maths intelligence mindset questionnaire

Please indicate how much you agree or disagree with each statement below, which describe your beliefs about maths' intelligence ability. Make sure that your answer is in the correct box.

	Strongly disagree 1	**Moderately disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Moderately agree 5**	**Strongly agree 6**
1. Your pupil maths intelligence is something about her/him that s/he can't change very much.						
2. Your pupil can learn new things, but s/he can't really change her/his basic maths intelligence.						
3. Your pupil has a certain amount of maths intelligence and s/he really can't do much to change it.						

D14 Mother questionnaires

Research title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Ergo number: 60757

Thank you for agreeing to take part in this research.

In this questionnaire, first, we want you to complete some demographic information, and then we want you to read a scenario. After that, we would like you to fill in three questionnaires.

Please remember:

- There are no right or wrong answers. We want to know what you think and feel.
- You do not need to spend much time on any one question – use your first instinct to decide on your answer.
- These questionnaires are anonymous and nobody outside of the research team will see your answers.

Please fill in the following demographic information about yourself:

1) What is your date of birth? ___ ___/___ ___/___ ___ ___ ___

D D M M Y Y Y Y

2) What is your level of education?

☐ Primary school graduate

☐ Middle school graduate

☐ High school graduate

☐ Diploma's degree

☐ Bachelor's degree

☐ Master's degree

☐ Doctorate degree or above (e.g., Associate Professor)

Now, we would like you to read a scenario. While reading, imagine you are the mother of this [5th or 6th grade] pupil and that this really happened to your child; try to picture how you would feel and what you would think and do if it happened.

Your child starts a new maths class at the beginning of his/her [5th or 6th grade] year. S/he likes maths and the teacher and thinks s/he knows the subject pretty well, so s/he studies a medium amount for the exam at the end of the first semester. Afterwards, your child says that s/he thinks it went okay, even though there were some questions that were confusing. Then, you open the Noor program to see your child's report for the first semester and find that s/he only got a score of 9 out of 30 in the maths exam - that's an F in maths.

Response questionnaire

Please indicate how likely you would be to have each of the reactions below, which reflect your responses to your child in a situation of failure in maths. Make sure that your answer is in the correct box.

	Strongly disagree 1	**Moderately disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Moderately agree 5**	**Strongly agree 6**
1. I might worry (at least for a moment) that my child isn't good in maths.						
2. I'd consider whether my child had enough ability in maths.						
3. I'd feel sorry for my child.						
4. I might feel a bit bad about myself as a parent.						
5. I'd probably find myself dwelling on his/her performance in maths.						
6. I'd try to comfort my child to tell her/him it's okay if s/he isn't the most talented in all subjects.						
7. I'd think my child just didn't study hard enough for the maths' exam.						
8. I'd think my child didn't go about studying in the right way for the maths exam.						

9. I'd encourage my child to tell me what s/he learned from doing poorly on the maths' exam.						
10. I'd discuss how s/he can use these kinds of mistakes to really master maths subject.						
11. I'd let my child know that this is a great opportunity to learn this maths material well.						
12. I'd discuss with my child whether it would be useful to ask the maths' teacher for help.						

Maths failure mindset questionnaire

Please indicate how much you agree or disagree with each statement below which describe your beliefs about maths' failure. Make sure that your answer is in the correct box.

	Strongly disagree 1	**Moderately disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Moderately agree 5**	**Strongly agree 6**
1. Experiencing failure in maths enhances performance and productivity.						
2. Experiencing failure in maths facilitates learning and growth.						
3. The effects of failure in maths are positive and should be utilized.						
4. Experiencing failure in maths debilitates performance and productivity.						
5. Experiencing failure in maths inhibits learning and growth.						
6. The effects of failure in maths are negative and should be avoided.						

[22/ 09/ 2020] [Version 2]

Maths intelligence mindset questionnaire

Please indicate how much you agree or disagree with each statement below which describe your beliefs about maths intelligence ability. Make sure that your answer is in the correct box.

	Strongly disagree **1**	**Moderately disagree** **2**	**Slightly disagree** **3**	**Slightly agree** **4**	**Moderately agree** **5**	**Strongly agree** **6**
1. Your child's maths intelligence is something about her/him that s/he can't change very much.						
2. Your child can learn new things, but s/he can't really change her/his basic maths intelligence.						
3. Your child has a certain amount of maths intelligence and s/he really can't do much to change it.						

D15 Pupil questionnaires

Research title: How do adults' responses to failures in maths at primary school influence children's beliefs about their maths abilities.

Ergo number: 60757

Thank you for agreeing to take part in this research.

In this questionnaire, first, we want you to complete some demographic information, and then we want you to read a scenario. After that, we would like you to fill in three questionnaires.

Please remember:

- There are no right or wrong answers. We want to know what you think and feel.
- You do not need to spend much time on any one question – use your first instinct to decide on your answer.
- These questionnaires are anonymous and nobody outside of the research team will see your answers.

Please fill in the following demographic information about yourself:

1) What is your age? (please choose your age from the following choices)

☐ 9 years old.

☐ 10 years old.

☐ 11 years old.

☐ 12 years old.

2) What is your grade during this academic year?

☐ Year 5 in primary stage.

☐ Year 6 in primary stage.

Now, we would like you to read a scenario. While reading, imagine you are this [5th or 6th grade] pupil and that this really happened to you; try to picture how you would feel and what you would think and do if it happened.

You start a new maths class at the beginning of your [5th or 6th grade] year. You like maths and your teacher and think you know the subject pretty well, so you study a medium amount for the exam at the end of the first semester. Afterwards, your parents asked you about the exam and you said that you think it went okay, even though there were some questions that were confusing. Then, you open the Noor program to see your report for the first semester (or you received your report from the school) and you find that you only got a score of 9 out of 30 in the maths exam - that's an F in maths.

Response questionnaire

Please indicate how likely you would be to have each of the reactions below, which reflect your responses in a situation of failure in maths. Make sure that your answer is in the correct box.

	Strongly disagree **1**	**Moderately disagree** **2**	**Slightly disagree** **3**	**Slightly agree** **4**	**Moderately agree** **5**	**Strongly agree** **6**
1. I might worry (at least for a moment) that I am not good in maths.						
2. I'd consider whether I have enough ability in maths.						
3. I'd feel sorry for myself.						
4. I might feel a bit bad about myself as a maths learner.						
5. I'd probably find myself dwelling on my performance in maths.						
6. I'd try to comfort myself that it's okay if I'm not the most talented in all subjects.						
7. I'd think I'm just didn't study hard enough for the maths' exam.						
8. I'd think I didn't go about studying in the right way for the maths exam.						

9. I'd think about what I learned from doing poorly on the maths' exam.						
10. I'd think how I can use these kinds of mistakes to really master maths subject.						
11. I'd think that this is a great opportunity to learn this maths material well.						
12. I'd think whether it would be useful to ask my maths' teacher or parents for help.						

Maths failure mindset questionnaire

Please indicate how much you agree or disagree with each statement below which describe your beliefs about maths' failure. Make sure that your answer is in the correct box.

	Strongly disagree **1**	**Moderately disagree** **2**	**Slightly disagree** **3**	**Slightly agree** **4**	**Moderately agree** **5**	**Strongly agree** **6**
1. I think failure in maths is bad and should be avoided.						
2. I think failure in maths hurts my learning.						
3. I think failure in maths can help me learn.						
4. I think failure in maths can help me grow.						

Maths intelligence mindset questionnaire

Please indicate how much you agree or disagree with each statement below, which describe your beliefs about maths' intelligence ability. Make sure that your answer is in the correct box.

	Strongly disagree **1**	**Moderately disagree** **2**	**Slightly disagree** **3**	**Slightly agree** **4**	**Moderately agree** **5**	**Strongly agree** **6**
1. Your maths intelligence is something about you that you can't change very much.						
2. You can learn new things, but you can't really change your basic maths intelligence.						
3. You have a certain amount of maths intelligence and you really can't do much to change it.						