# University of Southampton

Faculty of Environmental and Life Sciences

School of Psychology

**Reviewing Self-efficacy Interventions and Exploring Experiences of Resitting GCSE Mathematics**

by

Yasmin Abdul Kahar Bador

ORCID ID https://orcid.org/0000-0002-6081-9814

Thesis for the degree of Doctorate in Educational Psychology

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# University of Southampton

## Abstract

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Research has increasingly focused on understanding and improving students' academic performance. Academic success rests not only on academic elements but also factors such as motivation and self-efficacy. Educators and policymakers alike are interested in improving students' mathematics performance. Students experience pressure to perform, especially in high-stakes exams. This study explored the issues facing students learning mathematics with two papers; a systematic review and meta-analysis investigating whether self-efficacy and mathematics self-efficacy interventions improve mathematics performance, and a qualitative study to explore students' experiences resitting the high-stakes General Certificate of Secondary Education (GCSE) mathematics exams.

The first paper conducted a systematic review and meta-analysis of interventions for self-efficacy or mathematics self-efficacy that aimed to positively change the mathematics performance in students aged 11-25 years. Twenty-two papers were included in the meta-analysis. The analysis of the mathematics performance outcome produced an average random effect of $g$ = 0.21, 95% CI [0.02, 0.41]. The results indicated that the included interventions had a small but significant effect on mathematics performance. Issues with the instruments used in the included studies and with the studies' designs were highlighted. The heterogeneity across the studies and the small number of studies available were considered in interpreting the results.

In the second paper, eleven Further Education college students aged 16-19 years were interviewed about their experiences of resitting the GCSE mathematics exams. The data were coded using inductive framework analysis. Thematic analysis was used to develop four themes; 1) Struggling with Mathematics, 2) Learning That Works, 3) Relying on Others, 4) Being Left Behind. The findings show a complex picture of students who had previous negative education experiences but re-engaged with learning. Student-teacher relationships were found to be key for students to re-engage in learning and be confident in mathematics. The implications of the findings from the papers for practitioners, researchers and policymakers are discussed.

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# Research Thesis: Declaration of Authorship

Print name: Yasmin Abdul Kahar Bador

Title of thesis: Reviewing Self-Efficacy Interventions and Exploring Experiences of Resitting GCSE Mathematics

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;

Signature: Date: 7th June 2021

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# Definitions and Abbreviations

$\alpha$ ....................................... Cronbach's Alpha. A measure of internal consistency often used to measure scale reliability.

a priori................................. Knowledge that is acquired beforehand from theory or evidence as opposed to from the data in the study

analytical framework ........... In framework analysis describes “a set of codes organised into categories that have been jointly developed by researchers involved in analysis that can be used to manage and organise the data” (Gale et al., 2013, p. 1)

bottom-up coding ............... Developing codes from the raw data before moving on to the higher levels were groups of codes are created

categories............................ In framework analysis describes the grouping of codes “into clusters around similar and interrelated ideas or concepts” (Gale et al., 2013, p. 1)

CI ......................................... 95% Confidence Interval

codebook ............................ In qualitative studies describes a list of definitions of themes, subthemes and codes.

d .......................................... Cohen's d. The effect size for the standardised difference between two means.

df ......................................... Degrees of freedom

domains of bias .................. Assessments of bias in different aspects of trial design, conduct, and reporting a systematic review (Higgins, Thomas, et al., 2020)

ES ........................................ Effect size

flat structure ....................... In Atlas.ti describes the organisations of codes with minimal levels of code management

*g* .......................................... The Hedge's g statistic indicating the effect size for the difference between means

GCSE .................................... General Certificate of Secondary Education

Grand Tour .......................... Open-ended questions as described by ethnographer James Spradley (Spradley, 1979) which encourage participants to describe events and experiences

$I^2$ .......................................... The percentage of variance that is attributable to study heterogeneity in a meta-analysis in vivo codes ........................ Codes derived from participants' actual words

network diagram ................ Facility in Atlas.ti to create diagrams that help represent and explore conceptual structures

p-value (p)........................... Probability value

QM ...................................... Quadratic Mean

r........................................... Correlation coefficient

risk of bias........................... An assessment of the level of risk systematic error, or deviation from the truth, in results or inferences (Higgins, Thomas, et al., 2020).

signalling questions ............ Questions that elicit information about the study that is relevant to risk of bias (Higgins, Thomas, et al., 2020)

$Tau^2$..................................... An estimate of the between-study variance of the true effect sizes in a random effects meta-analysis

Z .......................................... Z-tests results which are the significance tests for the weighted average effect size

# Chapter 1 Do Interventions for Self-Efficacy and Mathematics Self-Efficacy Improve Mathematics Performance? A Systematic Review and Meta-analysis

## 1.1 Introduction

The influence of self-beliefs on academic performance has been of interest to researchers and policymakers for many years (Schunk et al., 2016; Seon Ahn et al., 2019). Bandura (1997) defined self-efficacy as an individual's belief in their ability to plan and carry out the tasks needed to achieve the desired outcome. Unlike global judgments of self-worth, self-efficacy is a domain-specific belief that results from evaluating one's own performance on a particular task (Bandura, 1997). Self-efficacy is linked to academic motivation, self-regulatory learning strategies, and persistence (Honicke et al., 2016). Research has demonstrated a positive relationship between self-efficacy and academic performance (Honicke et al., 2016; Multon et al., 1991). Self-efficacy is predictive of students' interest in science, technology, engineering, and mathematics (STEM) and the choice of future careers in the area (Betz et al., 1983; Lent et al., 1997). As a result, educators and policymakers are interested in fostering students' self-efficacy.

Policymakers use international educational assessments such as the Programme for International Student Assessment (PISA) to inform educational strategies. For example, in 2012, the Programme for International Student Assessment (PISA) asked 15-year-old students across 79 countries about their self-efficacy in mathematics (OECD, 2013a). The results showed that the difference in mathematics performance points explained by students' mathematics self-efficacy was equivalent to one school year. The findings demonstrate that self-efficacy plays an important role in student achievement worldwide.

The association between self-efficacy and academic performance has led to much research focusing on students' self-efficacy (Schunk et al., 2016; Seon Ahn et al., 2019). Practitioners and researchers are particularly interested in effective self-efficacy interventions (Warner et al., 2020). Although reviews have been conducted on interventions in different domains, such as reading interventions (Unrau et al., 2018) and the effects of self-assessment (Panadero et al., 2017), additional research is still needed to understand the usefulness of self-efficacy interventions in the development of best practice for teaching and learning in the classroom.

The purpose of this systematic review and meta-analysis was to examine the effectiveness of intervention studies on students' self-efficacy or mathematics self-efficacy in improving their mathematics performance. The next section outlines the self-efficacy construct with reference to Bandura's social cognitive theory (Bandura, 1997). Following that, an overview of existing evidence on the relationship between self-efficacy and academic performance prefaces a discussion on interventions. The research aims are presented before the review methods are outlined. The results and discussion conclude this study.

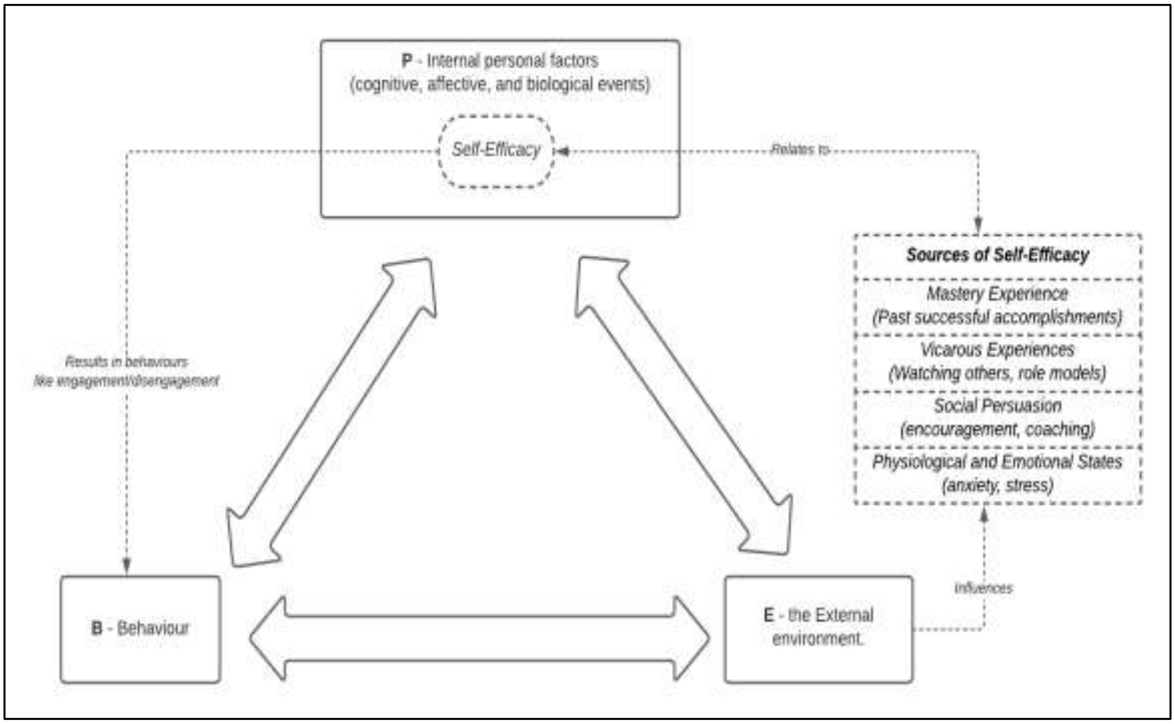
## 1.2 Background

### 1.2.1 Self-Efficacy and Social Cognitive Theory

Self-efficacy is a construct that Bandura developed as part of the Social Cognitive Theory (SCT) (Bandura, 1977, 1997). SCT is based on the idea that humans have agency, control their environment, and shape their future actions through intentionality and planning (Bandura, 2001). In Bandura's model of *triadic reciprocal causation* (1997), personal factors such as cognitive, affective, and biological processes interact with behavioural patterns and the environment (Bandura, 1997, 2012). Self-efficacy perceptions influence people's development of optimistic or pessimistic beliefs about their capabilities (Bandura, 2001).

**Figure 1**

*An Adapted Version of Bandura's Triadic Reciprocal Causation Model*




Bandura proposed four sources of self-efficacy: mastery experiences, vicarious experiences, social persuasion, and physiological and emotional states (Bandura, 1978, 1997). Figure 1 presents an adapted version of Bandura's model, showing self-efficacy as part of an individual's personal factors that determine their behaviour, with an example of students' engagement in lessons. The figure indicates the four sources of self-efficacy which are: mastery experiences gained for example through past successful accomplishments, vicarious experience gained through watching others such as role models, social persuasion via encouragement or coaching from others, and the individual's physiological and emotional states for example anxiety or stress. Lent et al. (1996) constructed and tested their four-factor model in two studies with 1295 and 481 students. Their model fitted the data well for the samples in both studies. They concluded that there was strong support that self-efficacy is made up of four factors as Bandura suggested.

Bandura suggested that children's self-efficacy is influenced by external sources, such as interactions with peers, teachers, and classroom structures (Bandura, 1994). Children's self-efficacy is enhanced by observing positive models and experiencing home contexts that facilitate mastery experiences (Schunk et al., 2016). In a study of American middle school students (n = 319) (11-13-years), all four sources of self-efficacy (mastery experiences, vicarious experiences, social persuasion, and physiological and emotional states) correlated with science self-efficacy (Britner et al., 2006). However, the only significant self-efficacy predictor was direct mastery experiences.

Byars-Winston et al.'s (2017) meta-analysis of 28 studies on the academic self-efficacy across 8965 participants support the notion that direct experiences strongly contribute to self-efficacy. Their path model demonstrated that personal achievements strongly predicted self-efficacy (correlation coefficient [r] = 0.51; CI [0.46, 0.56]). Social persuasion (r = 0.37, CI [0.31, 0.43]) and vicarious learning (r =.30, CI [0.25, 0.35]) were also positively associated with self-efficacy, but affective factors were not (r = 0.06, CI [0.06, 0.18]).

A study of 350 American undergraduates found that mathematics self-efficacy most strongly (r = 0.70) predicted mathematics performance compared to commonly presumed variables, including gender, previous achievement, and self-concept (Pajares et al., 1994). Previous achievement (r = 0.44) and mathematics self-concept had modest effects (r = 0.54). The distinctions between self-concept and self-efficacy are discussed next.

### 1.2.2 Self-Efficacy and Related Constructs

Researchers have differentiated self-belief constructs, such as self-esteem, self-concept, and self-efficacy (Bong et al., 2003; Seon Ahn et al., 2019). However, the understanding and conceptualising of the different self-belief constructs are sometimes unclear (Bong et al., 2003). Self-esteem refers to an individual's global evaluation of oneself (Rosenberg et al., 1995). Shavelson and Bolus (1982) proposed that self-concept describes an individual's perception of themselves, shaped by their experiences and understanding of interactions with others and the environment.

Self-concept is considered a relatively stable psychological construct (Bandura, 1977; Bong & Skaalvik, 2003), whereas self-efficacy is proposed to be malleable to interventions (Seon Ahn et al., 2019). Self-concept refers to past experiences, whereas self-efficacy evaluates future possibilities (Seon Ahn et al., 2019). For example, "I am a good mathematics student" (self-concept) and "I am confident I can solve mathematics problems" (self-efficacy). Bong and Skaalvik (2003) suggested that self-concept and self-efficacy share characteristics, such as referring to perceived competence and deriving information from mastery experiences, social comparisons and reflected appraisals.

Self-concept and self-efficacy have domain-specific and multidimensional features (Bong et al., 2003; Seon Ahn et al., 2019). An individual's self-concept represents an accumulated view of the individual (Shavelson et al., 1982). Sub-domains such as the academic, physical, social, and emotional areas reside in a hierarchical structure, and domain-specific improvements lead to general self-concept improvements (Bong et al., 2003). Self-efficacy is similarly multidimensional, as individuals develop different beliefs across different domains, but it is also context-specific (Seon Ahn et al., 2019). Being generally self-efficacious does not automatically translate to self-efficacy in other areas. The next section outlines the academic and mathematics domains of self-efficacy.

### 1.2.3 Academic and Mathematics Self-Efficacy Definitions

Academic self-efficacy is a student's belief that they can achieve their expectations in academic tasks (Schunk et al., 2016; Seon Ahn et al., 2019). Academic self-efficacy can be specific to a task, subject, or domain, for example, logical reasoning, mathematics self-efficacy, or academic self-efficacy. Educational research on self-efficacy has focused on four areas: self-efficacy development; self-efficacy influences on educational and career choices; self-efficacy correspondence to achievement and other related constructs such as motivation and self-regulation; and how teachers' self-efficacy influences students' performance(Seon Ahn et al., 2019). Researchers have identified various forms of self-efficacy in different educational contexts (Schunk et al., 2016), such as self-efficacy for learning (Schunk, 1996) and mathematics self-efficacy (Betz et al., 1983).

Hackett and Betz (1989, p. 262) defined mathematics self-efficacy as "a situational or problem-specific assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular [mathematics] task or problem". Lee (2009) demonstrated through factor analysis that self-concept, mathematics self-efficacy, and mathematics anxiety are independent constructs. The study used data from 41 countries in the PISA 2003 project and concluded that the constructs can be generalised between countries.

The notion that self-efficacy and self-concept are separate constructs concurs with Lent et al.'s (1997) confirmatory factor analysis of the data from 205 university students. Additionally, their findings support earlier studies that self-efficacy predicts math-related subject choices. In Betz and Hackett's (1983) study of 262 undergraduates and Hackett and Betz's (1989) study of 153 college students, mathematics self-efficacy predicted mathematics subject choices. Betz and Hackett (1983) also developed an assessment of self-efficacy for math-related tasks. The next section discusses measures of self-efficacy.

### 1.2.4 Self-Efficacy Instruments

Bandura stated in his guide to constructing self-efficacy scales that there is "no all-purpose measure of perceived self-efficacy" (Bandura, 2006, p. 307). Instead, he suggested that a domain-specific scale was needed. Perceived self-efficacy must be differentiated from the other constructs and outcome expectations. Such measures are valuable for predicting self-efficacy patterns and hypothesis testing (Bandura, 2006). A constructed scale achieves better accuracy by having specific questions about the task demands which are unique to each domain (Bandura, 2006).

Self-efficacy is typically assessed through self-report measures of the strength of an individual's beliefs and general confidence in achieving the desired outcome. Scales for general self-efficacy have been designed for adults (Schwarzer et al., 2010), children (Bandura, 2006; de Cássia Martinelli et al., 2009), adolescents (Muris, 2001), and college students (Owen et al., 1988). Self-efficacy measures have been used to study students' general academic efficacy (Bandura, 2006), in studies of domain-specific tasks such as reading and writing tasks (Unrau et al., 2018) and to investigate students' mathematics self-efficacy (Betz et al., 1983; Hackett et al., 1989; Lee, 2009).

There are limited mathematics self-efficacy instruments available (Kranzler et al., 1997). An example is a questionnaire used in the PISA survey in 2012 (OECD, 2013b) that asked students to rate their confidence in solving mathematics problems, for example, calculating a car's petrol consumption or solving basic algebra equations. The more established scale is the 52-item Mathematics Self-Efficacy Scale (MSES) developed by Betz and Hackett (1983). Students rate themselves from 0 to 9 (not at all to completely confident) in three domains: solving mathematics problems, for example, basic algebra and calculating distances, doing everyday mathematics, for example, splitting a bill, and performing mathematical college courses. The problem scale was based on Dowling's (1978) initial mathematics confidence scale for female college students. The MSES (overall $\alpha = 0.96$) consisted of 18 mathematics tasks ($\alpha = 0.90$), 16 math-related college course problems ($\alpha = 0.93$), and 18 mathematics problems ($\alpha = 0.92$). Examination of MSES suggests that psychometric properties are well grounded (Betz et al., 1983; Hackett et al., 1989; Pajares et al., 1995).

The MSES was revised for college students by incorporating Dowling's (1978) final problem scale and a reduced 5-point rating scale (Kranzler et al., 1997). The MSES-R scale and subscales were found to be valid and reliable (mathematics task $\alpha = 0.91$, course problems $\alpha = 0.92$, mathematics problems $\alpha =$

0.90). Recently, Pampaka et al. (2011) designed a scale based on the MSES to measure post-compulsory education students' self-efficacy. The MSES has been used to measure mathematics self-efficacy and to study the construct's relationship with career choice and academic performance (Kranzler et al., 1997). The relationship between self-efficacy and academic performance is discussed below.

### 1.2.5 Self-Efficacy and Academic Performance

Bandura suggested that self-efficacious students are more likely to challenge themselves, try harder, and persevere at tasks (Bandura, 1977). Evidence from systematic reviews shows a relationship between self-efficacy and academic performance. In a systematic review of 36 studies of 4998 participants with an average age of 16.6 years, Multon et al. (1991) demonstrated in the meta-analysis across different student samples, academic settings, designs, and criterion measures, self-efficacy beliefs were significantly related to academic performance ($r = 0.38$, CI [0.36, 0.41]). The findings are supported by Honicke and Broadbent's (2016) meta-analysis of 53 studies of 14,755 participants which found a moderate correlation between academic self-efficacy and academic achievement ($r = 0.33$, CI [0.28, 0.37]). The effect size was moderated by the achievement outcome measures ($QM = 27.89$, $df = 12$, $p = 0.005$) and self-efficacy measures ($QM = 60.73$, $df =25$, $p < 0.0001$). A systematic review of 64 studies on university students found a strong relationship between self-efficacy and achievement (Bartimote-Aufflick et al., 2016)

Further findings from Multon et al.'s (1991) meta-analysis suggested that age moderated the efficacy-performance relationship. Elementary students' (6-13-years) self-efficacy ($r = 0.21$) had a weaker relationship with academic performance than older students at high school (14-18-years) ($r = 0.41$) and college ($r = 0.35$). Pajares and Graham (1999) found that American middle school students' ($n = 273$; 11-12-years) self-efficacy predicted academic performance at the start of the year, but by the end of the year, the students reported lower effort and persistence. A longitudinal study of 761 European-

American students (6-17-years) found that older students' perceptions of competence in mathematics declined faster than younger students (Jacobs et al., 2002). Transitional influences, such as teacher and environmental changes, have been suggested to impact students' self-efficacy (Schunk et al., 2002).

On examination of the interventions studies in their meta-analysis, Multon et al. (1991) found a stronger relationship between self-efficacy and academic performance at post-treatment ($r = 0.58$) than pre-treatment ($r = 0.32$). They suggested that reviewed interventions, such as guided mastery, modelling, and feedback, enhanced the relationships between self-efficacy and academic performance. Instead of viewing self-efficacy as an individual's fixed quality, it is suggested that self-efficacy can be increased through therapeutic interventions by initiating positive cognitive reappraisal (Bandura, 1978; Bandura et al., 1981). Self-efficacy interventions are discussed below.

### 1.2.6 Description of the Intervention

Self-efficacy interventions are derived from behaviour change techniques, where individuals are facilitated to actively change their behaviour and motivation (Knittle et al., 2020; Warner et al., 2020). Michie et al. (2016) argued that theory must be systematically applied to identify target constructs and design effective interventions. However, most intervention studies do not explicitly report links to theory. Most of the theoretical perspectives of behavioural interventions come from behavioural theories, social cognitive theory, cognitive-developmental theories, and pedagogical theory (Dietrichson et al., 2020; Schunk, 2013). Self-efficacy interventions incorporate the four self-efficacy sources (mastery experience, verbal persuasion, vicarious learning, and affective state) to promote behavioural change (Bandura, 1997; Warner et al., 2020).

Several systematic reviews have studied general self-efficacy interventions for specific populations, such as university students (Bartimote-Aufflick et al., 2016) or domain-specific self-efficacy interventions, for example, for reading (Unrau et al., 2018) or using specific interventions such as self-assessment (Panadero et al., 2017). In a literature review of self-efficacy interventions, Warner et al. (2020) suggested that intervention effects may vary depending on several variables, for example, the type of measures, demographic variables, or individual differences in self-efficacy ratings. Interventions cannot be assumed to operate similarly across different contexts or demographic groups due to the influence of moderator variables.

In Panadero et al.'s (2017) meta-analysis of 19 studies of interventions using self-assessment components on students (n = 2305), the pooled self-efficacy effect (d = 0.73) was moderated by the self-assessment intervention tools used in the studies. Self-assessment means that students evaluate and assess their performance. It was suggested that assessment tools such as rubrics negatively affected self-efficacy (d = 0.197 CI [-0.50 -0.90]) because students become aware of the difficulties in achieving quality. Interventions using self-monitoring positively affected self-efficacy (Cohen's d = 1.46 CI [0.97 - 1.94]). Gender moderated the intervention effects, as self-efficacy in girls improved more than in boys.

This present review focused on interventions that aim to influence students' academic self-efficacy or mathematics self-efficacy to improve their mathematics performance. The term intervention refers to interventions derived from diverse educational strategies, focus, and delivery methods. Self-efficacy intervention can incorporate manipulations into students' environment, including goal setting, self-monitoring and self-evaluation skills, strategy instruction, and providing social models (Schunk et al., 2000). Bandura's theories suggest that interventions must specifically target the domain of interest (Bandura, 1997; Warner et al., 2020).

This review included a wide range of interventions that incorporated strategies to improve students' self-beliefs but excluded interventions solely to improve academic performance. Academic programs for improving mathematics performance characteristically centre around curriculum and instructional strategies (Dietrichson et al., 2020; Slavin et al., 2009). However, self-efficacy interventions are delivered by influencing a different range of factors, as outlined next.

### 1.2.7 How the intervention might work

Self-efficacy interventions to improve academic achievement may be implemented through a wide range of delivery mechanisms, for example, via self-help programs or delivered by instructors to groups or individuals (Warner et al., 2020). Multifaceted interventions may include socio-emotional components that provide students with emotional regulation skills and foster their self-efficacy beliefs. Interventions may aim to influence self-efficacy through one or more of the sources of self-efficacy, such as incorporating verbal persuasion through encouraging statements and feedback or providing vicarious experiences through videos and modelling. Personal factors may be influenced by interventions that alter students' emotional states, and students' behaviours may change by correcting their thinking or improving their academic skills (Warner et al., 2020). Self-efficacy can be changed by controlling environmental factors, such as school and classroom structures (Pajares, 2006).

### 1.2.8 Why it is important to do this review

#### 1.2.8.1 Prior reviews

There is a commonality between this review and previous self-efficacy intervention reviews (Bartimote-Aufflick et al., 2016; Panadero et al., 2017; Unrau et al., 2018). The common focus is on understanding how interventions can change students' self-efficacy and achievement. However, this review aims to investigate whether domain general self-efficacy interventions or domain-specific mathematics self-efficacy interventions most impact change in mathematics performance. Previous systematic reviews which have examined self-efficacy interventions include Unrau et al. (2018) on reading interventions, Panadero et al.(2017) on self-assessment interventions, and Bartimote-Aufflick et al. (2016) on interventions for university students.

Unrau et al. reviewed 30 studies of reading self-efficacy interventions in elementary school students (6-18-year-olds) (n = 2300 intervention participants; n =1957 control or comparison group participants). The meta-analysis results showed small to medium significant positive increase in students' reading self-efficacy in three types of studies: (n= 12) treatment-control studies (*g* = 0.24, CI [0.10, 0.39]); (n = 12) treatment-comparison studies (*g* = 0.44, CI [0.04, 0.84]); and (n = 7) pretest-posttest treatments (*g* = 0.36, CI [0.16, 0.57]). The treatment-control effect size was significantly positively moderated by vicarious experience as the major source shaping self-efficacy, (Q = 5.86, p = 0.015). The pre-test-posttest treatment effect size was significantly moderated by both vicarious experience (Q = 10.76, p = .001) and social persuasion (Q = 5.79, p = .016). No major source of self-efficacy was found to moderate the treatment-comparison studies effect size. The effect sizes are smaller than Panadero et al. 's (2017) review which found a medium effect of self-assessment interventions on students' self-efficacy (d = 0.73).

Bartimote-Aufflick et al.'s (2016) narrative review of interventions for university students suggested that, in line with previous evidence, self-efficacy strongly correlated with student achievement and other constructs, such as self-regulation, motivation, and strategy use. Students' self-efficacy improved with pedagogical interventions, for example, via modelling or multimedia. However, there was many inconsistencies including conflating self-efficacy with other self-belief constructs, a range of study designs, and varying levels of specificity in the measures used.

Previous school-based interventions for improving mathematics have shown a variety of approaches. Dietrichson et al.(2020) reviewed interventions for improving mathematics and reading students in grades 7–12 (12-19-years) across 71 studies. The mathematics interventions were categorised by topic-related skills and in the general domains of meta-cognitive strategies (43%), socio-emotional skills (8%), and general academic skills (12%). There is a lack of mathematical topic-related interventions, and many studies have used multiple interventions. There was a mixture of continuous and discrete outcome measures. The short-run effect of combined reading and mathematics intervention was positive and significant (effect size [ES] = 0.22, CI [0.15, 0.28]). The results from 36 effects sizes of 25 studies (n = 14961) with the mathematics intervention component was a small effect size (ES) = 0.33, CI [0.17- 0.50]. There was significant heterogeneity (Q = 158.5, $Tau^2$ = 0.09, and $I^2$ = 84.9%). The results from 83 effects sizes of 28 studies (n = 43,380) with interventions in the general domains were ES = 0.15, CI [0.07 - 0.24], Q = 76.5; $Tau^2$ = 0.02, $I^2$ = 64.7%. The findings highlighted the relatively low number of school interventions in mathematics and socio-emotional skills. The next section describes how this review contributes to this field.

#### 1.2.8.2 Contribution of this review

There is a significant research gap between the theoretical sources of self-efficacy and the implementation of positive change through school-based interventions (Pajares, 1997; Warner et al., 2020). Although there is a wealth of evidence on the relationship between self-efficacy and academic performance and math, educators will be more interested in the usefulness of intervention strategies and educational implications (Pajares, 1997). This review's literature search indicated that there has been no meta-analysis on self-efficacy or mathematics self-efficacy interventions and mathematics performance to date.

This review focuses on self-efficacy or mathematics self-efficacy interventions. The measures incorporate domain-specific evaluations in academic or mathematics areas, as opposed to general self-efficacy. SCT will be the specific theoretical basis (Michie et al., 2016) that this review refers to for behaviour change interventions. The review provides evidence whether fostering self-efficacy or mathematics self-efficacy can improve mathematics performance. This review excludes interventions aimed at student populations with learning difficulties and includes only interventions directed at middle school students (aged 11 upwards) up to 25 years and delivered in educational settings. This is a crucial phase in adolescents' education where they undertake important examinations, and there is pressure to perform well (Lee, 2009). The findings will contribute to our understanding of young people's self-efficacy in mathematics and how best to foster their mathematical self-efficacy to improve their mathematics performance.

#### 1.2.8.3 Aims and objectives of the current review

The objective of this systematic literature review was to assess the effects of interventions for self-efficacy or mathematics self-efficacy that aims to improve mathematics performance in students aged 11-25 years. This systematic review focuses on interventions delivered to young people in educational contexts.

The current study seeks to answer the following two research questions:

1. What is the effectiveness of self-efficacy or mathematics self-efficacy interventions for positive change in students' mathematics performance?
2. What is the relative success of interventions that target mathematics self-efficacy versus general self-efficacy for positive change in students' mathematics performance?

## 1.3 Method

### 1.3.1 Protocol and Registration

The study's inclusion criteria and analysis adhered to the standards in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins, Thomas, et al., 2020) and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). The title is registered with the Campbell Collaboration under Campbell Review (ECG20002).

### 1.3.2 Criteria for considering studies

The criteria for considering studies for inclusion in the final systematic review (Table 1) are summarized in the Population, Intervention, Comparison, Outcomes and Setting (PICOSS) Table.

**Table 1**

*Population, Intervention, Comparison, Outcomes and Setting (PICOSS)*

| | Inclusion | Exclusion |
|---|---|---|
| P - Population | Adolescents and young adults aged 11 to 25 years' old | Participants with confirmed mathematical difficulties (e.g., mathematics achievement below the 25th percentile or less on standardised mathematical tests)<br>Participants attending special education establishment<br>Participants with other diagnosed learning difficulties or developmental disorders<br>Children under 11 years of age<br>Adults over 25 |
| I – Intervention | Interventions with the principal aim of improving self-efficacy in academic tasks<br>Interventions with the principal aim of improving mathematics self-efficacy | Interventions aimed solely for general academic attainment<br>Interventions for related constructs such as self-concept, self-belief<br>Interventions for general self-efficacy but without an academic component<br>Interventions for wellbeing, improvement in students' outcomes and academic experience that did not target self-efficacy or mathematics self-efficacy specifically |

| | | |
|---|---|---|
| C – Comparator | Comparing the stated intervention with no intervention, usual care or a control intervention | No comparison control group |
| O – Outcomes | Mathematics Performance: Any objective or standardised measure of Mathematics performance as indicated by<br>• norm-referenced tests<br>• state-wide tests and national tests.<br>• Curriculum-based outcome measures<br>• Cognitive experimental measures of specific mathematics skills (e.g., speed recall of arithmetic facts, flexible strategy use)<br>Self-efficacy: Any objective or standardised measure of self-efficacy OR<br>Mathematics self-efficacy: Any objective or standardised measure of self-efficacy | Qualitative observations<br>Qualitative self-reports |
| S – Study Type | Experimental study Design with comparison control, e.g., Randomised controlled trials or repeated measures design | Observational study design, e.g., single-subject designs, case-report or cohort studies |

| | | |
|---|---|---|
| | Quasi-randomised designs with comparison control, e.g., no intervention, practice-as-usual, waiting list, or active control group | Study designs with no comparison control<br>Correlational studies<br>Longitudinal studies<br>Opinion pieces and editorials<br>Qualitative studies |
| S – Setting | Attending mainstream secondary or middle-level schools, colleges and universities.<br>Studies conducted in any low-, middle- and high-income countries | Primary and elementary schools<br>Employment settings<br>Temporary setting such as day workshops |

The term 'intervention' was defined as an act that aims to affect positive changes in self-efficacy or mathematics self-efficacy in students. Interventions may originate from various modalities (e.g. mathematical programs, tutoring and teaching programs, cognitive training, counselling) but must have the primary focus of increasing self-efficacy or mathematical self-efficacy. The review included interventions delivered by the researcher, students, educators, or other related parties. Interventions may be for individuals, groups, or whole-school programs.

Studies included measuring the change in the students' self-efficacy or mathematics self-efficacy must use validated instruments (and its subscales) such as the Mathematics Self-Efficacy Scale (MSES) (Betz et al., 1983) or a standardised scale constructed for the study. Where studies included a mixed population with a range of ages, a decision was made based on the calculated average of participants' ages as reported by the study. If the data was not available, a judgement was made based on the expected ages of students in the setting.

### 1.3.3 Search Methods

A comprehensive search to identify all eligible studies was conducted using the following four databases: PsychInfo, ProQuest Dissertations and Thesis (for grey literature), ERIC and Web of Science Core in October 2020. Unpublished theses and dissertations were included after considering possible publication bias if only published studies were used (Polanin et al., 2016). Included were articles from 1977, from when Bandura introduced the construct of self-efficacy (Bandura, 1997). No restrictions were placed on the language of the study. If a non-English study met the inclusion criteria, an initial translation of the title and abstract to check for suitability was done using Google Translate before further efforts were made to procure an English version of the text.

The main author YB conducted the literature search, and the results were outlined in the PRISMA flow diagram (Moher et al., 2009). The search parameters were constructed with the assistance of a specialist librarian based on the research questions and the PICOSS criteria. The full search strategy is provided in Table 2. Additionally, a hand search was conducted in DelphiS (an in-house database) and Google Scholar to locate additional articles.

**Table 2**

*Literature Search Terms and Databases Used*

| Provider | Database | Search Term | Number of articles |
|---|---|---|---|
| EBSCO | PsychInfo (1977- October 2020) | AB(self N2 (efficacy OR concept OR belief)) AND AB(intervention* OR trial*) AND AB(student* OR pupil* or learner* OR adolescen* OR teen* OR school* OR college OR undergraduate* ) AND AB(academic* OR examination* OR education* OR achiev* OR attain* OR success* | 266 |

| | | | |
|---|---|---|---|
| | | OR perform* OR grade* OR scor* OR result* OR assess*) AND AB(math*) | |
| ProQuest | ProQuest Dissertations & Theses Global (1977- October 2020) | AB(self NEAR/2 (efficacy OR concept OR belief)) AND AB(intervention* OR trial*) AND AB(student* OR pupil* or learner* OR adolescen* OR teen* OR school* OR college OR undergraduate* ) AND AB(academic* OR examination* OR education* OR achiev* OR attain* OR success* OR perform* OR grade* OR scor* OR result* OR assess*) AND AB(math*) | 166 |
| ProQuest | ERIC (1977- October 2020) | AB(self NEAR/2 (efficacy OR concept OR belief)) AND AB(intervention* OR trial*) AND AB(student* OR pupil* or learner* OR adolescen* OR teen* OR school* OR college OR undergraduate* ) AND AB(academic* OR examination* OR education* OR achiev* OR attain* OR success* OR perform* OR grade* OR scor* OR result* OR assess*) AND AB(math*) | 76 |
| | WebofScience Core (1977- October 2020) | AB=(self NEAR/2 (efficacy OR concept OR belief) ) AND AB=(intervention* OR trial*) AND AB=(student* OR pupil* OR learner* OR adolescen* OR teen* OR school* OR college OR undergraduate* ) AND AB=(academic* OR examination* OR education* OR achiev* OR attain* OR success* OR perform* OR grade* OR scor* OR result* OR assess*) AND AB=(math*) | 159 |
| Total articles | | | 667 |

### 1.3.4 Measures of treatment effect

Studies on self-efficacy interventions have used various instruments to assess the same construct (Schunk et al., 2016; Unrau et al., 2018). For this review, the outcomes for self-efficacy, mathematics self-efficacy, and mathematics performance were assessed in all studies using continuous scales (see Appendix A.1). The standardised mean differences (SMD) and 95% confidence interval (CI) were calculated from the means and standard deviations where available. The timing of the outcome assessment was measured at the end of the intervention period. Only the pre-and immediate post-intervention measures will be used when there is more than one outcome assessment within a period.

### 1.3.5 Data Collection and Analysis

#### 1.3.5.1 Study Selection

Studies were exported into Covidence (Veritas Health Innovation, 2021), a systematic review management utility. The title and full-text screening were conducted independently within the Covidence by YB and two Volunteer Research Assistants (VRA) by applying the inclusion and exclusion according to PICOSS criteria outlined in Table 1. In the case of duplicated studies, the earliest version of the study was included, and later versions were excluded.

While YB screened all the studies at each stage, a VRA screened 40% of titles and abstracts (208 titles) and 50% (30 studies) of the full texts. The VRA chose the studies at random using a systematic random sampling method, picking every 3rd text to screen. Disagreements were resolved through discussions between the YB and VRA to reach a consensus.

#### 1.3.5.2 Data Extraction

As part of the full-text screening in Covidence, relevant data were extracted by YB and compiled into a table in Word. A VRA then checked the data for accuracy. The extracted data included study characteristics (publication details, country, setting), participant characteristics (sample size, gender, age), and intervention characteristics (study design, aims, intervention and control/comparison conditions and group sizes, intervention duration, statistical results, and related key findings). The interventions were characterised by their theoretical basis, instructional method, and content, using the studies' authors' classifications as the basis.

#### 1.3.5.3 Unit of analysis issues

The Cochrane handbook recommends that cluster-randomised studies effect sizes be adjusted with an estimate of the intra-cluster (or intraclass) correlation coefficient (ICC) (Higgins, Eldridge, et al., 2020). Studies without calculated ICC figures were noted for any post hoc analysis. For studies with multiple intervention or control groups drawn from the same sample, groups were combined to create a single pairwise comparison (Higgins, Eldridge, et al., 2020) using the RevMan calculator facility.

#### 1.3.5.4 Missing data issues

YB contacted the author first to request missing information for studies with missing or incomplete data. If the standard deviation (SD) for the continuous outcome was not provided, then the study's other data were used to calculate the SD (Deeks et al., 2020). If the data were unavailable or could not be calculated, the study was omitted.

#### 1.3.5.5 Assessments of the risk of bias

Each study was assessed for the risk of bias using the following tools as recommended by the Cochrane Handbook (Deeks et al., 2020): Risk of Bias 2 (RoB2) (Sterne et al., 2019) for individual randomised trials (iRCT) or for cluster-randomised trials (CRT) (Eldridge et al., 2020), and risk of bias in non-randomised studies of interventions (ROBINS-I) for quasi-experimental design (QED) studies of interventions (Sterne et al., 2016). The tools have a fixed set of *domains of bias* (Table 3) with a series of *signalling questions* that guide the researcher to consider the study design, how it was conducted, and reported. The signalling questions helped to determine how the domain risk of bias was assessed. An overall judgement was reached for each study iRCT and CRT study as 'High' or 'Low' or 'Some concerns' indicated. The ROBINS-I tool operates similarly, and the overall bias was assigned as 'Low', 'Moderate', 'Serious', 'Critical', or 'NI (No Information)'.

**Table 3**

*Risk of Bias Tools and Domains*

| ROB 2 Domains (Higgins et al., 2011) | ROB 2 CRT Domains (Sterne et al., 2019) | ROBINS-I Domains (Sterne et al., 2016) |
|---|---|---|
| | Additional domains for cluster-randomised trials | |
| 1. Bias arising from the randomisation process<br>2. Bias due to deviations from intended interventions<br>3. Bias due to missing outcome data;<br>4. Bias in measurement of outcome<br>5. Bias in the selection of the reported outcome | Domain 1a: Risk of bias arising from the randomisation process<br>Domain 1b: Risk of bias arising from the timing of identification or recruitment of participants in a cluster-randomised trial<br>For domains 3- 5 of ROB 2, additional signalling questions and adjustments are added to the tool for CRT studies (Eldridge et al., 2020) | 1. Bias due to confounding<br>2. Bias in the selection of participants into the study<br>3. Bias in the classification of interventions<br>4. Bias due to deviations from intended interventions<br>5. Bias due to missing data<br>6. Bias in measurement of outcomes<br>7. Bias in the selection of the reported outcome |

YB and a VRA independently assessed each study to determine the risk of bias. Disagreements were resolved through discussions between YB and the VRA. The overall risk of bias was mapped using the ROBVIS (McGuinness et al., 2020) visualisation tool to produce figures for each RoB assessment.

#### 1.3.5.6 Data Synthesis

A standard random-effects meta-analysis conducted using the Cochrane Review Manager (RevMan) computer program, version 5.24 (The Cochrane Collaboration, 2020), was undertaken to estimate the pooled effect intervention effect across the studies for each of the available outcomes of mathematics performance, self-efficacy, and mathematics self-efficacy. The overall weighted random-effects analysis was calculated using the test statistics of Hedges g, upper and lower limits of the 95th confidence interval, z-values, and p-values.

#### 1.3.5.7 Subgroup analysis and investigation of heterogeneity

The possible causes of heterogeneity in individual studies have been examined individually and in groups (Glasziou et al., 2002). Methodological heterogeneity was explored by considering the variability in study characteristics (e.g. study design and instrument type). Similarly, clinical heterogeneity was examined by participant characteristics (e.g. age, gender, and inclusion criteria) and intervention characteristics (duration and intervention category).

The test statistics for heterogeneity (Deeks et al., 2020; Higgins et al., 2002) were calculated using the RevMan. Homogeneity was estimated using Q-Total, degrees of freedom, and p-values. The $I^2$ statistic (variation in effect estimates due to heterogeneity rather than sampling error) and $Tau^2$ (average heterogeneity) were also calculated and reported.

#### 1.3.5.8 Sensitivity and publication bias analysis.

The data were exported to Comprehensive Meta-Analysis (CMA) Version 3 (Borenstein, 2014) for further analysis. Individual studies were examined case by case to exclude the effect sizes. Sensitivity analysis was conducted via CMA using the "one-study removed" facility, which removed each study sequentially and estimated the effect of each effect size on the mean. The resultant plot was visually inspected for outliers. Further sensitivity analyses were performed in subgroups to explore the assumptions in the analysis and the results of the pooled mathematics performance effect size. A power analysis using G* Power 3 (Faul et al., 2007) was conducted to determine the minimum sample size for the resultant mathematics performance effect size. The following variables were investigated in turn: overall risk of bias, study design, instrument type, sample size, intervention duration, and intervention category. Publication bias was examined by visually inspecting a funnel plot created in the CMA of SMD versus SE and using Egger's test (Egger et al., 1997).

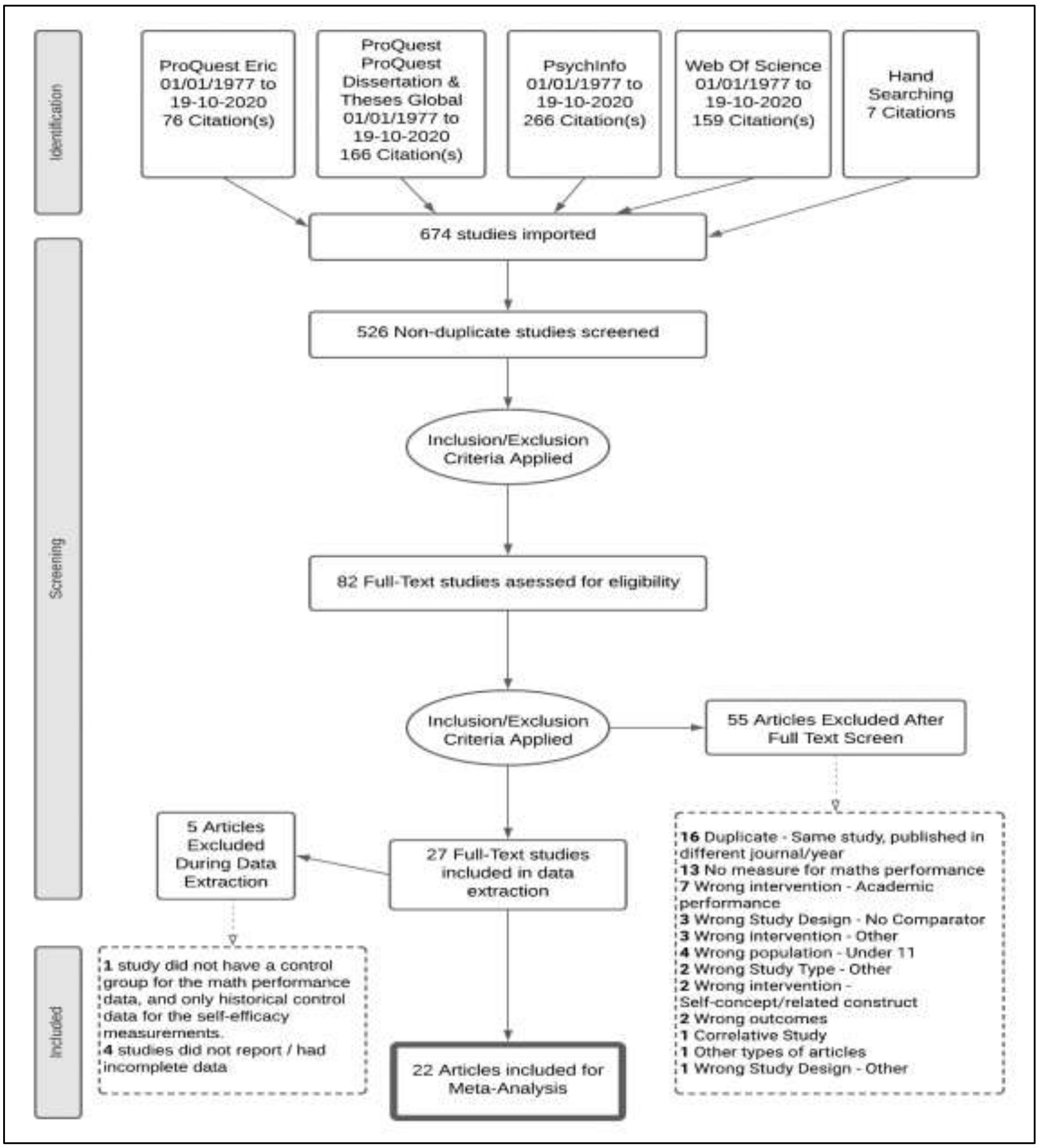
## 1.4 Results

### 1.4.1 Results of the search

The results of the search process are shown in the PRISMA flow diagram in Figure 2. A preliminary search identified 667 potential studies. Seven further studies were included after a manual search. When the data were exported to Covidence, 526 non-duplicate titles were left after 148 duplicates were removed. During the screening of titles and abstracts, 444 titles were excluded as irrelevant, based on the inclusion and exclusion criteria from leaving 82 studies to be assessed for full-text eligibility. A further 55 studies did not meet the inclusion criteria or were additional duplicates of studies printed in different years or journals (See Appendix A.2). The Inter-rater reliability (Cohen's Kappa) for the title screening was 0.25, and for the full texts, screening was 0.35, which were within the "fair" range (Cohen, 1960; Landis et al., 1977). A total of 27 studies met the inclusion criteria after the full-text screening, and a further five studies were excluded due to incomplete data (See Appendix A.2). A total of 22 studies were included in the meta-analysis (See Appendix A.1).

**Figure 2**

*PRISMA Flow Diagram*



### 1.4.2 Data Extraction Summary

A summary of the studies included in the meta-analysis is presented in Table 4, and the full characteristics of the studies are presented in Appendix A.1. A total of 7496 participants were included in the study. Three studies did not report the gender of the participants; the available data totalled 3479 females and 3348 males. Most were doctoral theses or dissertations (n = 11) and from the United States (n = 15). Two studies were from Germany, and one each from Ethiopia, Nigeria, Israel, Australia, Canada, and Norway. The data reflected the bias toward the availability of studies from the United States. Although no restrictions were placed on language, all the included studies were in English. Most of the studies were published after 2010, with eight studies published from 2011 to 2015 and a further six since 2016. The date range of the included studies was around 30 years after Bandura's (1977) self-efficacy theory was published.

**Table 4**

*Summary of the Included Studies (n = 22 studies, N = 7496 participants)*

| | | Study Characteristics | | | |
|---|---|---|---|---|---|
| Country | N | Publication year | N | Setting | N |
| United States | 15 | 1977 – 2000 | 1 | University | 5 |
| Germany | 2 | 2001- 2005 | 3 | Middle School | 6 |
| Nigeria | 1 | 2006 – 2010 | 4 | Secondary School | 4 |
| Norway | 1 | 2011- 2015 | 8 | High School | 2 |
| Israel | 1 | 2016-2019 | 6 | Community College | 2 |
| Ethiopia | 1 | | | College | 2 |
| Australia | 1 | | | College and University | 1 |
| Publication type | N | | | | |
| Journal | 8 | | | | |
| Doctoral Thesis/Dissertation | 11 | | | | |
| Unpublished Doctoral Thesis/ Dissertation | 3 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | Sample Characteristics | | | |
| Sample age range | N | Sample size | N | Gender | N |
| 11 – 15 years | 11 | < 50 | 3 | Female | 3479 |
| 15 – 18 years | 2 | 50 – 100 | 4 | Male | 3348 |
| 19 – 25 years | 7 | 100 – 200 | 7 | | |
| Not reported | 2 | 200 – 500 | 4 | | |
| | | 500 – 1000 | 2 | Studies with no gender data | 3 |
| | | >1000 | 2 | | |
| | | Design and Intervention | | | |
| Study design | N | Intervention focus | N | Intervention duration | N |
| iRCT | 8 | Self-Efficacy | 9 | 1 session | 3 |
| CRT | 4 | Mathematics Self-Efficacy | 13 | 1 – 3 weeks | 4 |
| QED | 10 | | | 4 -8 weeks (1- 2 months) | 7 |
| | | | | 2 – 6 months | 6 |
| | | | | 6 – 12 months | 2 |
| | | Instruments Used | | | |
| Mathematics Performance Instrument (n = 22) | N | Self-Efficacy Instrument (n = 9) | N | Mathematics Self-Efficacy Instrument (n = 13) | N |
| Standardised mathematics test/ with Cronbach's alpha | 5 | Recognised Self-Efficacy Scales | 4 | Mathematics Self-Efficacy Scale (MSES)/MSES-R (Revised) | 5 |
| Author constructed mathematics test | 3 | Author constructed, (with Cronbach's alpha) | 4 | Author constructed, (with Cronbach's alpha) | 5 |
| Course Exam | 4 | | | | |
| National Exam | 9 | Author constructed scale (no Cronbach's alpha) | 1 | Author constructed scale (no Cronbach's alpha) | 3 |
| NI | 1 | | | | |
| Total participants | 7418 | Total participants 3959 | | Total participants 3506 | |

*Note*. iRCT – Individual Random Control Trial, RCT – Random Control Trial, QED – Quasi-Experimental Design, NI – No information

The highest number of studies took place in middle schools (11-13-years) (n = 6), followed by universities (post-18) (n = 5), and secondary schools (11-18-years) (n = 4). Most studies (n = 7) had 100–200 participants, followed by studies with 50–100 (n = 4) and 200–500 (n = 4) participants. Three studies had fewer than 50 participants, and four studies had over 500 participants. Most studies had 11-15-year-old students (n = 12), six had 15-18-year-old students, seven had 19-25-year-old students, and two studies did not report the ages of the participants. If the reported age range in a study was above 25 years or below 11, the average participant age was calculated based on the study data. The study was included if the average age was between 11 and 25 years. Community colleges reported the widest age among their participant groups. If the wider population sample (for example, in a community college or university) is likely to be of the correct age, but the data are incomplete, the study is included.

A majority of the studies had interventions lasting from a month to six months. Three studies took place over one session, and two studies continued for over six months. There was a mix of theories on the interventions (Appendix A.1). Only seven studies that conducted interventions were based on social cognitive theory (Bandura, 1997) and aimed to specifically influence one or more self-efficacy sources. One study did not report the theoretical basis of intervention. Other studies used a hybrid of different approaches to achieve the required behavioural and self-belief changes. The mix of approaches is possibly due to the mix of aims and outcomes of the studies.

### 1.4.3 Excluded studies

The majority of the studies excluded during the screenings were either correlational studies; studies focused on related constructs, such as self-concept, that did not have mathematics performance as an outcome or a combination of these characteristics (Appendix A.2). Studies with interventions focusing on improving academic achievement and mathematics skills, rather than influencing self-efficacy or mathematics self-efficacy, were excluded. Studies in which self-efficacy was a moderator and not an outcome and correlational studies on self-efficacy were excluded.

One CRT and four QED studies that met the inclusion criteria reported incomplete data (Appendix A.2). Efforts were made to approach the other authors via email to contribute to the missing data; one study had a mix of control and historical data; two studies had no recent contact details, one author did not reply, and one author did not have the data. After excluding these five studies, 22 studies were included in the meta-analysis (Table 9).

### 1.4.4 Included studies

A total of 22 studies with 23 effect sizes were included in the meta-analysis. A study (22) with separate control and intervention groups for two different student samples and different outcome measures was treated with two different effect sizes. There were 14 studies on mathematics self-efficacy and eight on self-efficacy. A summary of the data extraction process is presented in Table 4.

A mixture of instruments was used to measure self-efficacy and mathematics performance across the studies. The majority either used a national exam (n = 9) or course exams (n = 4) for mathematics performance. Most (n = 5) reported Cronbach's alpha and others (n = 3) had no reported reliability information. There were five studies each of mathematics self-efficacy studies using the MSES and studies using constructed scales that reported the Cronbach's alpha. Four studies used recognised self-efficacy scales, and four used author-constructed scales across the self-efficacy studies. Three of the mathematics self-efficacy studies and one self-efficacy study constructed scales with no reliability information.

The included studies had a mix of designs: eight iRCTs, four CRTs, and ten QED studies. Five of the iRCTs were on self-efficacy and three on mathematics self-efficacy. Only one iRCT study (10) on mathematics self-efficacy used the MSES; the other two iRCTs (14, 19) used the authors' constructed scales. Three iRCT self-efficacy studies used standard scales to measure self-efficacy and two constructed scales. Three CRT studies investigated mathematics self-efficacy and self-efficacy. One CRT study used the MSES, while the other three studies used constructed scales. There were ten quasi-experimental studies, six studies on mathematics self-efficacy, and four self-efficacy studies.

### 1.4.5 Risk of Bias in included studies

The included studies were assessed according to their study design using the appropriate risk of bias tool, and ROBVIS figures were produced from the results. A summary of the overall risk of bias is presented in Appendix B.1. Two of the iRCTs were rated as "high" (2, 10), one with some concerns (1), and the rest rated "low" bias (Figure 15). Two out of CRTs were rated as "high" (5, 8), one had some concerns (18), and the other had low risk (20) (Figure 16). Two QED studies were rated critical (9, 21), one as "serious" (13), and the rest had "moderate" concerns (Figure 17). The QED studies were the most problematic, especially in domains 1 (bias due to confounding), 5 (bias due to missing data), and 6 (bias in the measurement of outcomes). The higher-quality studies mostly constituted of iRCT studies. The effects of low-quality studies on the pooled effect sizes were explored in the sensitivity analysis.

### 1.4.6 Synthesis of Results

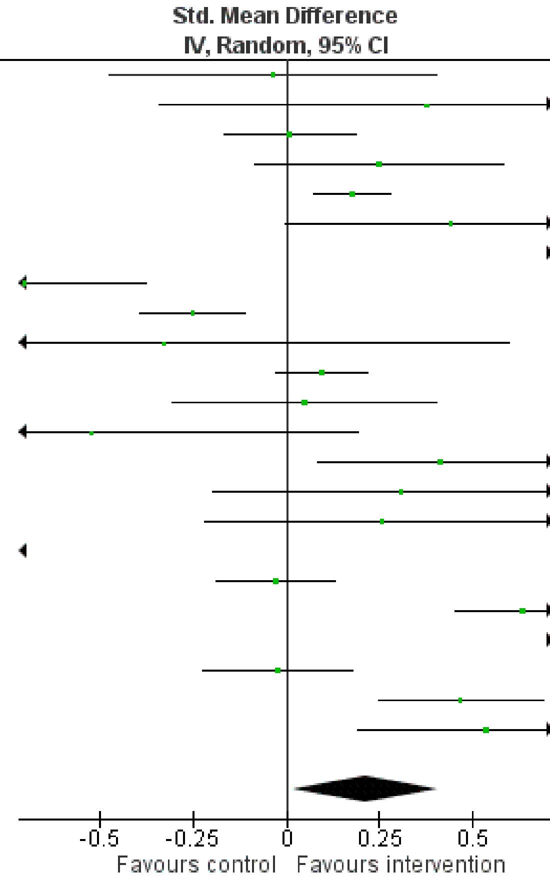
The first research question concerns the overall effect of intervention conditions and control on mathematics performance. There were 23 effect sizes, with a total of 7497 participants included in the meta-analysis. The studies were divided into two subgroups to compare studies with interventions on self-efficacy and mathematics self-efficacy. Eight studies (1, 8, 9, 10, 13, 17, 18, 20) reported negative effect sizes, indicating that the intervention was worse than the control. Fifteen studies reported positive effect sizes, indicating that intervention was better than control. The overall effect favoured the intervention condition as the effect estimate, and 95% confidence intervals were to the left of the line of no effect. The analysis showed a significant but small overall effect on mathematics performance in favour of the intervention with *g* = 0.21, CI [0.02, 0.41], Z = 2.14, $p = 0.03$. The distribution of studies was significantly heterogeneous, with Q = 316.85, df = 22 ($p < 0.0001$), $Tau^2 = 0.19$ and $I^2 = 93\%$. Table 5 shows the summary, and Figure 3 the forest plot of the mathematics performance outcomes.

**Figure 3**

*Primary Meta-Analysis and Forest Plot of Mathematics Performance Outcomes*

| | Intervention | | | Control | | | | Std. Mean Difference |
|---|---|---|---|---|---|---|---|---|
| **Study or Subgroup** | **Mean** | **SD** | **Total** | **Mean** | **SD** | **Total** | **Weight** | **IV, Random, 95% CI** |
| Acee 2009 | -0.01 | 0.3842 | 58 | 0.01 | 0.8216 | 30 | 4.1% | -0.03 [-0.48, 0.41] |
| Alcindor 2015 | 316.07 | 46.13 | 15 | 299.2 | 40.32 | 15 | 3.0% | 0.38 [-0.34, 1.10] |
| Austin 2005 | 2.95 | 1.17 | 255 | 2.94 | 1.1 | 239 | 5.0% | 0.01 [-0.17, 0.19] |
| Brewer 2009 | 65.4 | 19.98 | 60 | 60.12 | 21.76 | 84 | 4.5% | 0.25 [-0.08, 0.58] |
| Brisson et al. 2017 | 32.18 | 8.1048 | 1150 | 30.74 | 8.24 | 559 | 5.1% | 0.18 [0.08, 0.28] |
| Burrell 2012 | 6.89 | 3.31 | 45 | 5.41 | 3.29 | 35 | 4.1% | 0.44 [-0.00, 0.89] |
| Ezeahurukwe 2010 | 27.89 | 6.1794 | 212 | 20.06 | 3.1 | 67 | 4.6% | 1.39 [1.10, 1.69] |
| Falco 2008 | 7.36 | 1.92 | 74 | 8.64 | 1.7 | 79 | 4.5% | -0.70 [-1.03, -0.38] |
| Farkota 2003 | 24.77 | 6.75 | 455 | 26.5 | 7.08 | 326 | 5.1% | -0.25 [-0.39, -0.11] |
| Forbes 1988 | 2.735 | 1.018 | 18 | 3.1 | 1.24 | 6 | 2.4% | -0.33 [-1.26, 0.60] |
| Gamlem 2019 | 60.88 | 18.52 | 411 | 59.02 | 19.59 | 647 | 5.1% | 0.10 [-0.03, 0.22] |
| Getachew et al. 2016 | 3.62 | 0.81 | 63 | 3.58 | 0.773 | 60 | 4.4% | 0.05 [-0.30, 0.40] |
| Hood 2012 | 29.85 | 11.72 | 33 | 37 | 18.13 | 10 | 3.1% | -0.52 [-1.24, 0.19] |
| Huang and Mayer 2019 | 50.27 | 16.29 | 71 | 42.94 | 18.67 | 71 | 4.5% | 0.42 [0.08, 0.75] |
| Im 2012 | 1.95 | 2.08 | 63 | 1.33 | 1.64 | 20 | 3.9% | 0.31 [-0.20, 0.81] |
| Kereluik 2014 | 60.65 | 31.72 | 30 | 51.66 | 36.42 | 39 | 4.0% | 0.26 [-0.22, 0.74] |
| Kohen et al. 2019 | 72.4 | 11.7 | 58 | 85.5 | 9.3 | 33 | 4.0% | -1.19 [-1.65, -0.73] |
| Rakoczy et al. 2019 | -0.13 | 1.17 | 259 | -0.1 | 1.14 | 361 | 5.0% | -0.03 [-0.19, 0.13] |
| Snipes 2015 | 20.81 | 6.63 | 239 | 16.8 | 5.92 | 238 | 5.0% | 0.64 [0.45, 0.82] |
| Tintera 2004 | 75.15 | 21.34 | 93 | 29.58 | 21.21 | 70 | 4.3% | 2.13 [1.74, 2.52] |
| Wilkins 2014 | 86.02 | 10.28 | 198 | 86.24 | 9.8 | 185 | 4.9% | -0.02 [-0.22, 0.18] |
| Zimmerman et al. 2011 | 59.04 | 25.15 | 167 | 47.46 | 24.05 | 158 | 4.9% | 0.47 [0.25, 0.69] |
| Zimmerman et al. 2011 | 73.18 | 28.39 | 72 | 58.03 | 27.69 | 65 | 4.5% | 0.54 [0.20, 0.88] |
| **Total (95% CI)** | | | **4099** | | | **3397** | **100.0%** | **0.21 [0.02, 0.41]** |

Heterogeneity: $Tau^2 = 0.19$; $Chi^2 = 316.93$, df = 22 ($P < 0.00001$); $I^2 = 93\%$
Test for overall effect: Z = 2.14 (P = 0.03)




*Note.* MSE – Mathematics Self-Efficacy, SE – Self-Efficacy, SD – Standard Deviation, IV – Independent Variable, CI – Confidence Interval, P - Probability value, CI – Confidence Interval, z – test for overall effect, Q - Cochran's Q measure of heterogeneity, df – degrees of freedom, τ2 – Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity

**Table 5**

*Summary of Primary Analysis for Mathematics Performance*

| | Effect size and 95th confidence interval | | | Test of null | | Heterogeneity | | | |
|---|---|---|---|---|---|---|---|---|---|
| Outcome | k (n) | g | 95% CI | z-value | p-value | Q | $df_q$ | τ2 | I2 |
| Mathematics Performance | 23 (7497) | 0.22 | [0.02, 0.41] | 2.14 | 0.03 | 316.85 | 22 (p < 0.00001) | 0.19 | 93 % |

*Note.* k – number of effect sizes, g – Hedges' g measure of effect sizes, CI – Confidence Interval, z – test for overall effect, Q - Cochran's Q measure of heterogeneity, $df_q$ – degrees of freedom, $\tau^2$ – Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity

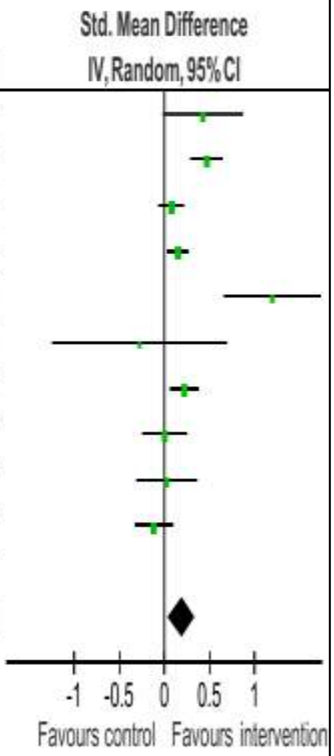
The second research question concerns the success of interventions which target self-efficacy (k = 10; total participants n = 3959) compared to mathematics self-efficacy (k = 13; total participants n = 3506). The results of the meta-analysis (Figure 4) for studies aimed at improving self-efficacy outcomes produced a significant small overall effect in favour of the intervention with *g* = 0.20, CI [0.04, 0.35], Z = 2.54, p = 0.01. The distribution of effect sizes was significantly heterogeneous, with Q = 38.31, df = 9 ($p < 0.0001$), with $Tau^2$= 0.04 and $I^2$ = 77%.

**Figure 4**

*Meta-Analysis and Forest Plot for Self-Efficacy Intervention Studies*

| | Intervention | | | Control | | | | Std. Mean Difference |
|---|---|---|---|---|---|---|---|---|
| Study or Subgroup | Mean | SD | Total | Mean | SD | Total | Weight | IV, Random, 95% CI |
| Acee 2009 | 5.88 | 0.84 | 58 | 5.51 | 0.89 | 30 | 6.6% | 0.43 [-0.02, 0.87] |
| Austin 2005 | 4.35 | 0.55 | 255 | 4 | 0.91 | 242 | 12.9% | 0.47 [0.29, 0.65] |
| Farkota 2003 | 1.03 | 0.78 | 436 | 0.97 | 0.74 | 318 | 13.7% | 0.08 [-0.07, 0.22] |
| Gamlem 2019 | 18.31 | 3.63 | 436 | 17.75 | 3.84 | 729 | 14.3% | 0.15 [0.03, 0.27] |
| Im 2012 | 3.7 | 0.98 | 63 | 2.58 | 0.74 | 20 | 5.3% | 1.19 [0.66, 1.73] |
| Kereluik 2014 | 2.5 | 0.892 | 10 | 2.76 | 0.89 | 7 | 2.1% | -0.28 [-1.25, 0.69] |
| Rakoczy et al. 2019 | 2.82 | 0.66 | 259 | 2.68 | 0.62 | 361 | 13.3% | 0.22 [0.06, 0.38] |
| Wilkins 2014 | 4.1 | 0.6 | 150 | 4.1 | 0.8 | 107 | 11.0% | 0.00 [-0.25, 0.25] |
| Zimmerman et al. 2011 | 3.55 | 0.89 | 71 | 3.53 | 0.76 | 65 | 8.8% | 0.02 [-0.31, 0.36] |
| Zimmerman et al. 2011 | 3.23 | 0.91 | 178 | 3.33 | 0.81 | 164 | 12.0% | -0.12 [-0.33, 0.10] |
| **Total (95% CI)** | | | **1916** | | | **2043** | **100.0%** | **0.20 [0.04, 0.35]** |

Heterogeneity: Tau² = 0.04; Chi² = 38.31, df = 9 (P < 0.0001); I² = 77%
Test for overall effect: Z = 2.54 (P = 0.01)




*Note.* SD – Standard Deviation, CI – Confidence Interval, IV – Independent Variable, df – degrees of freedom, Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity.

The results of the meta-analysis for studies aimed at improving mathematics self-efficacy outcomes produced a non-significant small overall effect in favour of the intervention with *g* = 0.16, CI [-0.04, 0.37], Z = 1.58, p = 0.11. The distribution of effect sizes was significantly heterogeneous, with Q = 68.51, df = 12 (p < 0.0001), with $Tau^2 = 0.10$ and $I^2 = 83\%$. Figure 5 shows a forest plot of studies aimed at improving mathematics self-efficacy.

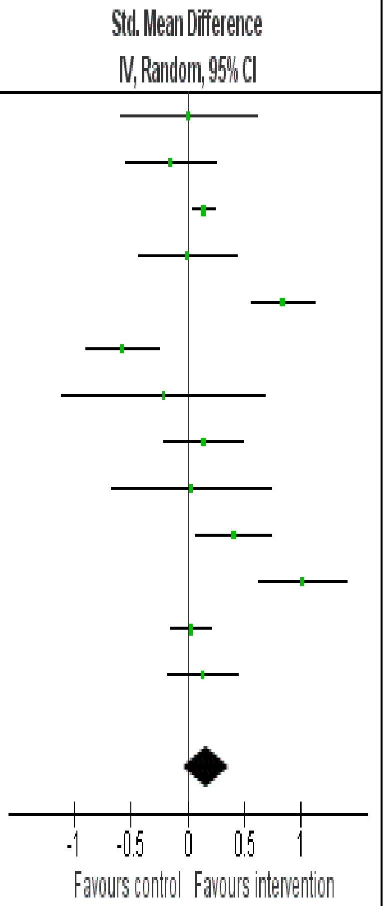
**Figure 5**

*Meta-Analysis and Forest Plot for Mathematics Self-Efficacy Intervention Studies*

| | Intervention | | | Control | | | | Std. Mean Difference |
|---|---|---|---|---|---|---|---|---|
| Study or Subgroup | Mean | SD | Total | Mean | SD | Total | Weight | IV, Random, 95% CI |
| Alcindor 2015 | 5.09 | 0.81 | 22 | 5.08 | 1.32 | 20 | 5.6% | 0.01 [-0.60, 0.61] |
| Brewer 2009 | 12.38 | 24.05 | 34 | 16.89 | 32.93 | 72 | 7.6% | -0.15 [-0.56, 0.26] |
| Brisson et al. 2017 | 2.77 | 0.74 | 1171 | 2.67 | 0.65 | 586 | 10.6% | 0.14 [0.04, 0.24] |
| Burrell 2012 | 4 | 0.97 | 45 | 4 | 0.81 | 35 | 7.2% | 0.00 [-0.44, 0.44] |
| Ezeahurukwe 2010 | 62.42 | 18.02 | 212 | 48.08 | 13.25 | 67 | 9.0% | 0.84 [0.56, 1.12] |
| Falco 2008 | 7.35 | 1.95 | 74 | 8.31 | 1.3 | 79 | 8.6% | -0.58 [-0.90, -0.26] |
| Forbes 1988 | 342.39 | 42.29 | 23 | 352 | 48.32 | 6 | 3.5% | -0.21 [-1.12, 0.69] |
| Getachew et al. 2016 | 3.67 | 0.66 | 63 | 3.57 | 0.77 | 60 | 8.2% | 0.14 [-0.22, 0.49] |
| Hood 2012 | 7.1 | 11.24 | 33 | 5.8 | 76.42 | 10 | 4.7% | 0.03 [-0.67, 0.74] |
| Huang and Mayer 2019 | 76.93 | 28.65 | 71 | 65.14 | 28.56 | 71 | 8.5% | 0.41 [0.08, 0.74] |
| Kohen et al. 2019 | 4.58 | 0.42 | 58 | 3.93 | 0.8 | 54 | 7.7% | 1.02 [0.63, 1.42] |
| Snipes 2015 | 3.21 | 0.9 | 239 | 3.19 | 0.02 | 238 | 10.1% | 0.03 [-0.15, 0.21] |
| Tintera 2004 | 3.69 | 0.72 | 93 | 3.59 | 0.76 | 70 | 8.7% | 0.13 [-0.18, 0.45] |
| **Total (95% CI)** | | | **2138** | | | **1368** | **100.0%** | **0.16 [-0.04, 0.37]** |

Heterogeneity: $Tau^2 = 0.10$; $Chi^2 = 68.51$, $df = 12$ ($P < 0.00001$); $I^2 = 82\%$

Test for overall effect: $Z = 1.58$ ($P = 0.11$)




A summary of the analysis of self-efficacy and mathematics self-efficacy outcomes is presented in Table 6. The results show that studies targeting self-efficacy had a statistically significant effect ($g$ = 0.20) and was slightly larger than the effect of interventions targeting mathematics self-efficacy ($g$ = 0.16), which were non-significant. The next sections present the investigations into heterogeneity, followed by subgroup and sensitivity analyses to explore how the studies contribute to the overall results.

**Table 6**

*Summary on Self-Efficacy and Mathematics Self-Efficacy Outcomes Meta-Analysis*

| | Effect size and 95% CI | | | Test of null | | Heterogeneity | | | |
|---|---|---|---|---|---|---|---|---|---|
| Outcome | k (n) | *g* | 95%CI | z-value | p-value | Q | $df_q$ | $\tau^2$ | $I^2$ |
| Self-Efficacy | 10 (3959) | 0.20 | [0.04, 0.35] | 2.54 | 0.01 | 38.30 | 9 (p < 0.0001); | 0.04 | 77% |
| Mathematics Self-Efficacy | 13 (3506) | 0.16 | [-0.04, 0.37] | 1.58 | 0.12 | 68.55 | 12 (p< 0.00001); | 0.10 | 82% |

*Note.* SD – Standard Deviation, CI – Confidence Interval, IV – Independent Variable, $df_q$ – degrees of freedom, Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity.

### 1.4.7 Heterogeneity

The large variability in both clinical and statistical factors influenced the overall synthesis across the outcomes of this review. There was statistical evidence of heterogeneity across mathematics performance, self-efficacy, and mathematics self-efficacy outcomes, with significant ($p < 0.0001$) $Chi^2$ test results (Q = 316.85, Q = 32.30, Q = 68.55) and $I^2$ statistics (93%, 77%, 82% ), indicating considerable heterogeneity (Deeks et al., 2020). There was greater heterogeneity in the mathematics self-efficacy studies (Q = 68.55) than in the self-efficacy studies (38.30). Meta-regression is not recommended for less than ten studies for each variable (Borenstein, 2009; Deeks et al., 2020). A subgroup analysis of mathematics self-efficacy outcomes (n = 13) or self-efficacy outcomes (n = 9) would have created small groups for each variable. Instead, a subgroup analysis between self-efficacy and mathematics self-efficacy studies for mathematics performance outcomes (n = 22) was selected for analysis.

### 1.4.8 Subgroup analyses

A subgroup analysis (Table 7) was conducted to compare the contribution of self-efficacy and mathematics self-efficacy studies to the overall mathematics performance effect size. The mathematics self-efficacy studies produced a small effect with *g* = 0.27, CI [-0.11, 0.65]. The distribution of mathematics self-efficacy studies was significantly heterogeneous, with Q = 241.18, df = 12 ($p < 0.00001$), $Tau^2 = 0.43$, and $I^2 = 95\%$. The self-efficacy studies had a similar effect size with *g* = 0.10, CI [-0.05, 0.26], and the distribution of self-efficacy studies was less heterogeneous but still significant with Q = 42.55, df = 9 ($p < 0.0001$), with a $Tau^2 = 0.04$ and $I^2 = 79\%$. The results of the subgroup differences p-value were not statistically significant ($p = 0.43$). This suggests that the target of the intervention (self-efficacy or mathematics self-efficacy) does not significantly modify mathematics performance outcomes.

**Table 7**

*Subgroup Analysis Between Self-Efficacy and Mathematics Self-Efficacy Studies*

| | Effect size and 95%CI | | | Test of null | | Heterogeneity | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subgroup | k (n) | *g* | 95%CI | z-value | p-value | Q | $df_q$ | $\tau^2$ | $I^2$ |
| Self-Efficacy | 10 (4038) | 0.10 | [-0.05, 0.26] | 1.34 | 0.18 | 42.55 | 9 (p < 0.00001) | 0.04 | 79% |
| Mathematics Self-Efficacy | 13 (3459) | 0.27 | [-0.11, 0.65] | 1.39 | 0.16 | 241.18 | 12 (p< 0.00001) | 0.43 | 95% |
| Difference | | | | | | 0.63 | 1 (p = 0.43) | | 0% |

*Note.* k – number of effect sizes, g – Hedges' g measure of effect sizes, CI – Confidence Interval, z – test for overall effect, Q - Cochran's Q measure of heterogeneity, $df_q$ – degrees of freedom, $\tau^2$ – Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity

### 1.4.9 Sensitivity analyses

A visual inspection was conducted on the resultant figure of the "one-study removed" analysis (Appendix B.2). There were no evident outliers within the standard error magnitudes and limits of the 95th confidence interval. The difference was only 0.01 in the average effect size between the top (largest effect size) and the bottom of the distribution (smallest effect size) when each study was removed sequentially. The probability is one effect size itself would not significantly influence the pooled effect size in either direction. Table 8 summarises the sensitivity analyses of the variables extracted from the studies. Several factors related to the research questions were explored: risk of bias, study design, instrument type, intervention category, duration, participant ages based on setting and sample size.

The first analysis was to examine the effect of excluding studies with a high risk of bias. Seven studies with a "high" overall risk of bias were excluded from the meta-analysis to test the association with mathematics performance effect sizes. The results showed a small increase to *g* = 0.32, CI = [0.06 , 0.58], Z = 2.44, p = 0.01. The $Chi^2$ test showed a small decrease, Q = 172.62, df = 14 ($p < 0.0001$), $Tau^2 = 0.22$ and $I^2 = 92\%$. The differences were minimal, indicating that removing these studies had no significant influence on the pooled effect size.

A further analysis removed a further nine studies rated with "some concerns" (ROB 2) or "moderate" (ROBINS-I), leaving six studies with a "low" overall risk of bias. The resultant analysis showed that the effect size was significantly affected by the removal of all lower-quality studies. Although the $Chi^2$ test still showed high heterogeneity with Q = 65.04, df = 6 ($p < 0.0001$), $Tau^2$ = 0.24 and $I^2 = 91\%$., there is now a medium significant effect size in favour of the intervention *g* = 0.68, CI [0.29 , 1.07], Z = 3.45, p = 0.0006.

Examining the six leftover "low bias" studies showed there was only one CRT study (20); the other five were iRCTs. There was a significant result for the test for subgroup differences: Q = 61.08, df = 1 ($p < 0.00001$), $I^2 = 98.4\%$. Removing the CRT study reduced the heterogeneity close to zero: Q = 3.95, df = 5 ( p= 0.56), $Tau^2 = 0$ and $I^2 = 0\%$. The zero value of $I^2$ does not indicate the lack of heterogeneity as the $Chi^2$ test chi-squared test has low power when there are a few studies (Higgins, Thomas, et al., 2020). Instead, the zero-value suggested that the heterogeneity was possibly unimportant, and these high-quality iRCT studies probably have similar characteristics to each other. There was a medium significant effect size in favour of the intervention *g* = 0.52, CI

[0.40 , 0.63], Z = 8.81, $p < 0.00001$. These results should be approached with caution due to the small number of studies (k = 5) and possible power issues.

A sensitivity analysis to explore the influence of study design on mathematics performance outcomes across all the studies showed a minimal effect on the overall effect size. Out of the CRTs, only one (5) reported the intraclass correlation coefficient (ICC), and there was no information in the other studies. It was expected that removing all CRT studies would influence the pooled effect size as there were inconsistencies in the reported effect sizes. Removing all the CRT studies (4, 6, 7, 9) (D) did not have a significant effect (p = 0.08) but it reduced the effect size to *g* = 0.18, 95% CI =,[-0.02, 0.39]. Moreover, the subgroup differences test was not significant between iRCT, CRT and QED study designs: Q = 1.58, df = 2 (p = 0.45), $I^2$ = 0%. Thus, the study design did not have a significant influence on effect size across the included studies. There was only a difference between study design when the risk of bias was accounted for, as previously shown. Further exploratory sensitivity analysis found non-significant results for intervention types, instrument types, intervention type, intervention duration, participants' age, publication type and sample size (See Appendix B.3).

**Table 8**

*Sensitivity Analysis Results*

| | Effect size and 95th confidence interval | | | Test of null | | Heterogeneity | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | Studies (n) | *g* | 95%CI | z-value | p-value | Q | $df_q$ | $\tau^2$ | $I^2$ |
| Risk of Bias (exclude high ROB) | 16 (3849) | 0.39 | [0.12 , 0.66] | 2.79 | 0.18 | 224.96 | 15 (p < 0.00001) | 0.27 | 93% |
| Risk of Bias (include only "low" ROB) | 6 (735) | 0.68 | [0.29 , 1.07] | 3.45 | 0.0006 | 65.04 | 6 (p < 0.00001) | 0.24 | 91% |

| | Effect size and 95th confidence interval | | | Test of null | | Heterogeneity | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | Studies (n) | *g* | 95%CI | z-value | p-value | Q | $df_q$ | $\tau^2$ | $I^2$ |
| Risk of Bias (include only “low” ROB; include only iRCT design) | 5 (1233) | 0.52 | [0.40 , 0.63] | 8.81 | p < 0.00001 | 3.95 | 5 (p = 0.56) | 0 | 0 |
| Study Design (excluding CRTs) | 19 (4851) | 0.18 | [-0.02, 0.39] | 1.74 | 0.08 | 185.90 | 18 (p < 0.00001) | 0.17 | 90% |

*Note*. g – Hedges’ g measure of effect sizes, CI – Confidence Interval, z – test for overall effect, Q - Cochran's Q measure of heterogeneity, df – degrees of freedom, $\tau^2$ – Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity

A G*Power independent samples t-test to detect a small effect size of Cohen's d = 0.21 (as from the primary meta-analysis of mathematics performance) with 80% power (alpha = .05, one-tailed) resulted in a suggested 282 participants per group for a total sample size of N = 564. Only the three studies (5, 9, 11) which met this criterion were included. Seven studies reported sample size calculations ( 1, 2, 4, 5, 16, 18, 19) and the rest had no calculations, or the information was unclear. Any “small study effects” (Sterne et al., 2000) are explored next in the publication bias analysis.

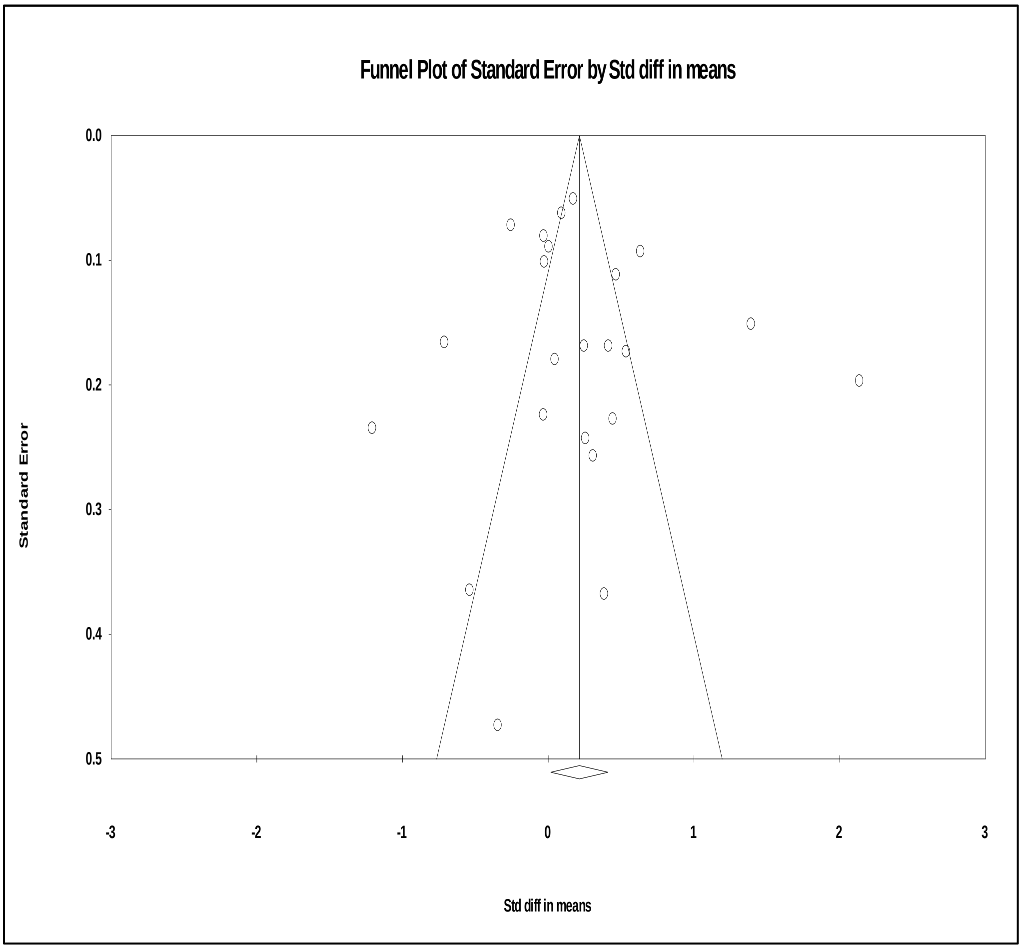
### 1.4.10 Publication bias

An analysis of publication type suggests that journal articles (*g* = 0.15, k = 9) and published theses (*g* = 0.19, k = 11) produced similar effect sizes. The results were significant for the subgroup differences between journals, published, and published studies (Q = 0.38) and between journals and theses or dissertations (Q = 0.29). The largest effect size (*g* = 1.39) was obtained in an unpublished study (7). Two unpublished studies (4, 8) did not have the minimum sample size suggested by G*Power, as do most of the studies in the full review.

A visual examination of the funnel plot (Figure 6) showed relative symmetry with several outliers in large studies with effect sizes in either direction. The Egger's test (Egger et al., 1997) the intercept = 0.98524, CI [-2.29, 4.26], with t = 0.63, df =21, p = 0.27 (1-tailed) indicates no significant publication bias. The rank correlation test (Begg et al., 1994) produced r = 0.051, p = 0.37, which also supports the rejection of the null hypothesis of no bias (p < 0.0001). The null result must be viewed cautiously because of the small number of studies and power issues (Hubbard et al., 1997).

**Figure 6**

*Publication Bias as Indicated by a Funnel Plot of SMD*



## 1.5 Discussion

### 1.5.1 Summary of main results

The purpose of this review was to examine the effectiveness of interventions that target self-efficacy or mathematics self-efficacy in improving mathematics performance. The search of databases resulted in 674 studies, and 27 studies met the inclusion criteria. All the studies had two outcome variables resulting from implemented interventions: mathematics performance and self-efficacy or mathematics self-efficacy. The pooled effects of self-efficacy or mathematics self-efficacy interventions on mathematics performance were calculated as a standardised mean difference using a random-effects model. Additionally, the pooled effects of interventions on self-efficacy and the pooled effects of interventions on mathematics self-efficacy were similarly calculated. Twenty-two studies with complete data included in the meta-analysis were a mix of study designs. There were eight iRCT, four CRT, and ten QED studies with a total of 23 effect sizes related to mathematics performance. Out of the 23 effect sizes, 10 effect sizes were from studies aimed at improving mathematics self-efficacy and 13 related to self-efficacy.

The number of CRT and QED study designs reflects the difficulties of conducting an individual random control trial study with students (Hutchison et al., 2010). For example, in educational studies, teachers and students in the same school may know which group they are in. There was significant clinical and statistical heterogeneity evidenced by the variety of mathematics performance measures, self-efficacy or mathematics self-efficacy measures, intervention design, and population characteristics.

The first analysis tested the mathematics performance outcome, which produced a small significant effect of $g$ = 0.21, 95% CI [0.02, 0.41]. Although this suggests that the studies' interventions improve mathematics performance, power and heterogeneity issues must be considered. The distribution of the studies was considerably heterogeneous, with $I^2$ = 93%, which suggests that some students perform in mathematics worse than others in some interventions.

For the second research question, an analysis was conducted to explore how effective interventions improved self-efficacy or mathematics self-efficacy beliefs. The results indicated a small but significant result for self-efficacy ($g = 0.20$, $p = 0.01$) and a small non-significant effect for mathematics self-efficacy ($g = 0.16$, $p = 0.11$). The results suggest that general self-efficacy interventions may be more effective than specific mathematics self-efficacy interventions in changing self-efficacy. The results have to be interpreted with caution, as significant heterogeneity was present, and there were a small number of studies in both analyses.

There were issues of conflating the definitions of self-efficacy with mathematics self-efficacy in some studies. The other confounding factor was the variety of measures for self-efficacy and mathematics self-efficacy. Bandura suggested that scales should be specific to the measured domain (Bandura, 2006). It is possible that the scales in the self-efficacy studies had better specificity than the mathematics self-efficacy studies. General self-efficacy interventions possibly had a greater mastery experience component that resulted in a significant self-efficacy outcome. The lack of theoretical detail in the interventions did not allow for further analysis.

A subgroup analysis was performed on the mathematics performance outcomes to compare the differences between self-efficacy and mathematics self-efficacy studies. The subgroup differences were not significant, indicating no statistically significant difference between mathematics performance outcomes associated with general academic self-efficacy interventions and those associated with mathematics self-efficacy. Both distributions of self-efficacy $I^2 = 77\%$ and mathematics self-efficacy $I^2 = 83\%$ of the studies were considerably heterogeneous. The results suggested that some students' self-efficacy or mathematics self-efficacy was worse than others in some interventions. Due to the small number of studies, meta-regression was not conducted.

Sensitivity analysis of intervention design, instrument types, intervention duration, and age of participants produced non-significant results. The probability of one study affecting the pooled effect was discounted in the "one-study removed" analysis (Appendix B.2). Investigations on the study design showed that the subgroup differences between the study designs were not significant, possibly because the studies had a mixture of different risk of bias.

An analysis of six studies with "low bias" only resulted in a positive and significant medium effect size of $g = 0.68$, but there was still considerable heterogeneity at $I^2 = 91\%$. Including only the five “low bias” iRCT studies suggest that these studies are more homogenous with Q = 3.95, df = 5 ( p= 0.56), $Tau^2 = 0$, and $I^2 = 0\%$. The effect size was smaller than that previously but still significant at $g = 0.52$. The significant result from including only “low bias” iRCT studies was possibly due to the studies' higher quality, but five studies were insufficient to make generalised conclusions.

### 1.5.2 Potential sources of variations on the effect sizes of interventions

The measurement of mathematics performance, self-efficacy, and mathematics self-efficacy was a confounding variable in this review, as various measurements were used. Different scales have different influences on outcome measures across studies (Arens et al., 2020; Multon et al., 1991). Further analysis was not pursued because of the limited number of studies and the available information.

Knittle et al. (2020) contended that broad-ranging labels are often used for different behavioural interventions that lack specificity. The included interventions may not have specifically targeted self-efficacy or general academic self-efficacy, as claimed. Michie et al. (2016) argued that behavioural interventions must have a theoretical basis and a good understanding of the underlying mechanisms. Seven studies reported SCT as the theoretical basis of their interventions, but the theoretical link often lacked details.

Only three studies met the minimum number of participants per group required for a small effect size at 80% power. Several authors commented on the possible limited power in their studies, but most did not report sample size calculations. There were outliers with large effect sizes in both directions, but the analysis showed no publication bias.

### 1.5.3 Overall completeness and quality of the evidence

The search included four electronic databases combined with manual searches. Published and unpublished thesis/dissertations were included, expanding the number of studies available in a small area. Two team members coded and checked the data during the screening and data extraction processes. There were no restrictions on geography, temporal, or language that contributed to source bias. Two members of the team, including the author, screened the studies and extracted the data. The review used stringent appraisal tools as part of the Cochrane Collaboration review process and reported the data according to the PRISMA and Cochrane standards.

### 1.5.4 Limitations and potential biases in the review process

Further searches by consulting experts in the field or other repositories were not pursued, and this may have contributed to publication and availability bias. The review team's experience, training, and preparation were limited which may have contributed to the low inter-rater agreement. The database search produced studies on self-efficacy that were often unclear in how they operationalised self-efficacy and implemented interventions.

Five studies were excluded because of a lack of information. Almost all the studies were conducted in the United States, and all were reported in English. The evidence from this review must be applied cautiously to other countries. The majority of theses and dissertations had a high risk of bias. Studies often had incomplete information, such as demographic information, analysis steps, or attrition information. Participants came from a variety of settings across a wide demographic range. No analysis was conducted on possible moderating effects of gender as there was incomplete information regarding gender distribution.

The review included a small number of studies which limited further investigations through meta-regression. There was no evidence of publication bias, and several outliers with large studies contributed to both negative and positive effect sizes. With such a small number of studies, there was no certainty regarding the bias results. Interventions used a wide variety of self-efficacy and performance measures. Studies have often measured multiple domains, and there are a variety of study aims. A large degree of statistical and clinical heterogeneity in the meta-analysis results was present due to the diverse range of studies.

### 1.5.5 Agreements and disagreements with other studies or reviews

This review's meta-analysis results show that self-efficacy and mathematics self-efficacy interventions had a small but significant positive effect on mathematics performance. Although self-efficacy interventions had a significant small positive effect on self-efficacy, mathematics self-efficacy interventions had a non-significant small positive effect on mathematics self-efficacy. The statistically significant effect size in mathematics performance due to self-efficacy and mathematics self-efficacy interventions supports the significant results from previous research on self-efficacy interventions in different domains (Panadero et al., 2017; Unrau et al., 2018)

The results showed that the small effect size of mathematics performance ($g$ = 0.21) was similar in magnitude to Unrau's (2018) review of interventions on reading self-efficacy ($g$ = 0.24) and Multon et al.'s (1991) review of the relationship between self-efficacy and academic performance ($g$ = 0.38). However, the findings were smaller than those of Panadero et al.'s (2017) self-assessment interventions for self-efficacy ($g$ = 0.73). It may be that this review and Unrau et al.'s were similar in that the interventions were aimed at improving self-efficacy in specific academic domains.

Research on self-efficacy has historical difficulties in how self-efficacy is operationalised and differentiated from similar constructs (Bong et al., 2003). Some authors used various terms such as "self-efficacy in mathematics" or interchangeably use self-efficacy and mathematics self-efficacy. This leads to the possibility of overlap in how these constructs were measured in these studies. Bandura's theoretical view was that self-efficacy measures had to be domain-specific (Bandura, 2006).

There were differences in operationalising and defining self-efficacy, conflation of self-efficacy with other constructs and various mathematics self-efficacy scales in this review. This echoes findings from previous meta-analyses of self-efficacy studies (Bartimote-Aufflick et al., 2016; Unrau et al., 2018). Several authors in this review (Falco, 2008; Forbes, 1988; Gamlem et al., 2019) also highlighted the difficulties in operationalising the scales and constructs.

These findings support the previous meta-analysis, which demonstrated a correlation between self-efficacy and academic performance (Honicke et al., 2016; Multon et al., 1991). While the findings showed that improving interventions aimed at students' self-efficacy improved mathematics performance, the findings also demonstrated that there may be less knowledge on how to implement the interventions effectively.

## 1.6 Conclusions

### 1.6.1 Implications for practice and policy

This review indicates that self-efficacy and mathematics self-efficacy interventions have a small and positive effect on mathematics performance, which can help educators design programs for students. However, the evidence also shows a need for evidence-based interventions based on social cognitive theory with well-defined parameters and scales. Interventions need greater specificity to be effective in improving self-efficacy in an academic context.

### 1.6.2 Implications for research

The results support the view that self-efficacy and mathematics self-efficacy interventions positively affect adolescents' mathematics performance. Further research is needed for this population, as this review had a wide range of ages in the participants. Consistent with recent agendas to decolonise the curriculum, more research is needed in non-English-speaking countries. The moderating effects of gender and specific populations were not covered in this review. There was good evidence of positive effects from a small number of high-quality individual randomised control trials and studies with interventions based on social cognitive theory. Future researchers need to design more robust studies that are firmly based on theory.

# Chapter 2 Under Pressure: A Qualitative Study of Students' Experiences of Resitting GCSE Mathematics

## 2.1 Introduction

In recent years, assessing young people's educational achievements and standardised testing has become the focus of policy debate nationally in the United Kingdom and internationally. Standardised testing is an established way for policymakers to hold schools accountable for educational standards (Stobart et al., 2012). Historically, many countries have conducted high-stakes testing to evaluate student attainment in schools (Bray, 1998; Parveva et al., 2009). High-Stakes Testing (HST) is when the test results have significant implications for students, potentially affecting their futures (Stobart et al., 2012). Today, students aged 15-16 in England, Wales, Northern Ireland, and other British territories sit for the General Certificate of Secondary Education (GCSE) qualification in the summer term of Year 11 ( Appendix C.1 shows the UK education system). Former British colonies inherited this examination, and their students sit the International GCSE (IGCSE) (Bray, 1998).

In 2015, the UK government reformed the GCSE based on Wolf's (2011) report on vocational education. She suggested that students aged 14-19 were doing programmes that did not equip them for work. Her recommendations were all post-16 students to continue to study English and mathematics if they did not achieve Grade C (or Grade 4 since 2017) and resit the examinations. The letter grades were changed to 1–9, with 9 being the highest (GOV.UK, 2018). The first mathematics examination results with the new grade system were in 2017 (OFQUAL, 2020b).

Students may resit in the following November or summer with other students. GCSE mathematics consists of foundation and higher-tier qualifications. Most post-16 students resitting GCSEs sit for the foundation paper and do so at further education (FE) colleges (Impetus PEF, 2017; Lupton et al., 2021). Research shows that some students reach the post-16 level without the ability to perform at the same expected level as their peers (ASCL, 2019; Higton et al., 2017; Longfield, 2019).

In 2019, 548,000 candidates aged 16 sat for GCSE mathematics, and 71.5% achieved grade 4 or above (OFQUAL, 2019). There were 55,955 entries for the November mathematics GCSE resists in 2019 and 55,125 entries in 2020 (OFQUAL, 2020a). In 2020, COVID-19 meant that students did not sit examinations as normal, and students were awarded calculated grades based on centre assessment grades. In November 2020, there were 72,115 entries to resit GCSE mathematics. Entries were previously around 55,000 (OFQUAL, 2020a). About a third of students do not achieve grade 4 in English and mathematics (ASCL, 2019; Lupton et al., 2021).

Reports on post-16 students suggested some 18-year-olds do not have the GCSE grades they need and cannot move into jobs or qualifications (ASCL, 2019; Longfield, 2019; Lupton et al., 2021). Davies (2020), in her literature review as part of a project on a new post-16 mathematics curriculum, identified that motivation and confidence were key to students' learning. Students' lack of confidence in mathematics hindered them from gaining GCSE qualifications. The Association of School and College Leaders (ASCL) argued the current system diminishes these students as the *Forgotten Third* (ASCL, 2019, p. 6) as they are not often heard about as often as their peers who achieved the grades (Blatchford, 2020).

Most of the studies on students resitting GCSEs are adult-focused, reporting, for example, teaching practices (Higton et al., 2017) or the curriculum (Davies et al., 2020; Lupton et al., 2021). There is limited research from the students' viewpoint on GCSE and the psychological theories behind students' behaviours and perceptions. Research on GCSE students' perspectives reported students' negative attitudes toward mathematics and difficulties with learning mathematics (Anderson et al., 2016; Bellamy, 2017) but not the psychological aspects of their experiences. This study addresses these issues by considering motivational and self-efficacy theories in response to the overarching research question: "What are the students' experiences of resitting the GCSE mathematics examinations?" The study adds the students' perspectives of resitting GCSE mathematics to the discussion on high-stakes testing and national assessments.

For this qualitative study, I interviewed 11 students from a large FE college. Using a social constructivist approach, I sought the meaning behind the students' narratives and social processes (Charmaz, 2006). The following sections present the factors affecting students’ learning and a review of the theory and existing research. The research aims are outlined next, followed by the study’s methods and analysis. Four themes were developed from the framework and thematic analysis, focusing on students' difficulties with learning, approaches to learning, relationships with others, and self-perceptions. There is a summary of the findings and a discussion within the context of previous knowledge. Implications for practitioners and researchers conclude this study.

## 2.2 Background

### 2.2.1 Self-Determination Theory

Self-determination theory (SDT), as proposed by Deci and Ryan (1985), suggests humans have a natural tendency toward learning and growth, with three basic psychological needs: autonomy, competence, and relatedness (Ryan et al., 2002). Autonomous individuals perceive their behaviour as internally directed and of their own volition, although external factors can influence their decisions (Reeve, 2012; Ryan et al., 2002). Competence is a feeling of confidence when dealing with challenges and acting upon them. Relatedness refers to the feeling of connectedness to others and feelings of belonging. SDT is a macro-theory of motivation that encapsulates theories associated with basic psychological needs, extrinsic versus intrinsic motivation, and how it influences individuals’ goals and how cognitive evaluation of external events affects motivation and individual differences in motivation (Reeve, 2012; Ryan et al., 2002).

Parents can support self-determination by fostering autonomy (Grolnick et al., 1991; Silinskas et al., 2019). Grolnick et al.’s (1991) study on the associations between children's perceptions of parental autonomy support, motivation, and school success, found that both maternal and paternal support were positively associated with perceived competence and autonomy. The findings were from 456 American children in Grades 3 through 6 (7-11-years) and their parents and four other samples from other districts. Similarly, Silinskas et al. (2019) suggested that parental help with homework increased motivation rather than skills. They studied Estonian 624 mothers and children between Grades 6 and 9. Mothers who fostered autonomy had children who persisted longer doing tasks.

As suggested by previous research, the teacher-student relationship and the learning environment contribute to GCSE students’ experiences (Anderson et al., 2016; Higton et al., 2017). Reeve (2012) proposed that the constant aspect of the learning environment is the teacher’s motivating style, whether autonomy-supportive or controlling. Reeve suggested a reciprocal relationship between students’ engagement, motivation, and changes in the learning environment. Engagement refers to how involved a student is in a learning activity. An autonomous supportive classroom offers students affirmative experiences of rewards, feedback, and opportunities to evaluate progress and set goals. Students receive opportunities to develop competence, and the challenges are set at optimal levels. These factors increase student engagement and, in turn, contribute to personalising their learning environment.

A study of 1412 Spanish high-school students showed that mathematics classrooms with supportive teachers fostered students' autonomous motivation (León et al., 2015). Structural equation modelling showed that both autonomous regulation and self-regulated learning were positively related to students’ mathematics performance. Autonomous students are more likely to self-regulate. A study of 526 Grades 11 and 12 (16-18-year-old) Belgian students concluded that students who perceived low autonomy did not use self-regulatory strategies for learning (Sierens et al., 2009). The communication of behaviour expectations was only effective under moderate and high autonomy conditions.

Although there is unequal power status between students and teachers instead of more equal peers, a positive environment facilitates relatedness (Reeve, 2012). An American study of 641 7-11-year-old students found that a sense of relatedness positively predicted classroom engagement (Furrer et al., 2003). The sense of relatedness to teachers declined in older students, and the correspondence to engagement was greater than in younger students. Studies on

American adolescents found parental and teacher relatedness corresponded to positive attitudes and motivation (Guay et al., 2017; Ryan et al., 1994). In older adolescents (n = 34, mean age 17.7 years), relatedness to teachers predicted autonomous academic motivation (Guay et al., 2008).

Niemiec and Ryan (2009) suggest that intrinsic motivation is maintained when autonomy, competence, and relatedness are met. Students who felt competent will not maintain their motivation if they do not have autonomy. A longitudinal study of 426 Italian students (14-18-years old) found that students' self-determination levels predicted their intention to drop out (Alivernini et al., 2011). Academic performance and self-determination levels were positively correlated with self-efficacy beliefs.

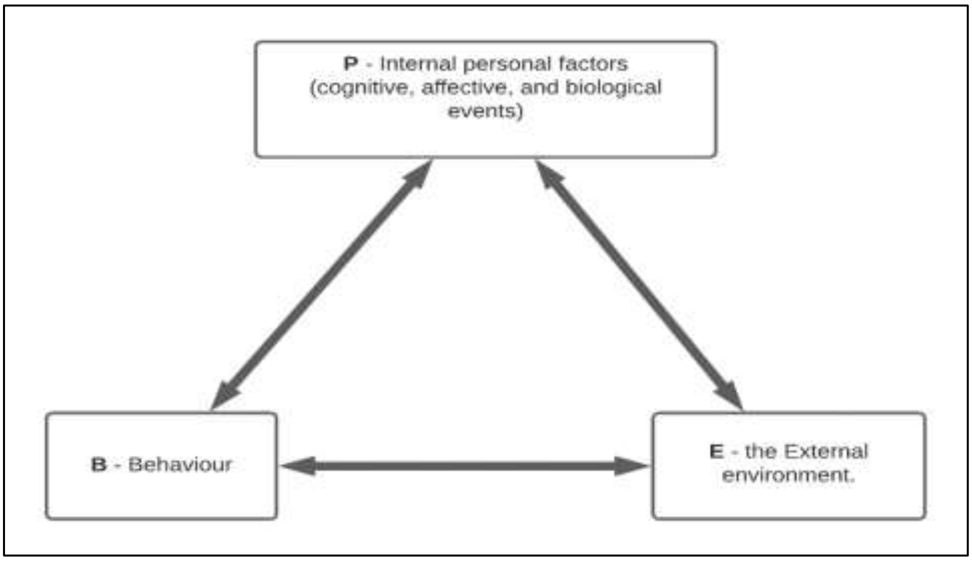
Perceived competence in SDT is closely related to self-efficacy, a construct of social cognitive theory (Bandura, 1997). Self-efficacy theory and SDT overlap in terms of competence beliefs, but SDT focuses on the reasons for motivational behaviour (Deci et al., 2012; Deci et al., 1991). In SDT, perceived competence enhances intrinsic motivation when there is a sense of autonomy. Self-efficacy and SDT are complementary constructs that help us understand why people engage in and persist in desired behaviours (Rodgers et al., 2014). Self-efficacy is concerned with competence beliefs initiating the desired behaviour within specific domains, as outlined next.

### 2.2.2 Self-Efficacy and Social Cognitive Theory

Self-efficacy is a construct of social cognitive theory (SCT), which refers to an individual's beliefs in their capabilities to plan and complete the actions needed to produce the desired goals (Bandura, 1986, 1997). SCT considers the individual's agency, cognition, prior behaviours, and the social and physical environments shaping their future actions (Bandura, 2001). Bandura's (1986) triadic model (Figure 7 ) outlines how a) cognitive, affective, and biological factors; b) behavioural patterns; and c) environmental factors influence and determine each other in a process referred to as reciprocal determinism (Bandura, 1978, 1997). Self-efficacy is specific, so efficacy in one area does not translate to another (Bandura, 1997). Individuals are motivated and persevere when positive incentives are present, and they believe they have the necessary skills (Bandura, 1997).

**Figure 7**

*Triadic Reciprocal Causation Model (from (Bandura, 1986))*




Research has linked academic performance, choices, and motivation to self-efficacy beliefs (Bandura, 1986, 1997; Pajares, 1996). Five factors influence adolescents' self-efficacy: developmental changes, group differences, schooling, peers, and families (Schunk et al., 2006). Meta-analyses have shown that self-efficacy is positively associated with academic performance and persistence in adolescents (Multon et al., 1991)and university students (Honicke et al., 2016). Multon et al. (1991) found that across 39 studies of 4,998 students with an average age of 16.6 years, academic achievement was positively related to self-efficacy. Similarly, Honicke and Broadbent's (2016) systematic review of 59 papers showed that academic self-efficacy was moderately correlated with academic performance.

Mathematics self-efficacy describes an individual's assessment of their ability to perform a particular mathematics problem or task (Hackett et al., 1989). Mathematics self-efficacy positively correlates with attitudes toward (Betz et al., 1983; Hackett et al., 1989). Betz and Hackett (1983) investigated the relationship between mathematical performance and mathematics in 262 US college students. Students’ mathematics self-efficacy expectations were related to their choice of mathematics subjects. Mathematics self-efficacy predicted American students' (10-11-years) mathematics performance at the start of and at the end of the year (Pajares et al., 1999)

Self-efficacy sources include mastery experience, social persuasion, affective state, and vicarious learning (Bandura, 1997). A mastery experience is an individual's successful past experiences. Social persuasion refers to others' encouragement and feedback. The affective state is an individual's emotional response to the task, and vicarious learning is the individual's experience of watching others' success at the task.

Sheu et al. (2018) found that direct personal experience, including mastery experiences and vicarious learning, predicted self-efficacy and outcome expectations. A meta-analysis of 104 self-efficacy studies showed that persuasion had a small but positive relationship with self-efficacy and a large positive path to outcome expectations. A Norwegian study of 896 students found that responsive teachers increased students' motivation, self-efficacy, and persistence in mathematics and a decline in anxiety (Gamlem et al., 2019).

Johnston-Wilder et al. (2015) interviewed 17 students on a mathematical resilience course. Students with repeated failures to gain a C in GCSE mathematics did not see the value in mathematics, reported limited confidence, and felt bored. Teachers often perceived them as not having the ability to succeed. The authors argued that the students were able in other subjects but had difficulties overcoming powerful emotions about mathematics. According to Bandura's triadic model, an individual's negative affective reactions contribute to low self-efficacy (Bandura, 1997).

### 2.2.3 Previous research on GCSE Resits

In 2019, only 24% of students passed the GCSE resit by the time they were 19 years (Department for Education, 2020). Students without special educational needs (SEN) are one and half times more likely to achieve Level 2 (86.7%) than the SEN population (52.8%). Ricketts (2010) argued that despite being a common practice, there is no theory of resits and a limited understanding for justifying resits. Rodeiro (2018) demonstrated that students with higher percentages of Level 3 qualifications were more likely to improve their grades than lower-achieving students. Her study on which students are likely to improve their GCSE grades due to resitting includes a multi-level regression on 67,759 GCSE mathematics students. The probability of students improving their grades decreased with an increasing number of attempts.

Other studies in the UK on university students (Proud, 2015) and A-level students (Arnold, 2017) support the notion that lower-achieving students who resit make limited progress. The average progress made by post-16 students resitting GCSE is close to zero (Davies et al., 2020). Post-16 educational progress was measured by the Department for Education points system(Department for Education, 2019). The lack of progress meant that most post-16 students were unlikely to achieve a grade of C or 4 despite resitting.

Research has focused on GCSE students’ experiences of examinations stress. In his study of GCSE students aged 15-16 from 12 schools, Denscombe (2000) noted that GCSEs add pressure to young people in addition to experiencing stressful conditions in modern life. Sources of stress for students come from teachers' and parents' expectations and internalised pressure to excel. Similarly, in Roome and Soan’s (2019) case study, Year 12 students (17-18-years) reported that pressure came from schools, parents, and friends. Support from schools and parents was the key to helping ease stress. More confident students had positive previous experiences and self-beliefs. Putwain’s (2011) study of 34 students (14–16-year-old) suggested that students who experienced memory failure in examinations had low competence beliefs and anticipated failure. His findings demonstrated that examination stress was subject-specific, with mathematics considered more stressful than other subjects.

The literature review for this study found limited research on psychological aspects specific to students resitting GCSEs. The research aims as follows discusses this gap.

### 2.2.4 Research aims

This study aimed to explore the experiences of students aged 16-19-years who were resitting GCSE mathematics examinations and to increase our understanding of how the processes and period of preparation for resitting GCSE mathematics were experienced by students. Specifically, this study addresses the following questions:

- What roles do the learning, revision, and testing processes play in students' experiences of preparing for and resitting GCSE examinations?
- How do students view themselves and the role of others in preparing for and resitting their GCSE exams?

Research on improving educational practice has reported a complex picture of factors that impact GCSE students’ learning and engagement (Davies et al., 2020; Education and Training Foundation, 2014; Higton et al., 2017; Impetus PEF, 2017; Longfield, 2019; Lupton et al., 2021). Educators reported that students had low motivation, confidence, and engagement with learning. Students described negative experiences in school, lack of support, and difficulties in lessons (Higton et al., 2017; Lupton et al., 2021).

Research focusing on students' perspectives found that students resitting GCSEs had limited motivation and confidence in mathematics (Anderson et al., 2016; Bellamy, 2017). Students in both studies reported having negative experiences at school with large classes, disruptions, and limited support from teachers. Anderson and Peart (2016) explored how an FE college engaged students resitting GCSE by interviewing and conducting focus groups with students. The findings showed that college was an improved experience for most students because of the better learning environment and teacher support concur with Highton’s (2017) interviews with post-16 students.

Debate centres on whether resitting GCSE examinations are best for all students (ASCL, 2019; Lupton et al., 2021). We rarely hear from the students, and understanding their perspectives is important to meet their needs. This study extends Anderson and Peart (2016) and Bellamy’s (2017) previous work on gathering the perspectives of FE students who are resitting GCSE by offering SCT and SDT as theoretical psychological perspectives. The interview schedule design was informed by both theories. I aimed to provide fresh insights on how students experience resitting GCSE mathematics through a social constructivist lens, as outlined in the Methods section.

## 2.3 Method

### 2.3.1 Research Design Overview

The key to my approach was interpretivism, as I wanted to understand the students' individual experiences. The interpretivist researcher is involved in the process rather than being a detached observer (Angen, 2000; Hudson et al., 1988). My ontological assumption is that participants intersubjectively construct multiple realities through social interactions (Angen, 2000; Hudson et al., 1988; Lincoln et al., 1985).

The qualitative study and interviews facilitated participants' narratives and contextualised the study (Charmaz, 2006; Lincoln et al., 1985). The exploratory nature of qualitative design is appropriate for this study as there is limited existing research on the topic, so our knowledge is limited (Charmaz, 2006; Hudson et al., 1988). The design facilitates thick (Geertz, 1973) qualitative descriptions to situate the study by analysing and interpreting observations.

I employed social constructivist epistemology (Charmaz, 2006) to develop an in-depth understanding of the GCSE phenomenon by interviewing students. Social constructivists aim to "understand how and sometimes why participants construct meaning and actions" (Charmaz, 2006, p. 130). A social constructivist perspective emphasises the link between social interactions and meaning-making. Participants and researchers co-construct knowledge through interactions (Charmaz, 1990, 2006), and, as a researcher, I acknowledge the students as social agents who construct meaning around their own experiences. My focus was on eliciting the participants' understanding and meanings attached to the situation and events and re-used their words to deepen my understanding.

As a trainee educational psychologist, I worked with students in schools and FE colleges. I had no prior relationships with the participants. During the study, my friends and I had children undergoing GCSE examinations or resitting their examinations. Steps were taken to reduce any bias (See Section 2.4.2).

### 2.3.2 Recruitment Process

Participants were recruited and interviewed over six months, from November 2019 to February 2020. (See Appendix E for study materials). Twelve invitations were emailed to FE colleges in South England, and one college agreed to participate. In line with the national average (Office for National Statistics, 2020), around 20% of the students were from black, Asian, or ethnic minority backgrounds. Although the surrounding area was mainly white British, the large town was ethnically diverse.

The college displayed the posters (Appendix E.5) I created, which included the study and contact details. The teachers and I spoke to the students in their classes. Seventeen interested students emailed me, one did not meet the inclusion criteria, and five did not attend the interview. Recruiting the students was challenging. The students and staff were unfamiliar with me, and the time frame coincided with the examinations. Recruitment ended when no more students came forward.

### 2.3.3 Study Participants and Selection

The inclusion criteria were students aged 16-19 years, resitting GCSE mathematics, and proficient in English. An opportunistic two-stage purposeful initial approach to sampling (Palinkas et al., 2015) was adopted. In this first stage, five female students and one male who met the inclusion criteria were interviewed. The second stage involved sampling in recruiting more male students. Four male and one female student were interviewed.

There were 11 participants in total (females, n = 6; males, n = 5; mean age, 16.6 years; SD = 0.7; age range = 16 -18 years). There were (n = 6) white British, (n = 4) Asian, and (n = 1) mixed white and Asian students. Three students had English as an additional language (EAL). Of the four SEN students, two were dyslexic, one had medical needs, and the other declined to provide information. Five students were resitting the second time, and six were doing their first resit. Most of the participants were non-SEN White-British students aged 16–19-years and doing their first resit (See Appendix D.1 for participant demographics).

### 2.3.4 Data Collection procedures

I gathered data for this study through 11 individual semi-structured interviews guided by a schedule (See Appendix E.1 for the schedule). The interview schedule was based on a descriptive, broad, open-ended *Grand Tour* line of questioning (Spradley, 1979, p. 49) informed by previous evidence and theory. The four areas were learning mathematics, coming to college, their current situation, and feelings about resitting.

The interview process had four stages: introductions, information seeking, reflecting on the situation, and conclusion (Charmaz, 1990). I explored students' self-perceptions before eliciting broad descriptions of their learning experiences. Participants were encouraged to lead the interview through open-ended questions that explored the meanings behind their narratives and social interactions (Charmaz, 1990). I asked about relationships with parents, teachers, peers, perceptions of the educational settings, and their social environments.

Each interview was digitally audio-recorded, uploaded to a computer, and lasted approximately 60 minutes. Before the interview, participants completed a demographic questionnaire (Appendix E.2) and were briefed before signing a consent form (Appendix E.4). After the interview, they were debriefed and given a £10 voucher as a gesture of thanks.

### 2.3.5 Ethical Considerations

Ethics approval was granted on 2 July 2019 by the University of Southampton Ethics Committee (Ethics Number 47247, Appendix E.6). The college head signed a consent form in September of 2019. The details of the study were sent to the students, their caregivers, and the college head (See Appendix E.3).

The interviews were conducted in a private room. The participants were signposted for further support as needed. The students contacted me privately via their college email. I allocated numbers and pseudonyms to the students and removed identifying information to ensure anonymity. All the data were stored on a password-protected computer.

## 2.4 Analysis

### 2.4.1 Data-analytic strategies

Two complementary approaches were used to analyse the data: framework analysis (FA) for coding and categorising the data and thematic analysis (TA) to identify themes across the data. FA sits within the family of qualitative methods that incorporate thematic and content analysis (Braun & Clarke, 2019; Gale et al., 2013). FA was chosen because it facilitates systematic and iterative examination of data to produce a thematic framework (Ritchie & Spencer, 1994).

The FA *codebook* approach creates a framework consisting of a matrix populated from the summarised interview data. The matrix facilitates code categorization and reduction while enabling analysis at different levels (Ritchie et al., 2013). The analysis process is flexible; retrieval of original content is easy to compare within and between cases (Ritchie & Lewis, 2003; Ritchie & Spencer, 1994).

I adopted Gale at al.'s (2013) seven-stage FA approach (Figure 8): 1) transcription; 2) familiarisation with the interview; 3) coding; 4) developing an analytical framework; 5) applying the analytical framework; 6) charting data into the framework matrix, and 7) mapping and interpreting the data which involves developing common themes across all categories.

Thematic analysis (TA) was chosen to complement the FA process as it facilitates data organisation into themes with rich details. Themes are "patterned responses or meanings within the data set” (Braun et al., 2006). TA is a six-step process: 1) familiarisation, 2) data coding, 3) generating initial themes, 4) reviewing and developing the themes, 5) refining, defining, and naming themes; and 6) writing the report (Braun et al., 2021).

Although the FA and TA processes overlapped, as shown in Figure 8, there were distinct differences. FA was used to code and categorise data. Parkinson et al. (2016) suggested that the development of framework categories is separate from the development of analytical themes. The initial focus in FA is the management and of data, and interpretation occurs later. FA does not stipulate an interpretation method. TA was chosen to develop themes across the data in the matrix.

#### 2.4.1.1 Transcription

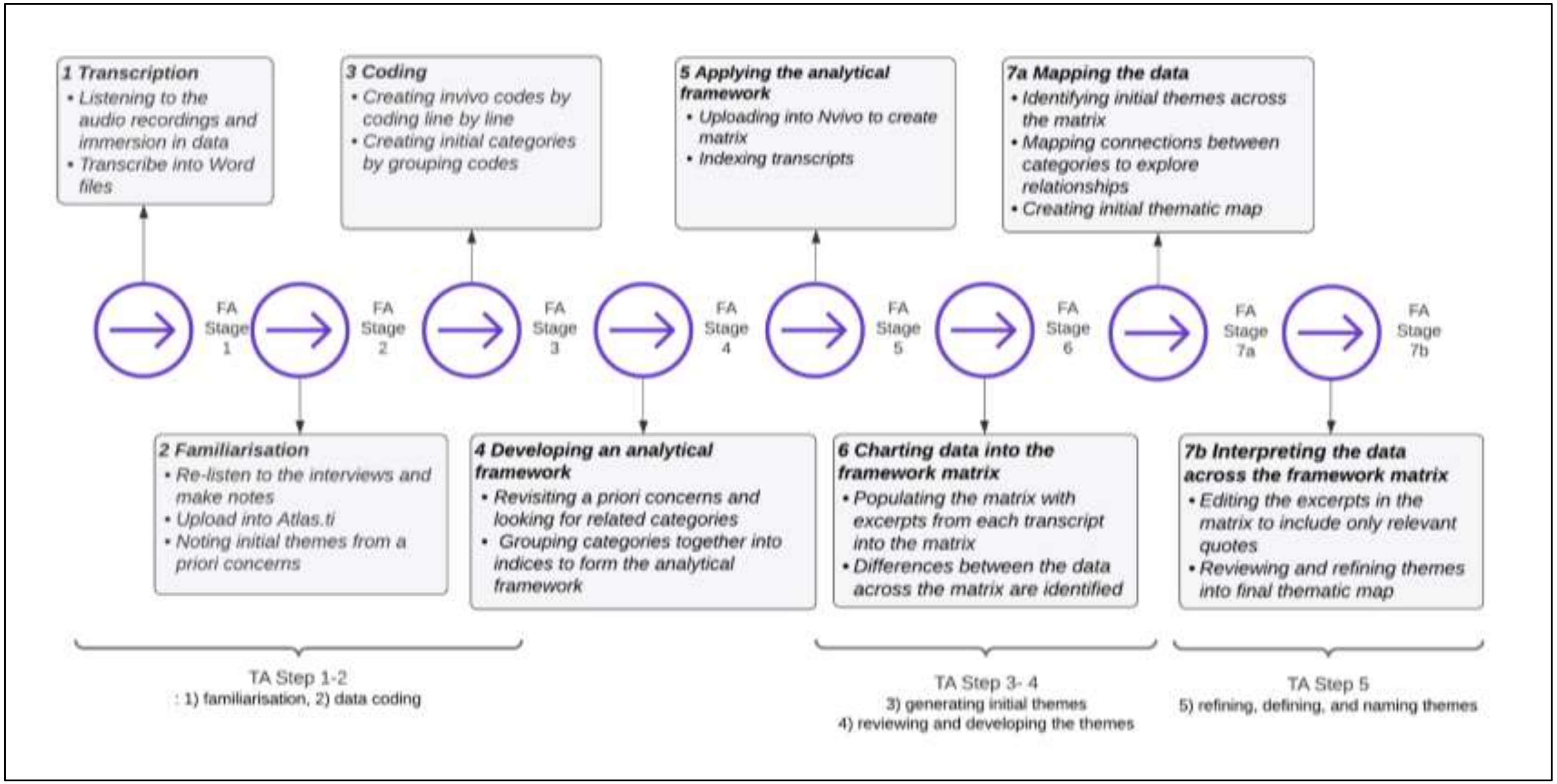
I transcribed five interviews verbatim in Microsoft Word. A transcription service transcribed the remaining six. The data were loaded into Atlas.ti (ATLAS.ti Scientific Software Development GmbH, 2020) as its flat structure facilitated interconnecting low-level data before making higher-level interpretations (Friese, 2019). Data were collected, transcribed, and analysed simultaneously after completing each interview.

#### 2.4.1.2 Familiarisation

I immersed myself in the data by listening to each audio recording, reading each transcript, and memoing a priori ideas while remaining open to ideas from the data (Parkinson et al., 2016; Pope et al., 2005).

**Figure 8**

*The Seven-Stage Approach to Framework Analysis with Thematic Analysis*




*Note*. FA – Framework Analysis. TA – Thematic Analysis

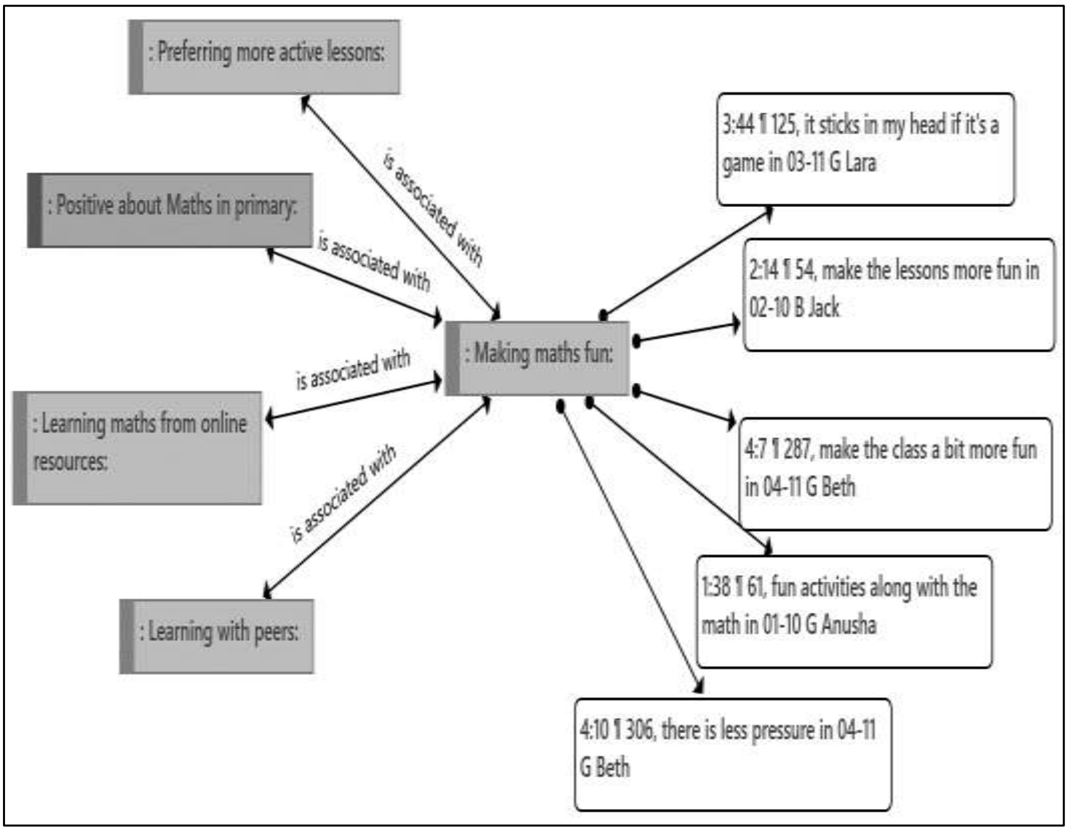
#### 2.4.1.3 Coding

The coding was conducted in three stages: *in vivo* line-by-line coding, grouping into initial and intermediate categories. Coding was performed iteratively and developed inductively by coding *bottom-up* and staying close to the data (Patton, 1990). *In vivo* codes were obtained from participants, and meaningful excerpts were captured (Charmaz, 1990; Saldana, 2013). A total of 823 *in vivo* codes were created.

I grouped *in vivo* codes into 111 initial codes using Atlas.ti network diagrams. The initial codes were labelled with meaningful gerunds describing the process or experience. Figure 9 shows an example of an initial code network diagram.

**Figure 9**

*"Making Maths Fun" Initial Code Network*

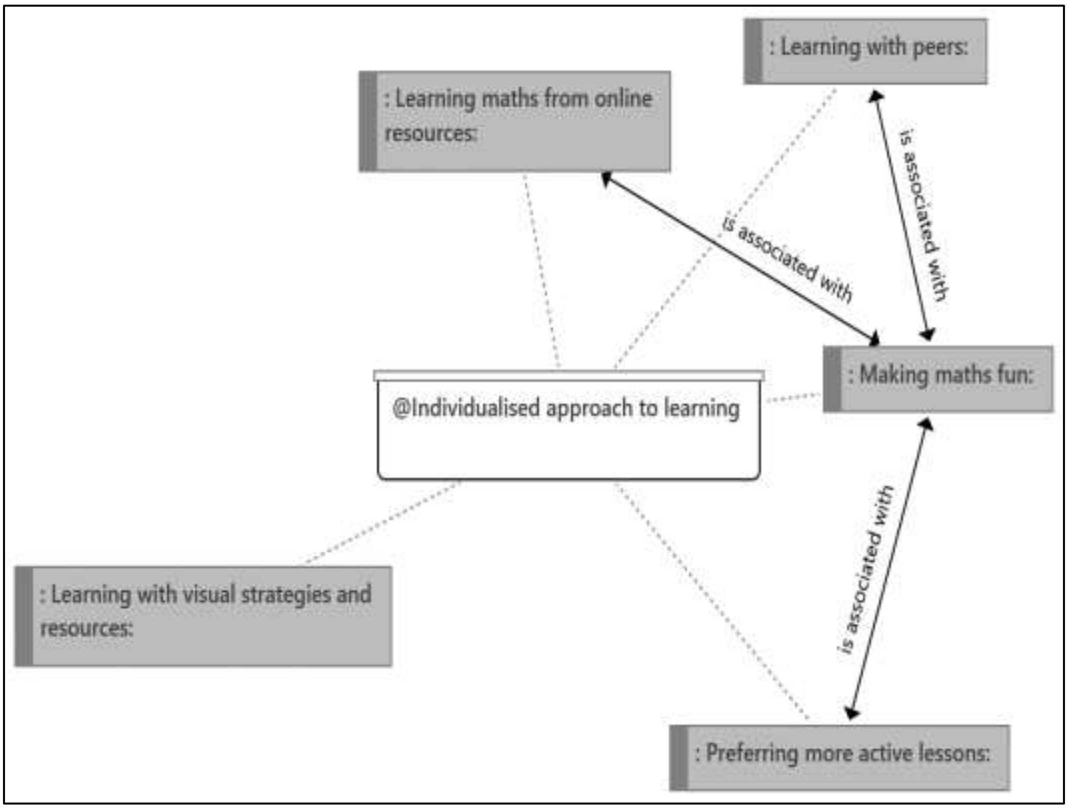



*Note.* Lines denote relationships between excerpts and initial codes and inter-code relationships. Colon denotes initial codes. Numbers denote interview transcript number and excerpt position.

The priority in the next stage was data reduction and management (Midgley et al., 2017; Parkinson et al., 2016). The initial codes were grouped into 25 categories containing similar ideas or constructs. When multiple categories potentially applied to an excerpt, I applied the more meaningful category to eliminate overlapping codes. Appendix D.3 shows how the category "Individualised approach to learning " was developed, including the "Making mathematics fun" initial codes, and Figure 10 shows the category network diagram.

**Figure 10**

*"Individualised Approach to Learning" Category Network*




*Note.* Dotted lines denote codes to category relationships. Full lines denote relationships inter-code relationships. Colon denotes initial codes, @ denotes categories

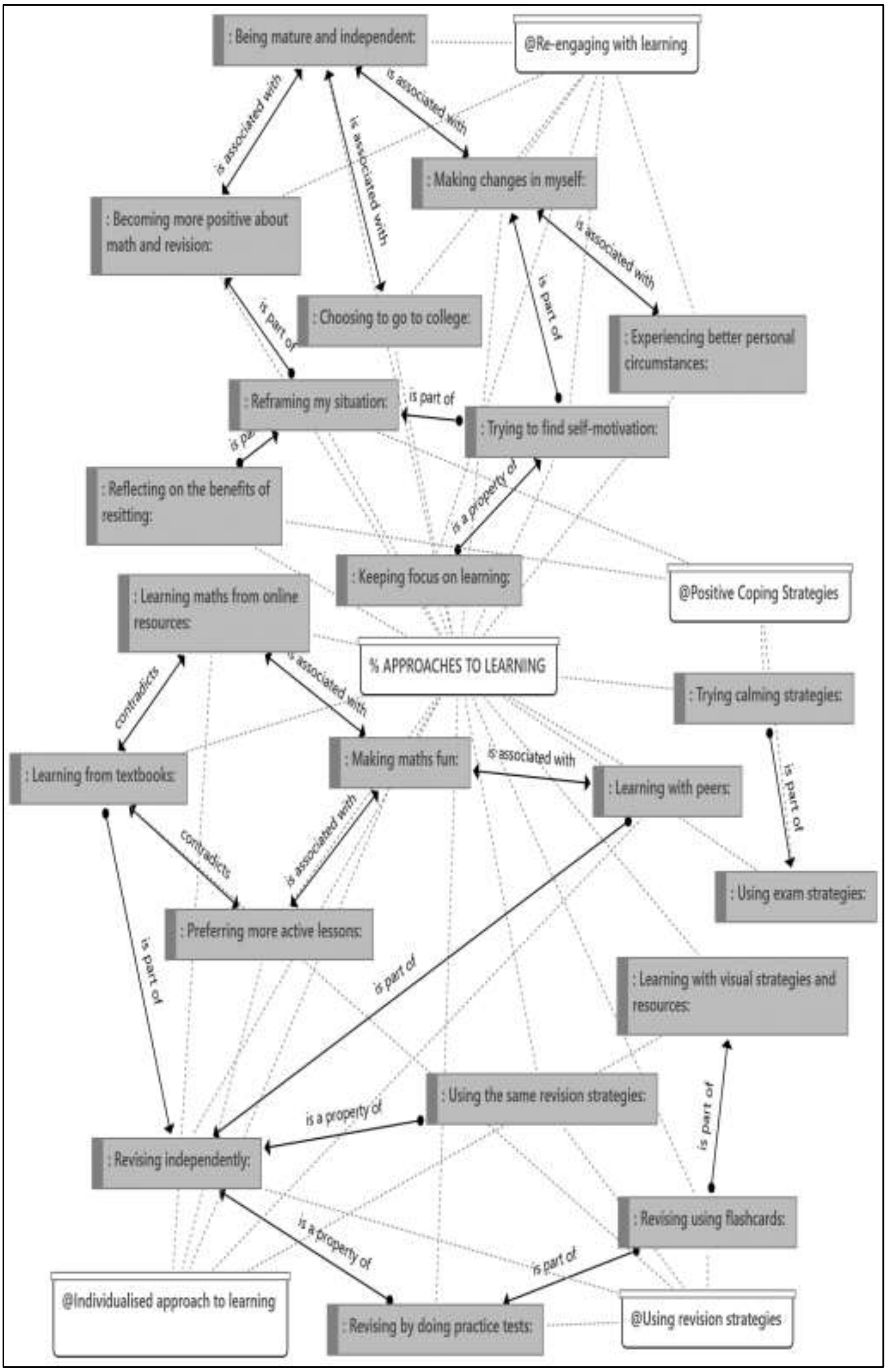
Data saturation was reached by the 10th transcript and confirmed by the 11th interview data. Repeated patterns were observed, the codebook did not change considerably (Baker et al., 2012; Guest et al., 2006), and no new categories emerged (Kiernan et al., 2018). Eleven interviews concur with the viewpoint that saturation is usually reached within this number of interviews (Baker et al., 2012; Guest et al., 2006).

#### 2.4.1.4 Developing and applying an analytical framework

This stage aimed to identify an analytical framework by ordering the data in a meaningful way (Gale et al., 2013; Ritchie et al., 1994). I revisited my memos and research questions to develop the framework indices. Data were grouped by considering previous ideas, connections were made between and within categories, and meaningful indices were developed from the data using network diagrams. An example of an a priori concern is how students revise. Appendix D.3 shows an example coding for index 5, "Approaches to Learning", and the index network diagram in Figure 11 shows the connections between categories. Six indices with broad descriptive labels were developed from network diagrams to form the analytical framework, which were: 1) supportive factors; 2) relationship challenges; 3) preparation and sitting for examinations; 4) difficulties experienced; 5) approaches to learning; 6) feelings and perceptions.

**Figure 11**

*"Approaches to Learning" Index Network Diagram*




*Note.* @ - Categories, % Index, Dotted lines denote relationships between categories and initial codes. Full lines denote inter-category relationships

#### 2.4.1.5 Applying an analytical framework

The data were exported to NVivo (QSR International Pty Ltd., 2020). The *framework matrix* facility was used to index and chart the data into an analytical framework matrix. Each participant was an NVivo *case*, which was a row in the matrix. The six indices were applied as matrix columns. Indexing is when the original data are tagged to indicate their relationship to a concept (Gale et al., 2013; Ritchie et al., 2003). NVivo created and populated the matrix automatically with all participants' quotations.

#### 2.4.1.6 Charting the data

Charting consists of summarising and arranging the data to develop a thematic framework (Gale et al., 2013; Ritchie et al., 1994). Excerpts were truncated, extended, or deleted as appropriate so that they accurately summarised the category. See Appendix D.4 for examples from two participants.

#### 2.4.1.7 Mapping and interpreting the data

In the mapping and interpretation stages, the research question is revisited to guide the findings and understanding patterns in the data (Parkinson et al., 2016). The interpretation stage summarises the key aspects of the data, mapping associations, and providing explanations (Gale et al., 2013; Ritchie et al., 2003). The focus is on moving from categorisation in FA to identifying the latent meanings in the data (Terry, 2021) using thematic analysis.

First, I focused on in vivo codes corresponding to analogies, metaphors, unique terms, and actions that capture significant meanings, concerns, or experiences (Charmaz, 2006). I then captured the related excerpts and codes in a new Atlas.ti thematic network diagram (Figure 12). I developed subthemes around the code groups and refined them to address the research question. I created initial broad themes based on a central organising concept (Braun et al., 2013; Braun et al., 2016).

**Figure 12**

*Development of Thematic Map Network Diagram*


*Note.* The map shows the initial codes and related excerpts, which are grouped into initial themes

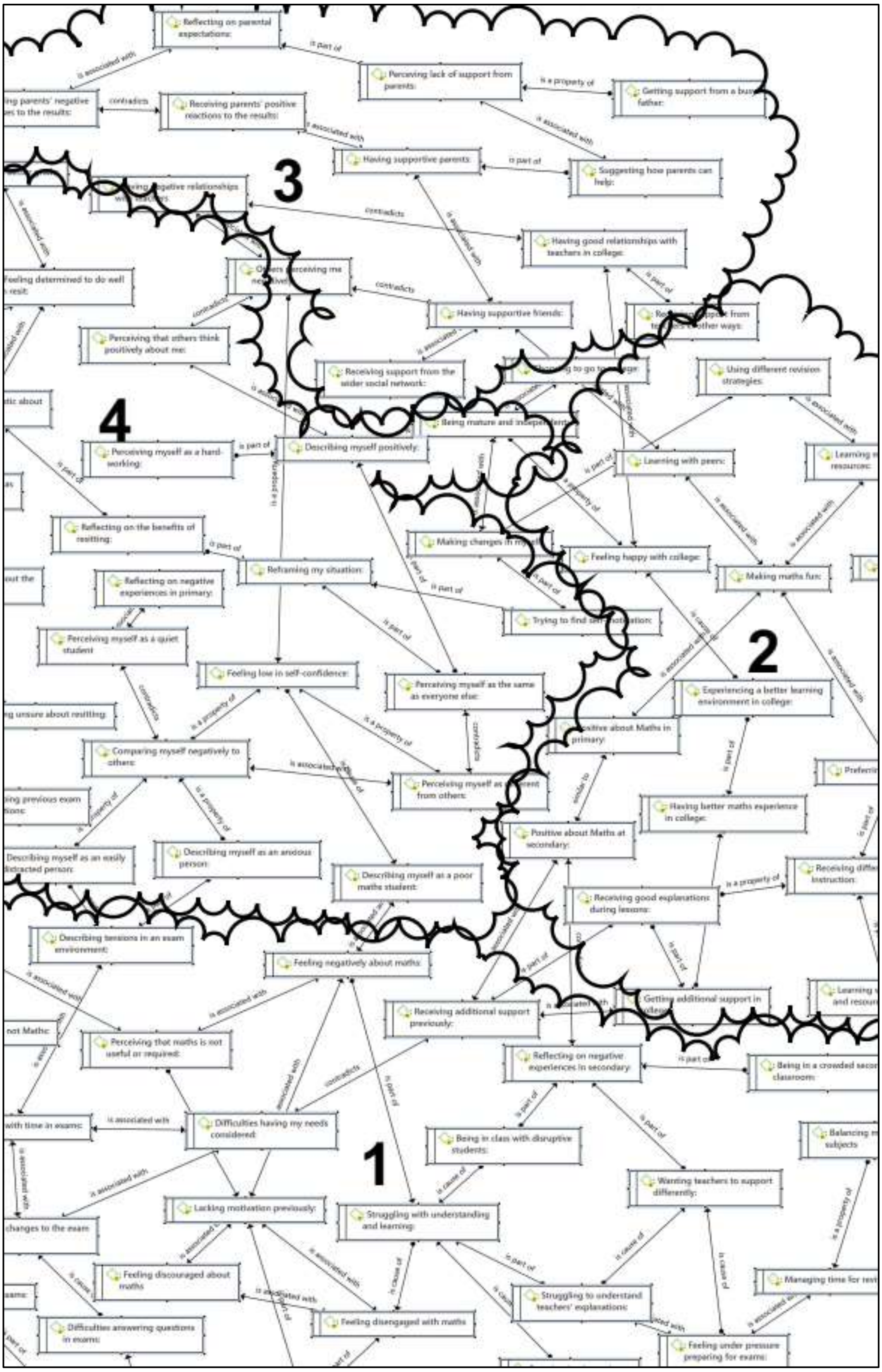
#### 2.4.1.8 Developing, Reviewing and Refining the Themes

The new thematic network diagram was then compared with the framework matrix. I edited the matrix to incorporate only the more powerful excerpts related to the research question and developing themes. The excerpts represent the underlying subjective meanings and developed themes (Pope et al., 2005; Ritchie et al., 2003). By doing this, I applied the initial themes from the thematic network to the matrix to assess the relevance of the patterns across the dataset (Terry, 2021). Constant comparisons (Charmaz, 2006) were made across all data to identify gaps and relationships. If gaps existed in the matrix, the themes were appropriately revised, as shown in Appendix D.4

As a social constructivist researcher, I looked beyond implicit statements (Charmaz, 2006) in developing a refined thematic network map by collapsing similar initial themes (Figure 13). The final four themes (Figure 14) represented the latent meanings behind the identified sub-themes, underlying codes, and excerpts (Braun et al., 2006, 2013). See Appendix D.5 for examples of representative quotes and relations to themes.

**Figure 13**

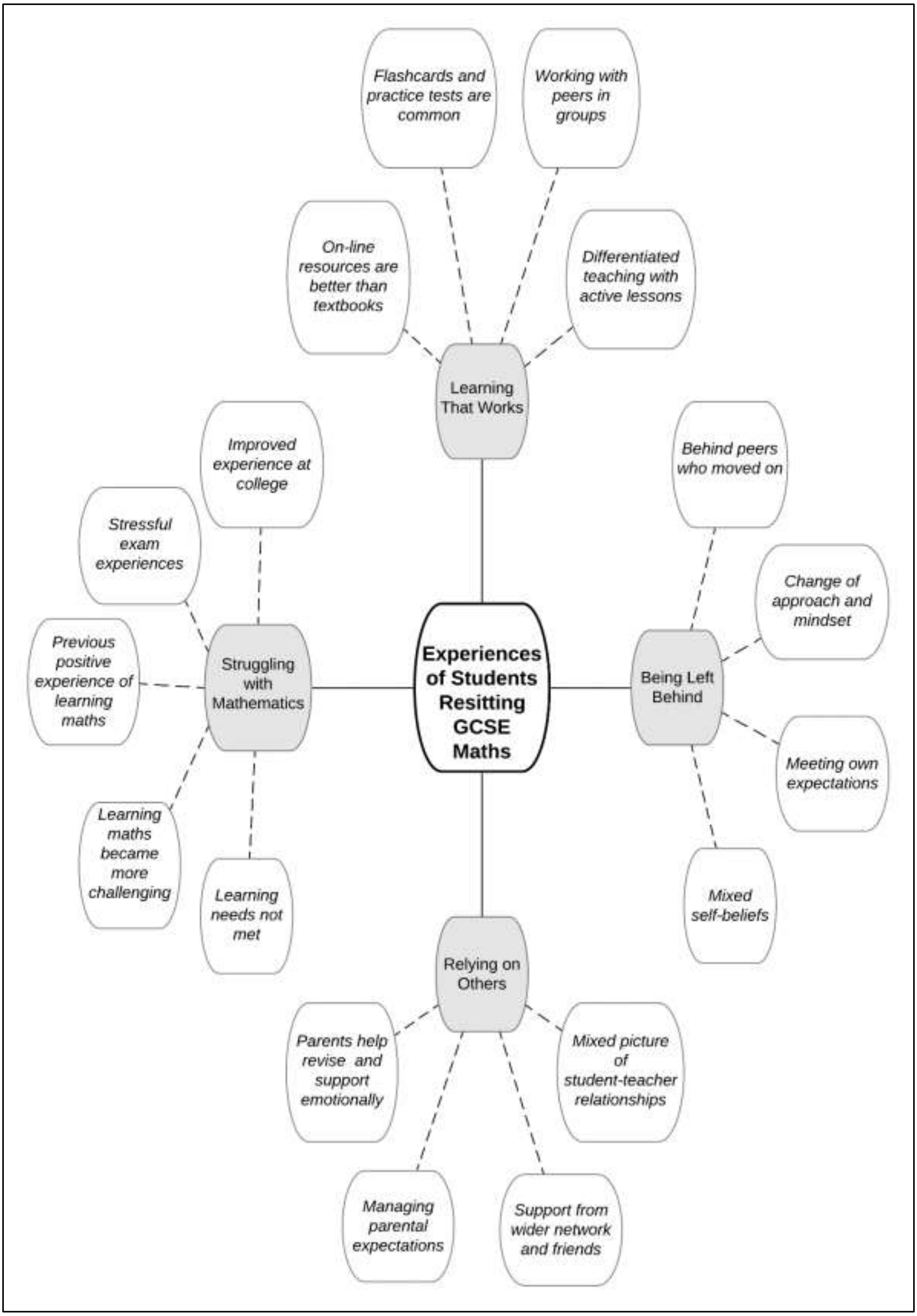
*Thematic Network Map with Final Theme Groups*




*Note*: 1) Struggling with Mathematics, 2) Learning That Works, 3) Relying on Others, 4) Being Left Behind. Only initial codes and inter-code relationships are shown on the map.

**Figure 14**

*Final Thematic Map with Four Themes*




*Note.* Dotted lines denote relationships between subthemes and the four main themes.

### 2.4.2 Methodological Integrity

I took the following steps to protect methodological integrity (Levitt et al., 2018): immersing myself in the literature to understand the data needed and identify the research gap; collecting data until reaching saturation; keeping reflective memos (see Appendix D.2); creating a codebook (see Appendix D.3); clarifying the interview schedule as some participants misunderstood the questions (an amendment with additional questions was approved on 4 February 2020); having two research assistants cross-check the transcripts and coding two transcripts; and consulting my supervisors, peers, and other professionals throughout the study.

## 2.5 Findings

Four key themes relevant to students' experiences resitting GCSE mathematics were developed: 1) "Struggling with Mathematics", 2) "Learning that Works", 3) "Relying on Others", 4) "Being Left Behind". Themes One and Three were most prevalent across the thematic network, matrix, and many participant quotes. Themes Two and Four were present across the dataset but were mentioned less.

The following system was used to illustrate the relative range of the findings (adapted from (Midgley et al., 2017)): most participants (data more than eight interviews); many participants (more than five interviews); some participants (more than two interviews) and a few participants (one or two interviews). Students with additional needs were described as “SEN student” for brevity, but it was not intended as a definitive label. Students on their second resit were identified with “2$^{nd}$ resit”.

### 2.5.1 "Couldn't do it anymore " - Struggling with Mathematics

Theme One highlights the difficulties students face in learning mathematics and taking examinations. In primary school, most students liked mathematics describing it as "interesting" (Sarah), "easy and basic" (Ahmed), and "fun" (Rita). Danny (SEN student) believed the primary teachers "actually gave me a chance to do stuff [maths]".

> Maths in primary was amazing; I had the most amazing teachers; they were just so amazing. I loved primary school. (Lara, SEN student)

A few spoke of difficulties adjusting to a different school system like Chandran, who entered primary school from India. Beth was home-schooled and found entering college "a bit difficult because I never learnt it before".

Some students who continued to like maths in secondary school attributed this to having good teachers: "I actually enjoyed maths in year 11 because of my teacher, my teacher was very engaging with the students." (Chandran). However, most students like Jane found secondary mathematics became more challenging: " I used to be really good at maths… and then year 10. I don't know what happened, but I just couldn't do it anymore". Sarah enjoyed maths until when she perceived problems with her teacher:

> In year 7, I enjoyed maths because my class was really good and the teacher, he explained everything really well, and I used to find maths really easy then…. I got the same teacher in year 9, 10 and 11 …. She wouldn't explain it properly, and she would teach like really difficult ways. (Sarah)

Others had similar complaints about their lessons. Danny felt his teachers "crammed everything in" and " We ended up doing around three topics per lesson… 50 minutes of that and 15 minutes of something else". For Sarah, the teaching she received was a demotivating factor:

> Last year I didn't really revise that much for maths…. I lost interest in it…. Because of my maths class and my maths teacher… I was getting like grade 3s, and I thought that I wouldn't be able to do it, so I lost interest in like revising for it as well. (Sarah)

Feeling demotivated was an issue for many. Jack commented that " I've seen loads of people that were basically discouraged by the maths, I was like it in Year 11". Some felt they lacked motivation previously and "didn't care that much" (Ahmed). Others felt demotivated just for maths:

> It's probably like, the way maths is because my other subjects are more engaging, maths is, just learn the equations, remember them and do them for the exam, it's kind of boring…. it's just not engaging enough with my life. (Chandran, 2nd resit)

A few were discouraged by negative comments from teachers. Danny reported that "everyone just kept saying to me and the rest of our year,… you're definitely gonna fail." Similarly, Jane's teacher was discouraging: "She kept saying to our whole class that we were all going to fail, so that didn't really like help like motivation or anything."

Some students' schools did not meet students' additional needs. The support Joe received after an illness "wasn't very consistent". A few had difficulties getting their learning difficulties recognised, which impacted their learning and examinations:

> It was um, hard because, because, I'm dyslexic... I asked to be like sat in a different room to the hall… and it didn't happen. And we had, my mum and me had to constantly fight for like extra time in my tests. (Danny, SEN Student)

> It made me annoyed about at school because, um, I could have had extra time if the school actually did the screening… I could have got higher marks and better grades. And I could have been in A-levels at the moment, but because they didn't do that, I'm now pushed back a year. (Jack, SEN Student)

Many students spoke about disruptions in their learning. For example, some students had replacement teachers. Chandran reported a "frustrating" experience as "The first teacher would get angry at us for not doing the stuff he was telling us to do." Some students had disruptive classmates:

> When you have students who are very naughty, and they'll be distracting the teacher or even the students and not able to get some of the stuff done by the end of the lesson, so that'll just pull everyone down and distract others like me as well at times. (Anusha, 2nd resit)

Some students complained about crowded classrooms, which made it difficult to get the teacher's support. Joe suggested that with "thirty-odd students", he felt " you couldn't really get that help, say if I was stuck on a question". Lara compared her school experience with the small class in college where it was "so much nicer to have the space":

> At secondary school like literally in rows like sat next to each other. Like there would never be tables like spread out like this; it's just be like line, line, line. (Lara, SEN Student)

Most of the students recounted stressful experiences from previous examinations. Rita felt constantly stressed, "it's not even when you enter the exam, it's when you wake up, and you know you have an exam; it starts from there". Some anxious students like Anusha had difficulties managing the time in examinations," I feel like the first hour I'll do good and then when I have 30 minutes left, I'll struggle and when the teacher say you have five minutes then I'll panic".

Students found the exam environment stressful. Jane described it as "it's just weird being with like loads of other people, and then like if someone's going really fast you're like why … am I doing something wrong, or if you finish earlier, you're like just a bit confused." Some students preferred doing examinations in a smaller room like Lara, "I couldn't be in the big hall because of I like really, really, anxious and I hate being around loads of people.". Chandran explained that "it's more comfortable being in a smaller room compared to like those big exam rooms which that's like three invigilators walking next to you all the time".

Many students described how doing examinations was anxiety-provoking. Some students reported they "blank out" (Chandran) or forget information. "When I'm in the exam hall like everything just like grows wings and flies away from me" (Rita). Anusha suggested that it was because "they are just too much in that nervousness". The experience was overwhelming for some:

> It's not just for Maths um, I also panic, so I basically will forget the answer more because I'm panicking, so I'm basically stressing about trying getting it all down, so I forget steps and get it wrong, but just the thing happens in all the exams and just end up forgetting

> or writing the same thing over and over again because I just panic and it's just this thing I can't get over. (Jack, SEN Student)

For most students and especially those with SEN, the college provided a better learning environment and more supportive teachers. Many students felt that the college teachers were more responsive. Joe's teacher was "encouraging" and "reactive" because "she'll help you out immediately". Chandran compared it to his school experiences, "Here, the teacher would go over it again in your free time, so you can come over in your free time and the teacher would teach it to you again." Lara described the support she received:

> Yeah, she comes to me all the time. Cos like sometimes I need help with like hearing sort stuff and like seeing cos sometimes the board isn't clear at all, and I can't read it, so she is very helpful. (Lara, SEN student)

Students also reported a better classroom atmosphere. Sarah described her class as "they're really well behaved and like they don't mess around or anything." Joe was "learning a lot better" because "everyone knows that they also need a pass." Lara believed the teachers were "tough" when students misbehaved:

> No one in like in secondary school, people mess about and could get away with the but here if you mess about you don't get away with it so like is kind of like "Boom! Done", you're out of the class. (Lara, SEN Student)

The next theme expands on how the students learn mathematics, followed by the third theme on their relationships with teachers, peers and parents.

### 2.5.2 "Make the class a bit more fun "- Learning That Works

Theme Two describes students' learning strategies and experiences learning maths. The students used a variety of strategies, including flashcards, highlighting and doing practice tests. Nearly all the students used online resources to learn, such as Maths Watch. They described the online resources as "helpful" (Ahmed and Jane) and had "a lot of variety" (Sarah). Lara believed that "Giving website to students is actually the most helpful thing". However, Beth (SEN student) felt negative about online homework, "I was just like no", and similarly, Chandran preferred writing on paper. Chandran explained that "my routine is like writing on paper, like essays and stuff like that, I just … it's like I don't think about going online and doing my homework online."

A few students said that they rarely used textbooks. Sarah did not like reading from textbooks, "Because when it's on the textbook, it looks a bit more complicated." Reading was more challenging for dyslexic students like Jack:

> Just reading over a book on how to do it, it's not really my thing.... So what I do I'd read little bit, then I try to see the videos online to explain any of the other bits and then try and get it into my memory, and then write flashcards of it. (Jack, SEN Student)

Jack, however, thought flashcards were ineffective "because I wasn't practising them." For others, flashcards were useful "to write the question on one side and the answer on the other" (Jane) and "revise one card and then keep it aside" (Anusha). For Beth (SEN student), "before I just read out of a book and I feel like the flashcards are more productive". For some students, doing practice tests were useful: "I went up from a grade 2 to 3 in a couple of weeks because I was doing these tests to help me understand" (Lara).

Many students benefitted from working with peers. Some learnt with friends, and others gained confidence by observing peers:

> Once we've done the answers, we compare it to each other, and if it's the same, then obviously it's right, but then if it's different, I would ask her how she got hers, and she would ask me how I got mine. (Sarah).

> I really didn't know how to do until the other day, when my … like the whole class was contributing and the people around me were sitting, and I was like … that's not hard you know to do it. (Rita, 2$^{nd}$ resit)

Students were aware of distractions such as mobile phones and social media. Some spoke of measures they took:

> I'll put my phone on silent, turn it off, maybe listen to a bit of music, just tell my family when I'm at home just let me you know, try not to … like interrupt me for thirty minutes, an hour. (Joe, 2nd resit)

> I could like take it [mobile phone] away but the thing I still think about it…. It's so annoying… I wish I was born in the sixties or something!… Because then they didn't have like the internet and stuff, right? I think I'm going to tell my dad to take it away. (Rita)

Some students preferred lessons when the teachers introduced activities. Beth reasoned that there was "less pressure than just having to be serious and read things" and suggested to "make the class a bit more fun by like… because in our other class that I did last year, we did a few Cahoots". Students felt activities made lessons more engaging:

> cos' if you sit for two hours then you get really bored… with the stuff they teach so what they can do just do one hour of learning and the other hour of quizzes and fun activities along with the math (Anusha, 2nd resit)

Most of the students appreciated teachers who considered their individual needs. For example, explaining the problem and demonstrating how to solve it. Joe felt he learned better when "someone shows me how to do it". Chandran appreciated that his teacher "treated us like individuals" because "not everybody's the same in maths." Students felt more supported and able to learn:

> She explains a topic well, and if you need like help, yeah, she would always come up to you and she … like when we're doing our work, she walks around each table, and she looks at our work, she explains it to us and tells us how to get the right answer (Sarah)

The next theme illustrates the students' additional reflections on relationships with teachers and others.

### 2.5.3 "My biggest supporter" - Relying on Others

Theme Three consists of the students' reflections on their social interactions and relationships with parents, peers and teachers. Most students reported a mixed picture of their relationships with teachers. Some had negative student-teacher relationships at school, which made them felt unsupported.

> My teacher, she don't like me so she would never really help me. She would always go to other people and then come to me… my teacher's horrible to me, like my dad had to phone up and make a complaint because she just wasn't helping me. (Lara, SEN student)

> I wouldn't say they didn't have a positive attitude because some did because, like my maths teacher in Year 11 was like, uh really good. She helped me a lot, but some, some of the teachers were just terrible! (Danny, SEN Student)

At college, some experienced a different student-teacher relationship. Jack felt it was more relaxed as "you can joke about teachers more than you can in school." Chandran suggested students had more "freedom" because "The teachers don't pick on you if you don't want to answer the question". A few thought they had a more supportive teacher:

> My maths teacher currently, she's encouraging … she wants us to succeed you know, as did my other maths teachers probably but … she's a very different maths teacher you know. And yeah, I mean she's strict when she needs to be, but I mean like strict but fair like. (Joe, 2nd resit)

All the students mentioned having parental support: “When I told my mum I got a 2 again, she didn’t say anything to me, she was like, you’re definitely going to get it.  My mum’s my biggest supporter” (Rita). Their mothers were their main emotional allies and helped with revision:

> She's supporting me, yeah, really motivates me, she's like my best friend, my mum she's really nice and even my dad, the dad that that's not there usually, so my mum really helps me. (Anusha)

> If I'm stuck, I ask my mom and then she, she is, good at maths. Say she, she explained in an easier way and like a good method. Yeah, my dad not that much cos he's like busy with other stuff. (Ahmed)

Although a few commented that their dads were mostly unavailable, some fathers were more involved in supporting their children. Fathers mostly helped in practical ways like explaining problems (Beth) or marking papers (Sarah). Lara's father helped with her revision by playing games and "randomly just test me on one of the questions". When Lara's teacher was "horrible," her dad phoned to complain:

> My dad said that whatever I get, he's going to be proud of me for. As long as I try my best, it doesn't matter what I get; it's just the fact that I'm trying…. he was really, really over the moon when he saw I passed my English. (Lara, SEN Student)

Some students relied on other family members such as sisters, brother (Joe), and aunt (Sarah) to help with revision with mixed results. Jane's sister was "really good at maths" and explained problems to her. However, Jack' sister "tries to help, but she doesn't really understand maths too much either."

Managing parental expectations was challenging for some students even if their parents' intention was to be supportive:

> My mum, she's like failure is not the answer and can succeed… and everyone makes, makes mistakes… so don't feel like it's done and that's the finality to it, just don't feel like that. (Anusha, 2nd resit)

Trust was an issue between a few students and their parents. Chandran did not disclose his results to his parents, "they thought I already passed... I didn't really tell them about it".

> The last time they just kept saying, how uh, I'm going to do bad and stuff… I had my plan, and I was comfortable with my plan. They kept... just nagging me to do like revise every 10 minutes. (Danny, SEN Student)

Many students felt their parents were disappointed with their results and described their reactions as "sad" (Anusha), "upset" (Beth), and "wasn't too happy" (Rita). A few students had more supportive parents, like Beth: "They told me last year, if you don't pass it this year, you've got next year to do it, and you don't need to panic about it". Danny compared his response to his mother's:

> I handled it okay, actually…. I just said, I just said it's not the end of the world, we can do it again but... my mum was really angry with me….. Even though she said, she wouldn't be. (Danny, SEN Student)

A few students internalised the stress describing it as "pressure". Sarah thought adults needed to know "that there's a lot of pressure going on in our minds because we have to resit it again and like we're all stressed out about if we are going to pass or not".

> Pressure going on inside of you like you have to do good and they expect from you to do good and when they have targets as well that you have to aim for… as well as working outside college as well (Anusha, 2nd resit)

Many students like Lara relied on friends to study with, "we'll all sit together, and we'll like teach each other". Most of the students' friends were encouraging and supportive: "My friends would help me, saying like it will be over in like however long, they got me through it, so they were quite supportive" (Beth). The next theme outlines the students' self-perceptions.

### 2.5.4 "Seventeen in a mainly sixteen environment"- Being Left Behind

Theme Four consists of the students' reflections on how they saw themselves and others around them. Many students emphasised their similarity to their peers: "Same as my friends basically, like you know easy to get along with, fun, like eager to learn and stuff" (Rita).

> I've always thought myself just a very normal student, you know, kind of not being like you know, the brightest kid in the class or the most disruptive kid, you know, kind of trying to do it by the books. (Joe, 2nd resit)

Students were positive about their personal qualities. They described themselves as "funny" (Beth), "happy" (Lara), "friendly" (Rita), "confident" (Sarah), and "very motivating" (Lara).

> I'm really like hard, kinda hard-working, independent. If I've some ideas, I like, some share them like in groups, and I'm not really talkative that much…. And I'm really like kind and friendly like human being. (Ahmed)

Most of the students found it challenging to reflect on how they are as students. Some felt they had other talents: "I'd say I'm more creative than academic, so I guess during maths I would prefer to be you know in like an art lesson or something like that" (Joe). Many believed others saw them as hard-working, but some were more cautious in their responses:

> They'd probably say that I'm hard-working like cos I do a lot of revision, and they'd probably say that I'm a very happy person…. I get on and do my work; I don't just sit there and lounge about; I get on and make sure I get all my work done. (Lara, SEN Student)

> I do need that little extra push, but … you know like sixteen, seventeen years old, it is a kind of like forming process, right?... I need to change… I'm still getting into that mindset and like forcing myself to maybe do a little bit of extra revision, like if I'm bored. (Joe, 2nd resit)

Many students like Joe perceived themselves more positively than how they were last year and commented on how they were making changes in their approach to studying:

> I've learnt that from last year I've kind of … I've changed….Because now I'm actually more focused on maths because I want to get the grade 5…. Last year I used to aim low, but this year, I'm actually aiming more higher. (Sarah)

However, many had negative self-perceptions or compared themselves negatively to peers or family. Joe and Danny described themselves as "distracted", whereas Lara thought of herself "as a worrier". Jack minimised the differences between himself and his peers "most of my friends actually pass their maths but just barely, so we pretty much all in the same boat". However, others felt more keenly about their perceived lack of abilities:

> It matters a lot because, like my older sister, didn't fail in it. And I feel like I don't want to be like the … the one child that didn't pass in her maths, you know? (Rita, 2nd resit)

> I don't know. I feel different than other students that I'm doing maths again for two times. And … I don't really feel like … normal in a way … like there's something wrong with me, like my brain and stuff, so yeah. (Chandran, 2nd resit)

Many students believed others assumed they were "not good in learning" (Sarah) or "didn't try hard enough" (Lara). A few believed others think less of them and assumed they were "dumb."

> I literally think that they think we're dumb!... I would agree with them, but I'm like … but I know more you know, I know other things…. sometimes I get it from my sister…. But I've gotten used to it. But I'm like, no, I'm not really dumb, I do know it, but you just don't know how to use it, you know? (Rita, 2nd resit)

Many associated themselves negatively with mathematics based on their previous learning experiences. Like Joe, Danny was in the lower ability set since Year 7:

> I've never been too good at maths; I always was more of a creative like … I did a lot better in English than I did in maths, so it was one of my weaker subjects…. I would try to get the work done, but you know I'd have to ask for assistance from different teachers. (Joe, 2nd resit)

> The whole system is set up for smart people, only smart people….. I know it takes me a lot longer to do things than everyone else… when you put in sets, it really doesn't help them. Because it just then proves that you're not smart… when you're in a classroom about six teaching assistants in the classroom as well. (Danny, SEN student: 295-299)

A few students were unsurprised by their results, but others were very upset. Jack panicked in the exam and "wasn't too shocked" to get a "bad grade." Jane hoped she passed but "didn't think I was going to." Chandran described his disappointment, "I was kind of sad actually, I actually started crying as well, I was like, because I actually did a lot of revision for that lesson, … for maths, for the exam. Then I felt let down, … it was just pointless."

A few felt ambivalent about resitting, especially when comparing themselves to their peers. Joe felt "It's one of those things that I don't want to do" as he would "rather pursue other things". Lara felt her friends felt similarly "we all feel like we wish it was just done".

> I guess it was a bit weird since you know I'm doing my GCSEs surrounded by people, not of my year, so I can't like go up to a friend of my previous year 11 year and ask them what it was about because they'd be off in sixth form. (Danny, SEN Student: 58)

> I feel like I should have passed this and told my friends I'm not doing it anymore…. So I feel frustrated because I see them … doing well in maths, they already did well in maths, and there's just us redoing it again and again. (Chandran, 2nd resit)

Like Chandran, Beth, Rita, Joe, and Anusha already did a resit last year. Only two students, Danny and Ahmed, were resitting both subjects. Although a few felt discouraged missing the needed marks previously, "I was close, from getting a four… which put me off, disheartened me" (Anusha), others became more determined:

> It's going …[to be the] third time, yeah. Because some people would say, oh, I don't really want to do this anymore. I just want to get a four to tell you the truth; I just want the grade….I was not going to back out now. (Rita, 2nd resit)

Many students were determined to pass: "I am going to do this, this year. I'm not gonna let myself resit again, so I'm basically try and stay confident and not lose... umm courage" (Jack). Students aspired to pass for various reasons, for example, getting their "dream job" or, like Chandran and Ahmed, to get into university. Even though some students had definite future plans, many students were ambivalent:

> Because then I can go on to like a Level 3, because I'm on a Level 2 course at the moment because I didn't pass maths, but I want to go for an apprenticeship, and I don't want to come back in for maths. (Jane)

> I've always been unsure about my future. I always knew I wanted to go to college, didn't know what for at the time, and now that I'm in college, I know what courses I want to do, but I'm definitely not sure about what I want to do after college. (Joe, 2nd resit)

Many were optimistic about obtaining better results and positively reframed resitting the exams. Anusha and Danny both described it as not "the end of the world." Ahmed summarised his situation as "Kind of annoying, but it'll be, will be okay though soon." Most of the students are resigned to their situation:

> I'm seventeen in a mainly sixteen environment, so I'm kind of like, I don't know, like a year behind in a sense…. just kind of like take it like I was on a bit of a gap year or something… It's just something that needs to be done, you know, I'm not too worried about it. (Danny, SEN Student)

### 2.5.5 Summary of findings

The findings demonstrate how the participants' learning and examination experiences evolved through the course of their education. The social constructivist view is that knowledge and interpretation are temporally, culturally, and socially situated (Angen, 2000). Many participants felt positive about mathematics in primary school, which continued to secondary school for some. The following section reviews the findings in relation to previous studies.

## 2.6 Discussion

This research set out to ask participants from an FE college who are resitting GCSE mathematics about their experiences in resitting mathematics. The findings addressed the two research questions (RQ): 1) What roles do the learning, revision, and testing processes play in students' experiences of preparing for and resitting GCSE exams? 2) How do students view themselves and the role of others in preparing for and resitting their GCSE exams? Four themes developed in the analysis were: 1) struggling with mathematics, 2) learning that works, 3) relying on others, and 4) being left behind. Themes One and Two correspond to RQ1 and Themes Three and Four to RQ2, respectively. The findings are explored in terms of research questions and the literature.

### 2.6.1 RQ1: The roles learning, revision, and testing processes play in students' experiences

#### 2.6.1.1 Theme One: Struggling with Mathematics

As in previous studies on GCSE students, participants' learning experience in secondary school was negative compared to college (Anderson et al., 2016; Higton et al., 2017). Although previous research has identified motivation as an issue for this population (Education and Training Foundation, 2014; Higton et al., 2017; Impetus PEF, 2017), the students' reasons have received limited attention. Consistent with Anderson and Peart's (Anderson et al., 2016) findings, participants felt demotivated by the lack of discipline and large class sizes, making it difficult to get support. As Higton et al. (2017) identified, contextual factors affected the students' learning, and their motivation was affected by prior negative learning experiences.

Participants reported being affected by the negative comments from their teachers. This is consistent with Wallace's (2014) findings that positive teacher-learner interactions enhanced FE students' engagement. The year-long study of 203 FE college teachers suggested that interactions that included humour and empathy led to improved teacher-student relationships.

Participants had positive attitudes toward mathematics early in their education, but their perception of mathematics was mostly negative once they were in secondary school. A few were still engaged because they had good teachers. The findings support that although primary students' mathematics attitudes were positive, attitudes decline as students mature (Dowker et al., 2019; Jacobs et al., 2002). The findings concur with research (Bellamy, 2017; Brown et al., 2008) that GCSE students regarded and described mathematics negatively.

Participants' descriptions of stressful exam experiences and forgetting answers echo the accounts from previous research with GCSE students (Putwain, 2011; Roome et al., 2019). Similar to Putwain's study (2011), participants described stress with words like "panic" and "stress" interchangeably. This study supports Putwain's findings that students who experienced exam stress had poor academic self-beliefs and anticipated failure.

Participants needing extra support, including students with SEN, found it challenging to get the support they needed at school. Students with SEN were overrepresented among the participants, supporting the evidence of the attainment gap between SEN students and non-SEN students (Department for Education, 2020; Longfield, 2019). Consistent with Highton (2017), participants reported better support for their needs in college. Students with special needs struggled to be assessed and have their requirements to be considered.

Participants reported a better experience in college, similar to previous research (Anderson et al., 2016; Higton et al., 2017). FE teachers are prepared to re-engage demotivated learners (Anderson et al., 2016; Education and Training Foundation, 2014). Research has found that teachers and the classroom environment affect students' academic achievement and motivation (Silinskas et al., 2019). Eccles proposed that as students grow older, their psychological changes may be mismatched with the educational environment (Eccles et al., 1984; Eccles et al., 1993).

#### 2.6.1.2 Theme Two: Learning that Works

Although Theme One supports the belief that students resitting become demotivated (Anderson et al., 2016; Higton et al., 2017), Themes Two and Three showed that the teacher-student relationship affects the participants' motivation and engagement which correspond to previous evidence of FE students (Attwood et al., 2003, 2004; Wallace, 2014). Participants appreciated teachers who considered their needs and differentiated the lessons accordingly. Effective practices with GCSE students include differentiated learning and individualised support plans (Education and Training Foundation, 2014; Higton et al., 2017).

Participants described a variety of approaches to learning, with online learning being the most popular. As in previous studies, participants disliked textbooks and preferred a pedagogic approach that incorporated enjoyable activities (Attwood et al., 2004; Nardi et al., 2003). Relying only on textbooks was more challenging for students with dyslexia. Recommendations on effective post-16 practices include the use of games and online learning (Education and Training Foundation, 2014; Higton et al., 2017).

Participants were aware of challenges in self-regulating their learning, such as managing their use of social media. They also reached out to peers to work in groups and gained confidence when together they achieved success. Watching teachers demonstrate problem-solving or peers successfully solve problems was crucial in building the participants' confidence.

### 2.6.2 RQ2: Students views of themselves and the role of others

#### 2.6.2.1 Theme Three: Relying on others

This theme illustrates how support from teachers is crucial for supporting feelings of classroom relatedness. The findings found a mixed picture of the teacher-student relationship related to the perceived quality of the teaching they received. Some participants reported negative teacher-student relationships in secondary school, echoing previous research (Anderson et al., 2016). Students experienced a different and better relationship with teachers at college, which is consistent with previous evidence (Anderson et al., 2016; Attwood et al., 2004). College teachers are likely to adopt an autonomous teaching style that treats students as adults, supporting better teacher-student relationships (Anderson et al., 2016; Higton et al., 2017).

Theme Three showed a picture of students relying on families, peers, and teachers for learning and emotional support. Research has shown that parents (Silinskas et al., 2019; Vukovic et al., 2013) and teachers (Zhou et al., 2020) mediate students' mathematics anxiety. This study found that students relied on parents for help with revision and emotional support, similar to previous evidence (Grolnick et al., 1991). Unlike previous research showing a decline in parental learning support as students mature (Silinskas et al., 2019), some participants continue to rely on their parents. This may be due to their low mathematics abilities and confidence.

Participants' reported difficulties in managing parental expectations and pressure corroborated previous research (Denscombe, 2000; Putwain, 2009). Participants relied not only on their parents but also extended family members and peers for support, similar to the results of previous studies (Denscombe, 2000; Roome et al., 2019).

#### 2.6.2.2 Theme Four: Being Left Behind

Students' self-perceptions are influenced by their relationships with parents, teachers, peers, and perceptions of those close to them (Denscombe, 2000; Putwain, 2009; Roome et al., 2019). Both participants in this study who believed the education system was against them had additional needs and were in lower sets from Year 7. A few students questioned their abilities, and many students were sensitive to some people's low perceptions of them. The exam system reinforced feelings of failure in students (ASCL, 2019) and affected their self-worth and identity (Denscombe, 2000).

In his review of 16-18 mathematics education for the Department of Education, Professor Adrian Smith (2017) argued that negative attitudes toward mathematics are ingrained in UK society. Previous research has suggested that students internalise these attitudes (ASCL, 2019; Nardi et al., 2003). However, this study's findings suggest that these students had a history of negative experiences in education, which compounded their feelings of failure. As Johnston-Wilder et al.(2015) suggested, students may adopt self-protection mechanisms in their narratives and do not make efforts to study. This is true for some participants when describing their efforts last time, but most participants were determined to pass this time and felt optimistic about their futures.

### 2.6.3 Parallels and variations with theory

When interpreting this study's findings through social cognitive theory (SCT) and self-determination theory (SDT), there are similarities and differences in how the findings fit the theories. Participants who struggle with mathematics had a negative view of mathematics (Theme One) and strong emotional responses when discussing examinations and learning mathematics. SCT proposes that previous negative experiences influence an individual's evaluation of future success in a task (Bandura, 1997). Participants' previous negative experiences with mathematics, including their affective states, have the effect of lowering their beliefs about being able mathematics students. Participants were positive about their other abilities and characteristics, but not when associated with mathematics. The negative math-related self-perceptions corresponded to previous research (Bellamy, 2017; Johnston-Wilder et al., 2015) that participants were confident in their interest areas but not in mathematics. Self-efficacy is domain-specific (Bandura, 1997), so these students feel more self-efficacious and perform better in the other subjects.

Some students reported better experiences learning mathematics in college than in school. The college environment provides a source of self-efficacy through social persuasion from teachers. The findings showed that participants working with peers (Themes Two and Three) benefit from vicarious experiences of peers' success and modelling from teachers. Positive social persuasion via feedback and encouragement teachers and parents build participants' self-efficacy. Autonomous students are also more likely to self-regulate (León et al., 2015). The reciprocal relationships between personal factors, behaviours, and the environment are evidenced in Bandura's triadic reciprocal model (Figure 7).

SDT suggests that connecting with peers fulfils the students' need for relatedness. Students report that college teachers build good relationships and consider how students want to learn (Themes One, Two, and Three). Research on re-engaging FE students suggests that in college, the curriculum structure and teaching approach were more supportive of fostering autonomy and thus self-determination (Anderson et al., 2016; Attwood et al., 2004; Education and Training Foundation, 2014). In college, students are encouraged to use online resources, which encourage autonomy and feelings of competence (Alamri et al., 2020). Autonomy-supporting teachers foster self-determination, which in turn positively influences the learning environment (Reeve, 2012). The teachers' strategies enhance feelings of relatedness, which correlates with engagement and autonomous motivation (Furrer et al., 2003; Guay et al., 2008).

Participants described how others' comments affected their motivation (Theme One). Supportive others enhance feelings of relatedness according to SDT, which contributes to motivation (Ryan et al., 2002). As social persuasion positively correlates with self-efficacy and outcome expectations (Sheu et al., 2018), negative comments from some teachers and parents adversely affect students' self-efficacy. Conversely, students report receiving support from their parents and friends (Theme Three), which would positively affect their motivation and self-efficacy.

Although SDT and SCT both touched on how competence beliefs influence students' motivation and performance, the anxiety evidenced in Theme One is not fully explained by either theory. The concept of examination stress (Putwain, 2011) might be better explained by other theoretical frameworks. As Denscombe (2000) suggested, the exams are closely tied to the students' identity (Theme Four). Identity formation is not considered by either SDT or SCT.

### 2.6.4 Limitations

This study had several limitations, including limitations regarding time and scope, the number of participants, and sample sites. Its exploratory nature limited the range of issues examined in this study. Limited or unexplored matters included SEN, participants' socioeconomic and racial backgrounds, and gender influences. As this was a qualitative study, measurements of participants' self-beliefs were not conducted. Data triangulation, for example, via corroboration from the participants and data from another site, could not be obtained because of the limited time available.

### 2.6.5 Implications from this study

This study found that participants' self-efficacy and self-determination significantly influenced their reported learning behaviour and attitudes. Academic and non-cognitive factors play an important role in students' academic success (Han et al., 2020). Building positive relationships with previously disengaged students can change how they see themselves and others.

The findings of this study support previous reports (ASCL, 2019; Higton et al., 2017; Longfield, 2019) that students' previous education history is considered, as their previous experiences in learning mathematics can influence self-efficacy beliefs. FE colleges play a role in ensuring that they take account of students' educational histories and provide learning environments that foster autonomous learning and positive experiences of success with mathematics.

While this study explored resitting GCSE mathematics from the students' perspectives, it did not have a sufficient sample size and sites. Further research with larger samples and more sites might confirm and expand on this study's findings. There was some indication of difficulties facing students who entered the education system from other educational backgrounds. Further research on the influence of ethnicity, socioeconomic background, SEN, and EAL factors may illustrate additional challenges facing particular groups of students.

The findings show some students held negative self-beliefs and how their perceptions impacted their view of themselves. Studying and measuring students' self-beliefs would inform how self-efficacy influences their GCSE mathematics performance. Future research may be useful in exploring how having to resit examinations shape the students' identities.

This study ended in February 2020 before the Covid-19 restrictions. Participants indicated they were favourable to online learning. This may be relevant to future studies on how these students learnt during the restrictions. Students resitting GCSE mathematics may be unduly affected by the pandemic. Further study would indicate whether these students are being left behind.

## 2.7 Conclusions

This study sought to explore students' experiences of resitting GCSE mathematics exams and found that most of the students had positive attitudes toward learning despite having negative educational histories compounded by experiences of failure that affected their confidence in mathematics. This research has added these students' voices to the discussion on high-stakes exams in the UK. It shows a more complex picture beyond previous suggestions of within-individual factors, for example, the student's lack of motivation or ability. If students are to succeed and believe in their abilities in mathematics, then the study's findings show that they must be supported to feel autonomous and competent in the classroom and are facilitated to have positive experiences of mathematics success in the classroom. Above all, the findings emphasise the students' reliance on good relationships with parents, teachers, and peers. Good relationships are reparative for students who feel forgotten by the educational system and are key to their success in mathematics.

# Appendix A Chapter 1: Screening and Article Selection

## A.1 Characteristics of Included Studies

Table 9 summarises the methods, participants, interventions, outcome measures and the risk of bias for studies included in the meta-analysis. Other outcomes, not only self-efficacy or mathematical self-efficacy corresponding to mathematics performance, were calculated in several studies. Only the measures used to calculate effect sizes are outlined.

**Table 9**

Characteristics of Included Studies

| 1. Author (Publication Year) | (Acee, 2009) |
|---|---|
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To test the differential effects of the Enhanced Value Reappraisal Intervention (VR-E) on students' self-efficacy beliefs, value perceptions, exam performance, and continued interest in statistics |
| Method | iRCT |
| Participants | Setting: University (n = 1);<br>Students with an average age of 20.51 (SD=1.57)<br>Age range = 18 to 30 years;<br>Total n = 88; (female n = 88); female undergraduates who were enrolled on Introduction to Statistics |
| Intervention | An intervention based on expectancy-value and self-regulation theories. Goal Setting (GS-E) asked students to set and self-evaluate learning objectives goals. Value Reappraisal Enhanced Goals Setting (VR-E) gave students messages about the importance of learning statistics. Control Condition students completed the Texas Information Literacy Tutorial modules and answered reflective questions. Participants were randomly assigned to one of three conditions: Control (n = 30), GS-E (n = 27), and VR-E (n = 31);<br>Duration and frequency: 2.5 hours weekdays for approximately 2 weeks |

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| Instruments | Self-Efficacy: Self-efficacy for course tasks was measured with the Perceived Academic Competence Scale (PACS) (Kaplan et al., 1997);<br>Mathematics Performance: Mathematics course exams |
| Risk of Bias (Tool) | Some Concerns (ROB 2) |
| 2. Author (Publication Year) | (Alcindor, 2015) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To examine the effect of an intervention in preservice teachers' mathematics self-efficacy, anxiety, and problem-solving skills |
| Method | QES |
| Participants | Setting: University (n = 1);<br>Students aged: 19-20 years n = 24, 21-22 years n =13, 23-24 years n = 5;<br>Undergraduate elementary and special education preservice teachers;<br>Total n = 50; (females n =37; males n = 12); |
| Intervention | A social cognitive theory-based intervention consisting of a combination of relaxation training, managing maladaptive thoughts, training to manage mathematics anxiety, sharing accomplishments and practical problem-solving.<br>Duration and frequency: six 60-minute sessions for 3 weeks |
| Instruments | Mathematics Self-Efficacy: Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1983);<br>Mathematics Performance: College Basic Academic Subjects Examinations (CBASE) Mathematics section |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |
| 3. Author (Publication Year) | (Austin, 2005) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To measure the effects of a strengths-development intervention in education for possible global benefits in academic achievement and self-perceptions of academic ability |
| Method | iRCT |

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|---|---|
| Participants | Setting: High school (n = 1);<br>Age range: 14-15 years (Freshmen students);<br>Total n = 527 (females n = 236; males n = 291); |
| Intervention | An intervention based on Positive Psychology using the StrengthsFinder instrument. Students identified and explored their signature strength themes through an academic lens.<br>Duration and frequency: daily for 6 weeks. |
| Instruments | Self-Efficacy: Self-Perceptions of Academic Abilities, a self-efficacy scale developed for the study consisting of 44-items adapted from the Motivated Strategies for Learners Questionnaire (Pintrich, 1991) and Patterns of Adaptive Learning Scale (Midgley et al., 2000); $\alpha$= .86;<br>Mathematics Performance: Grade-point averages (GPA) |
| Risk of Bias (Tool) | High (ROB 2) |
| 4. Author (Publication Year) | (Brewer, 2009) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To improve middle school students' overall academic achievement, subjective well-being (SWB), gratitude, and self-efficacy. |
| Method | iRCT |
| Participants | Setting: Middle School (n = 2) 11 – 14 years (6th to 8th-grade students) ;<br>Total n = 93 Students identified as at-risk and in an after-school program |
| Intervention | Positive Psychology based intervention. The Leadership and Young Professionals (LYP) integrated a series of temporally-based positive psychology interventions with professional development exercises. (a combination of gratitude journaling, character strengths building, goal setting, problem-solving exercises);<br>Duration and frequency: ten total sessions (which included 75 minutes per session for a total of 750 minutes) over 10-week |
| Instruments | Mathematics Self-Efficacy: Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1983); |

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| | Mathematics Performance: Final exam (paper and pencil), with 10 multiple choice questions and 15 open-ended questions |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |
| 5. Author (Publication Year) | (Brisson et al., 2017) |
| Publication Type (Country) | Journal Article (Germany) |
| Aim of Study | To investigate the effectiveness of two short relevance interventions |
| Method | CRT |
| Participants | Setting: Academic track schools (n = 25);<br>Mean age: M = 14.41 years, SD = 0.57;<br>Total n = 1978 female = 53.3% Students from (n = 82) 9th Grade mathematics classrooms; |
| Intervention | A social cognitive theory-based intervention consisted of two short relevance intervention conditions (writing a text or evaluating quotations about the utility of mathematics);<br>Duration and frequency: 6 weeks |
| Instruments | Mathematics Self-Efficacy: A scale developed for the study consisting of a questionnaire using 4-point Likert type scales ranging from 1 (completely disagree) to 4 (completely agree) that were adapted from previous studies<br>Mathematics Performance: A curriculum-based standardised test assessing mathematics knowledge (α = .89 for a similar test) |
| Risk of Bias (Tool) | High (ROB 2 CRT) |
| 6. Author (Publication Year) | (Burrell, 2012) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To demonstrate the benefit of a communal learning context to increase African-American students' efficacy and subsequent achievement. |
| Method | QES |

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| Participants | Setting: Middle School (n = 1);<br>Age range: 11-12 years (6th-grade students);<br>Total n = 80; (females n = 45; males n = 35);<br>Students from n = 6 mathematics classes;<br>All participants were African-American |
| Intervention | A social cognitive theory-based intervention based on two short relevance intervention on the communal learning context (sitting together and sharing one set of materials) or the individualised learning context (sitting at individual desks with their personal materials).<br>Duration and frequency: 1 study session |
| Instruments | Mathematics Self-Efficacy: A scale developed for the study consisting of a 15-item scale based on Pajares et al.'s (1999) scale. Both the pre-and post-test had α = .89.<br>Mathematics Performance: A 24-item mathematics estimation task, split into pre-and post-test halves of 12-items with four-choice multiple-choice questions |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |
| 7. Author (Publication Year) | (Ezeahurukwe, 2010) |
| Publication Type (Country) | Unpublished Doctoral Thesis (Nigeria) |
| Aim of Study | To examine the effects of elaborative interrogation and self-assessment learning strategies on mathematics achievement, test anxiety and self-efficacy of low achieving male and female students |
| Method | QES |
| Participants | Setting: Secondary School (n = 4)<br>Participants were in senior class three (SSII) (Grade 12 equivalent, 17-18-years), their ages were not reported;<br>Total n = 279 low mathematics achieving students. Genders not reported. |
| Intervention | Constructivist and cognitive learning theories-based intervention consisting of elaborative interrogation and self-assessment learning strategies; |

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| | Duration and frequency: 6 weeks each with one session of 40 minutes per week |
| Instruments | Mathematics Self-Efficacy: A scale developed for the study consisting of a 30-item questionnaire derived from the original version of the General Self-Efficacy Scale (GSES) **Malthus Jerusalem and Ralf Schewarzer (1993) $\alpha$ = .97;<br>Mathematics Performance: Mathematics Achievement Test ($\alpha$ = .93) |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |
| 8. Author (Publication Year) | (Falco, 2008) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To examine the effectiveness of a curricular intervention to improve the mathematics achievement motivation of 6th-grade students through a school counselling guidance curriculum. |
| Method | CRT |
| Participants | Setting: Middle School (n = 1);<br>Age range: 11-12 years (6th-grade students);<br>Total n = 79 (females n =40 males n = 39) |
| Intervention | A social cognitive and expectancy-value theories based intervention, "Skill Builders", that consisted of a school counselling guidance curricular unit that would improve students' self-efficacy beliefs by teaching skills related to human agency;<br>Duration and frequency: 30 minutes, once a week, for nine weeks |
| Instruments | Mathematics Self-Efficacy: A scale developed for the study consisting of a 10-item instrument containing sample mathematics problems and is consistent with other measures of mathematics self-efficacy (***Pajares, 1996). $\alpha$ = .97;<br>Mathematics Performance: Items from the earlier 40-item tests were used to create the achievement measure. $\alpha$ = .79 |
| Risk of Bias (Tool) | High (ROB 2 CRT) |
| 9. Author (Publication Year) | (Farkota, 2003) |

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|---|---|
| Publication Type (Country) | Unpublished Doctoral Thesis; Australia |
| Aim of Study | To examine student learning in mathematics in the first year of secondary school to determine the effects of a 15-minute teaching intervention. |
| Method | QES |
| Participants | Secondary School (n = 2);<br>Age range: 11 – 12 years (Year 7);<br>Total n = 967 (females = 445 males = 500) |
| Intervention | A social cognitive and constructivist theory-based intervention consisting of classroom scripted teaching as part of a Direct Instruction mental mathematics program;<br>Duration and frequency: 15–20 minutes at the beginning of the regular mathematics lesson, weekly up to a minimum of 4 times per week over two weeks |
| Instruments | Self-Efficacy: A self-efficacy scale developed for the study, which consists of five subscales, on how confident the students felt with a 4-point Likert scale rating;<br>Mathematics Performance: Mathematics Achievement measure from data provided by schools using the Australian Council for Educational Research (ACER) database (no other details available) |
| Risk of Bias (Tool) | Serious (ROBINS-I) |
| 10. Author (Publication Year) | (Forbes, 1988) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To explore the impact of a digital mathematics intervention on secondary English Language Learners students' mathematical capabilities and perceptions of their future possibilities |
| Method | QES |
| Participants | Setting: High School (n = 1);<br>Age range: 13 – 15 years (ninth and tenth grade);<br>Total n = 50 Hispanic students |

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| Intervention | A social cognitive theory and capability approach-based intervention using HELP Mathematics intervention group - a mental digital mathematics intervention designed specifically for English language learners;<br>Duration: 6 months |
| | Mathematics Self-Efficacy: A scale developed for the study consisting of a 52-item scale derived from the 75 items MSES (Betz & Hackett, 1983);<br>Mathematics Performance: The final grade in the statistics course |
| Risk of Bias (Tool) | High (ROB 2) |
| 11. Author (Publication Year) | (Gamlem et al., 2019) |
| Publication Type (Country) | Journal Article (Norway) |
| Aim of Study | The aim of this study is to examine the effects of an intervention aimed at developing teachers' responsive pedagogy to strengthening student learning in mathematic |
| Method | QES |
| Participants | Schools (n = 9 intervention group; n =11 control group);<br>Age range = 13–14 years (ninth grade);<br>Total = 1,166;<br>Intervention: (females n = 218 males n = 218) Control: (females = 366 males = 364) |
| Intervention | A cognitive learning theory-based intervention consisting of teachers' responsive pedagogy to enhance student learning in mathematics through feedback dialogues, students' self-regulatory processes, and by strengthening students' beliefs in their abilities to master mathematics;<br>Duration and frequency: Around 7 months during the students' mathematics classes |
| Instruments | Self-Efficacy: Norwegian version of the Cross-Curricular Competencies questionnaire (CCC) (Lie et al., 2001);<br>Mathematics Performance: A national achievement test in mathematics |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |

| 12. Author (Publication Year) | (Getachew et al., 2016) |
|---|---|
| Publication Type (Country) | Journal Article (Ethiopia) |
| Aim of Study | To test the theory of self-efficacy in the Ethiopian context and show how the classroom-based intervention strategy influences students' self-efficacy belief and students' academic achievements. |
| Method | QES |
| Participants | Setting: University (n = 1);<br>Mean age : M = 19.47;<br>Total n = 123; (females n = 33; males n = 90) |
| Intervention | A social cognitive theory-based intervention that drew on Bandura's conception of the sources of self-efficacy. The intervention group were taught applied mathematics II with instructional strategies containing self-efficacy intervention management via mastery, vicarious, verbal, and emotional experience by the classroom teacher versus control group on treatment as usual (n = 60; males n = 48; females n = 12);<br>Duration: 4 weeks (3 hours per week). |
| | Mathematics Self-Efficacy: A scale developed for the study consisting of a 14-item scale on self-efficacy measure adapted for college students was used to measure students' level of self-efficacy belief in mathematics before and after the experiment.<br>Mathematics Performance: Numerical grade students received on mid and final exams of applied mathematics II. |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |

| 13. Author (Publication Year) | (Hood, 2012) |
|---|---|
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To evaluate the impact of a differentiated instruction model on the achievement of ethnic minorities in a developmental mathematics class. |
| Method | QES |

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| Participants | Setting: College (n = 1);<br>Age range: 18 -24 years;<br>Total n = 42; (females n =22; males n =20);<br>First-year college students enrolled in developmental mathematics classes;<br>All participants were African-American |
| Intervention | A learning styles theory-based intervention that consisted of a classroom intervention using differentiated instruction based on learning styles theory versus control group on treatment-as-usual;<br>Duration and frequency: One semester/about 15 weeks |
| | Mathematics Self-Efficacy: MSES (Betz & Hackett, 1983)<br>Mathematics Performance: The Asset, a district-wide norm-referenced and criterion-referenced test. |
| Risk of Bias (Tool) | Critical (ROBINS-I) |
| 14. Author (Publication Year) | (Huang et al., 2019) |
| Publication Type (Country) | Journal Article (United States) |
| Aim of Study | To evaluate the effect of self-efficacy features in an online example based statistical learning environment on learning outcome performance, self-efficacy, and task anxiety |
| Method | iRCT |
| Participants | Settings: University (n = 1) and from a crowdsourcing platform;<br>70 Students at n = 1 university and 77 online participants;<br>Mean age = 21.47 years (SD = 4.21);<br>Total n =142 (females n = 72 males n = 70) |
| Intervention | A social cognitive theory-based intervention where participants learned statistical rules in an example-based online environment with four self-efficacy features added (treatment group) or none (control group);<br>Duration and frequency: One session |
| Instruments | Mathematics Self-Efficacy: A scale developed for the study consisting of a 100-point confidence rating scale on performing six tasks on the |

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| | knowledge and application of statistical rules;<br>Mathematics Performance: A transfer test consisting of both near transfer questions (n = 6) and far transfer questions (n = 5). |
| Risk of Bias (Tool) | Low (ROB 2) |
| 15. Author (Publication Year) | (Im, 2012) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To explore the effects of emotional support and cognitive, motivational messages delivered by pedagogical agents on mathematics anxiety, self-efficacy, and mathematics problem-solving. |
| Method | iRCT |
| Participants | Setting: Community college (n = 1);<br>Age range = 16 - 48 years;<br>Mean age = 24.07 years;<br>Total n = 83 (females n = 35 males n = 48) ;<br>All were General Education Development (GED) students in n = 3 mathematics classes (GED students have not earned a high school diploma) |
| Intervention | An intervention based on achievement motivation and expectancy-value theories. The intervention consisted of computer modules to deliver cognitive-motivational messages and instructors for emotional support;<br>Duration and frequency: One session |
| Instruments | Self-Efficacy: A scale developed for the study consisted of five items with 5 Likert-type scale questions (1- Strongly disagree to 5 -Strongly Agree), two items for pre-test, and three for post-test. $\alpha > .95$ (for a previous study);<br>Mathematics Performance: A mathematics problem-solving test based on (Shen, 2009) |
| Risk of Bias (Tool) | Low (ROB 2) |
| 16. Author (Publication Year) | (Kereluik, 2014) |
| Publication Type (Country) | Doctoral Dissertation (United States) |

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|---|---|
| Aim of Study | To explore the implementation and utilisation of self-regulated learning (SRL) scaffolds in online K-12 courses |
| Method | iRCT |
| Participants | Setting: High School;<br>Age range: 17- 18 years (Grade 12);<br>Total n = 69; Students in n = 6 mathematics courses. |
| Intervention | An intervention based on integrating self-regulated learning scaffolds in online K-12 course;<br>Duration and frequency: two academic terms (18 weeks) |
| Instruments | Self-Efficacy: The Motivation Strategies and Self-Related Beliefs subtests of the PISA Student Characteristics Questionnaire (Artlet et al., 2003);<br>Mathematics Performance: Final Course Grade |
| Risk of Bias (Tool) | Low (ROB 2) |

| 17. Author (Publication Year) | (Kohen et al., 2019) |
|---|---|
| Publication Type (Country) | Journal Article (Israel) |
| Aim of Study | To explore the mathematics self-efficacy and problem-solving skills of low and high achieving students middle school students. |
| Method | QES |
| Participants | Setting: Middle school (n = 1);<br>Age range: 14 – 15 years (9th grade);<br>Total n =111 Students who were already in advanced mathematics classes |
| Intervention | An intervention based on instruction techniques used to teach the unit for analysis of functions based on dynamic visualisations;<br>Duration and frequency: Ove five weeks, one weekly session of about 90 minutes as part of the middle school mathematics curriculum |
| Instruments | Mathematics Self-Efficacy: A scale developed for the study consisting of a judgment of confidence 5-level Likert scale based on ((Usher et al., 2009)<br>Mathematics Performance: Mathematics problem-solving tests for |

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|---|---|
| | assessing students' mathematics procedural and conceptual understanding |
| Risk of Bias (Tool) | Moderate (ROBINS-I) |
| 18. Author (Publication Year) | (Rakoczy et al., 2019) |
| Publication Type (Country) | Journal Article (Germany) |
| Aim of Study | To examine how a formative assessment intervention in mathematics classes affected students' interest and achievement. |
| Method | CRT |
| Participants | Setting: Middle track schools (n = 18);<br>Mean age = 15.1 years (SD = 7.46 months);<br>Total n = 620 (female n = 279; males = 341) |
| Intervention | An intervention based on formative assessments to support students to identify where in their work that needs improvements;<br>Duration and frequency: The 13 lessons took place over approximately three weeks. |
| Instruments | Self-Efficacy: A scale developed for the study consisting of a Self-report on a four-item scale ranging from 0 (completely disagree) to 3 (completely agree). a = .88;<br>Mathematics Performance: Achievement in mathematics was assessed via a scale developed for the study with 19 pre- and 17 post-test items. Test items that consisted of technical and modelling items on the topic of Pythagoras' theorem |
| Risk of Bias (Tool) | Some Concerns (ROB 2 CRT) |
| 19. Author (Publication Year) | (Snipes et al., 2015) |
| Publication Type (Country) | Journal Article (United States) |
| Aim of Study | To examine the impact of the Elevate Mathematics summer program on the mathematics achievement and algebra readiness of rising grade 8 students. |
| Method | iRCT |

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|---|---|
| Participants | Setting: School (n = 8);<br>Age range: 13 -14 years (7th grade);<br>Total n = 496;<br>n = 461 students indicated their gender; (females n = 205; males n = 256) ;<br>Students were in Grade 7 and in the Elevate Mathematics Summer program. |
| Intervention | An intervention based on the Elevate Mathematics program to facilitate the development of non-cognitive skills to support personal growth and academic performance;<br>Duration and frequency: an intensive 75-hour (19 days over four weeks), summer preparatory course, and practised over the school year. |
| Instruments | Mathematics Self-Efficacy: Mathematics interest and mathematics self-efficacy were assessed using measures drawn primarily from a student perception survey $\alpha > .9$;<br>Mathematics Performance: Mathematics Diagnostic Testing Project (MDTP) Algebra Readiness test |
| Risk of Bias (Tool) | Low (ROB 2) |

| 20. Author (Publication Year) | (Tintera, 2004) |
|---|---|
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To explore the facilitative effects of using graphing calculators (GC) on the learning of college algebra. |
| Method | CRT |
| Participants | Settings: University (n = 1) Community college (n = 1);<br>Mean ages: GC group = 20.5 years; Text-Only group = 29.3 years;<br>Total n = 163;<br>GC group (n = 93) 79% (n = 73) female, 21% male;<br>Text-Only group (n = 70) 66% (n = 46) female , 34% male |
| Intervention | An intervention based on learning styles, social cognitive theory and chronometric theory;<br>Duration and frequency: two 30-minute lessons per week for six weeks. |

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| Instruments | Mathematics Self-Efficacy: Mathematics Self-Efficacy Scale (MSES-R) /Revised MSES (Kranzler & Pajares, 1997);<br>Mathematics Performance: A computerised quiz included fifteen multiple-choice questions that involve algebraic skills from the first two chapters of the college algebra textbook. |
| Risk of Bias (Tool) | Low (ROB 2 CRT) |
| 21. Author (Publication Year) | (Wilkins, 2014) |
| Publication Type (Country) | Doctoral Dissertation (United States) |
| Aim of Study | To examine the efficacy of the Brainology© program interventions and determine if these program interventions can positively increase student motivational behaviour and academic achievement. |
| Method | QES |
| Participants | Setting: middle school (n = 5);<br>Age range: 13 -14 years (7th grade);<br>Total n = 684 (females n = 460 males n = 346) |
| Intervention | A growth-mindset based intervention, Brainology© (Mindset Works, 2002-2011). The intervention was designed to teach about the brain's neuroplasticity to develop growth-mindset oriented thinking in students;<br>Duration and frequency: 12 classroom hours over one school year. |
| Instruments | Self-Efficacy: Patterns of Adaptive Learning Styles (PALS) Academic Efficacy (Midgley et al., 2000);<br>Mathematics Performance: Students' mathematics benchmark assessment scores and science and mathematics quarterly grades |
| Risk of Bias (Tool) | Critical (ROBINS-I) |
| 22. Author (Publication Year) | (Zimmerman et al., 2011) |
| Publication Type (Country) | Journal Article (United States) |
| Aim of Study | To examine a classroom-based intervention study for helping struggling learners respond to their academic grades in mathematics as sources of self-regulated learning. |

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| Method | iRCT |
| Population | Setting : School (n = 8);<br>Age range: 13 -14 years (7th grade);<br>Total n = 496 (females n = 236 males n = 260 ) |
| Intervention | An intervention based on self-regulated learning (SRL). Learners were facilitated to reflect on their academic grades in math;<br>Duration and frequency: one class over a 15-week semester. |
| Instruments | Self-Efficacy: A scale developed for the study consisting of a 5-point scale. Students rated their confidence in solving the mathematics problems on the periodic examination based on Bandura et al.'s (1981) findings.<br>Mathematics Performance: Mathematics final examinations |
| Risk of Bias (Tool) | Low (ROB 2) |

*Note*: n – number of participants. iRCT – Individual Randomised Control Trial, CRT – Cluster randomised trial, QES – Quasi-experimental study, Rob – Risk of Bias, ROBINS-I - Risk of Bias in Non-randomised Studies - of Interventions. $\alpha$- Cronbach's alpha measure of scale consistency. ** Ezeahurukwe (2010) reported basing the study scale on Malthus Jerusalem and Ralf Schewarzer (1993) but did not include references to the article.*** Falco (2008) reported basing the study scale on Pajares (1996), but this might be the wrong date as the actual article mentioned was (Pajares, 1997). References for the instruments used that were reported in the studies are included in this review's bibliography. See List of References for full bibliography.

## A.2 Characteristics of Excluded Studies

**Table 10**

Excluded Studies and Exclusion Reasons

| Author, Editor or Organisation | Exclusion Reason |
|---|---|
| Excluded during full-text screening | |
| (Acee, 2010) | Duplicate - Same study, published in different journal/year |
| (Akindipe, 2020) | Wrong population - Under 11 |
| (Alcindor, 2016) | Duplicate - Same study, published in different journal/year |
| (Ali et al., 2017) | No measure for mathematics performance |
| (Allee-Smith, 2017) | Correlational Study |
| (Allee-Smith, 2018) | Duplicate - Same study, published in different journal/year |
| (Ball, 2014) | Wrong intervention - Other (Stereotype threat) |

| | |
|---|---|
| (Ball, 2015) | Wrong intervention - Academic performance |
| (Baynard, 2021) | Wrong study type - Other |
| (Bird, 2015) | Duplicate - Same study, published in different journal/year |
| (Briggerman, 2016) | Wrong intervention - Academic performance |
| (Brock, 2017) | Duplicate - Same study, published in different journal/year |
| (Brock, 2019) | Wrong intervention - Other |
| (Burrell, 2014) | Duplicate - Same study, published in different journal/year |
| (Creighton-Lacroix, 2000) | Wrong intervention - Academic performance |
| (Diaz, 2019) | Duplicate - Same study, published in different journal/year |
| (Diaz, 2020) | No measure for mathematics performance |
| (Dillihunt, 2003) | Wrong population - Under 11 |
| (Eberhart, 2020) | No measure for mathematics performance |
| (Falco, 2019) | Other types of articles |
| (Falco et al., 2010) | Duplicate - Same study, published in different journal/year |
| (Fanchamps et al., 2019) | Wrong outcomes - Algorithmic thinking |
| (Firth-Clark et al., 2019) | Wrong study design - Other - Multiple cohort study |
| (Fitzpatrick, 2018) | Wrong population - Under 11 |
| (Freeman, 2011) | Wrong Study Type - Other |
| (Freeman, 2012) | Wrong intervention - Academic performance |
| (Garcia Joven, 2018) | Wrong intervention - Academic performance |
| (Grimm, 2020) | Duplicate - Same study, published in different journal/year |
| (Hanlon et al., 1999) | Wrong study design - No Comparative group |
| (Herriman, 2018) | Wrong outcomes - not self-efficacy intervention |
| (Im, 2013) | Duplicate - Same study, published in different journal/year |
| (Jackson, 2011) | Wrong intervention - Academic performance |
| (Jackson, 2012) | Wrong population - Under 11 |
| (Jackson, 2014) | Duplicate - Same study, published in different journal/year |
| (Kwan, 2018) | Duplicate - Same study, published in different journal/year |
| (Lai et al., 2020) | Wrong study design - No Comparative group |
| (Linnenbrink-Garcia et al., 2018) | No measure for mathematics performance |
| (Mousseau, 2013) | Wrong intervention - Self-concept/Self-belief or related construct |
| (Nasution et al., 2019) | No measure for mathematics performance |
| (Núñez et al., 2013) | Wrong intervention - Other (Mentoring) |
| (Oldham, 2018) | No measure for mathematics performance |
| (Pittman et al., 2017) | Wrong intervention - Academic performance |
| (Ramseur, 2016) | No measure for mathematics performance |
| (Ramseur, 2018) | Duplicate - Same study, published in different journal/year |
| (Ritzhaupt et al., 2011) | Wrong study design - No Comparative group |
| (Rowland, 2004) | No measure for mathematics performance |

| | |
|---|---|
| (Rowland, 2005) | Duplicate - Same study, published in different journal/year |
| (Samuel et al., 2019) | No measure for mathematics performance |
| (Schukajlow et al., 2019) | No measure for mathematics performance |
| (Snipes et al., 2016) | Duplicate - Same study, published in different journal/year |
| (Somakim et al., 2019) | No measure for mathematics performance |
| (Terry, 2016) | No measure for mathematics performance |
| (Terry, 2017) | Duplicate - Same study, published in different journal/year |
| (Terry, 2013) | No measure for mathematics performance |
| (Townsend et al., 2003) | Wrong intervention - Self-concept/Self-belief or related construct |
| Excluded during data extraction | |
| (Bird, 2014) | Incomplete data – no reply to email |
| (Freeman, 2010) | Use of historical controls |
| (Kim et al., 2007) | Incomplete data – no reply to email |
| (Kwan, 2016) | Incomplete data – the author did not have data |
| (Turner, 2012) | Incomplete data – no author contact details |

*Note*: See List of References for full bibliography

# Appendix B Chapter 1: Analysis Information

## B.1 Risk of Bias ROBVIS figures

**Figure 15**

*Risk of Bias 2 (Rob 2) Assessment For Individual Random Control Trial Studies*

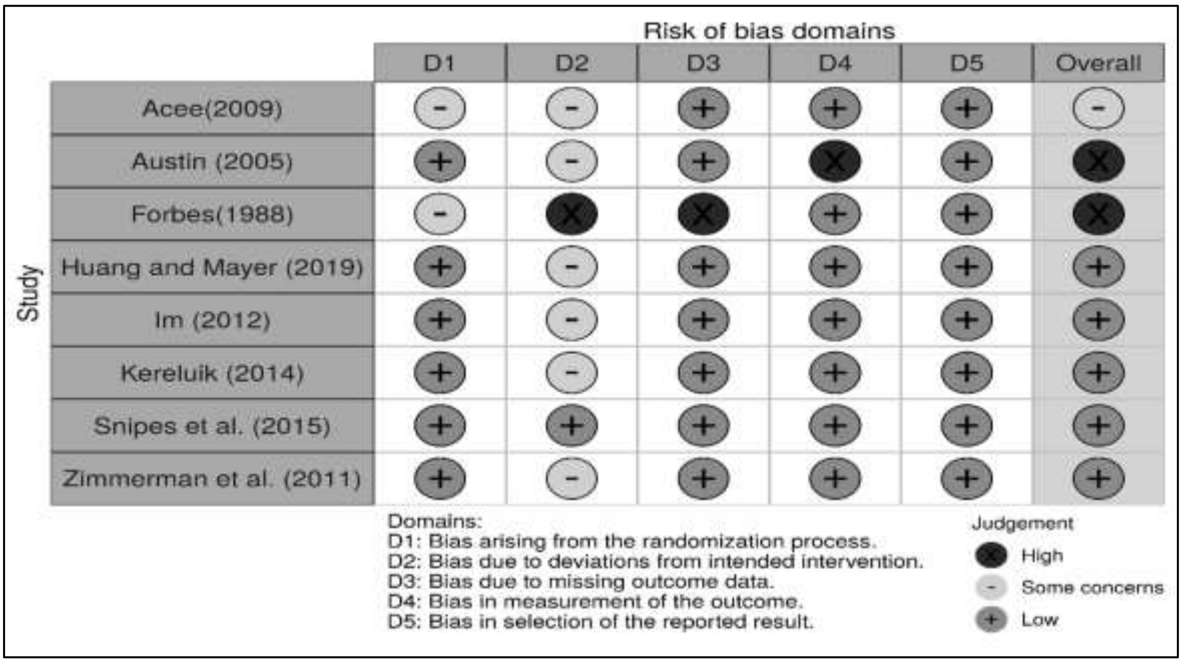



**Figure 16**

*Risk of Bias 2 for Cluster Randomised Control Trials (RoB 2CRT)*

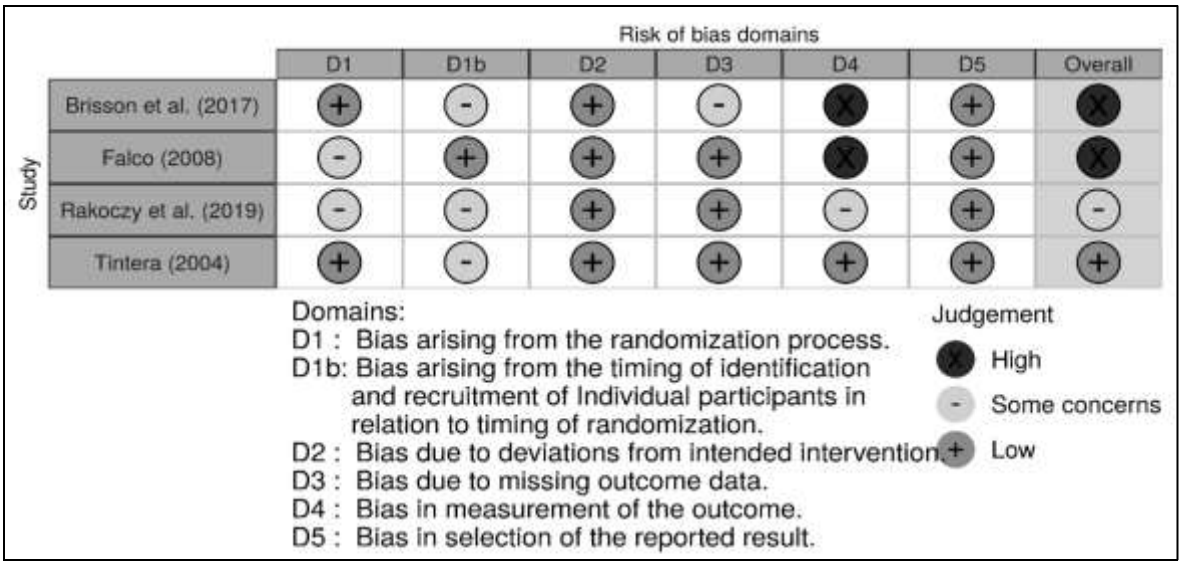



**Figure 17**

*Risk of Bias for Non-randomised studies (ROBINS-I)*

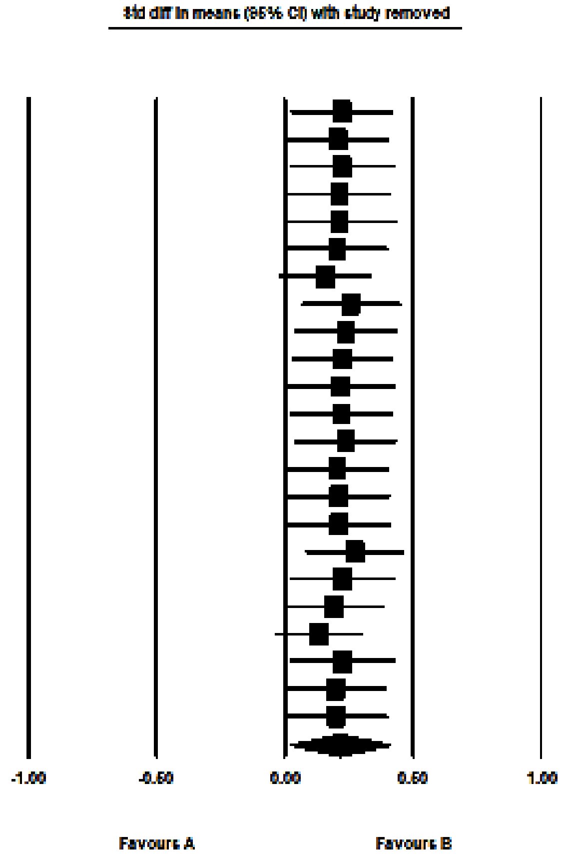
| Study | Risk of bias domains | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | D1 | D2 | D3 | D4 | D5 | D6 | D7 | Overall |
| Alcindor 2015 | - | + | + | + | - | - | + | - |
| Brewer 2009 | - | + | + | + | - | - | + | - |
| Burrell 2012 | + | + | + | + | - | - | + | - |
| Ezeahurukwe 2010 | - | + | + | + | - | - | + | - |
| Farkota 2003 | X | - | + | + | - | - | + | X |
| Getachew et al. 2016 | + | + | - | + | - | - | + | - |
| Hood 2012 | X | + | X | ! | - | X | X | ! |
| Kohen et al. 2019 | + | + | + | + | - | - | + | - |
| Wilkins 2014 | + | + | + | + | - | X | X | X |
| Gamlem 2019 | + | + | + | + | - | - | + | - |

Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

Judgement
! Critical
X Serious
- Moderate
+ Low

## B.2 Sensitivity Analysis with "One Study removed"

| Study name | Subgroup within study | Outcome | Statistics with study removed | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Point | Standard error | Variance | Lower limit | Upper limit | Z-Value | p-Value |
| Acee 2009 | Blank | Math Performance | 0.224 | 0.103 | 0.011 | 0.022 | 0.426 | 2.177 | 0.030 |
| Alcindor 2015 | Blank | Math Performance | 0.208 | 0.102 | 0.010 | 0.008 | 0.409 | 2.041 | 0.041 |
| Austin 2005 | Blank | Math Performance | 0.224 | 0.106 | 0.011 | 0.015 | 0.433 | 2.104 | 0.035 |
| Brewer 2009 | Blank | Math Performance | 0.212 | 0.104 | 0.011 | 0.009 | 0.415 | 2.043 | 0.041 |
| Brisson et al. 2017 | Blank | Math Performance | 0.214 | 0.114 | 0.013 | -0.010 | 0.437 | 1.874 | 0.061 |
| Burrell 2012 | Blank | Math Performance | 0.204 | 0.103 | 0.011 | 0.002 | 0.406 | 1.982 | 0.047 |
| Ezeahurukwe 2010 | Blank | Math Performance | 0.158 | 0.093 | 0.009 | -0.025 | 0.341 | 1.695 | 0.090 |
| Falco 2008 | Blank | Math Performance | 0.258 | 0.100 | 0.010 | 0.063 | 0.454 | 2.593 | 0.010 |
| Farkota 2003 | Blank | Math Performance | 0.239 | 0.103 | 0.011 | 0.036 | 0.441 | 2.313 | 0.021 |
| Forbes 1988 | Blank | Math Performance | 0.228 | 0.102 | 0.010 | 0.029 | 0.427 | 2.241 | 0.025 |
| Gamlem 2019 | Blank | Math Performance | 0.219 | 0.111 | 0.012 | 0.002 | 0.435 | 1.975 | 0.048 |
| Getachew et al. 2016 | Blank | Math Performance | 0.221 | 0.104 | 0.011 | 0.018 | 0.424 | 2.137 | 0.033 |
| Hood 2012 | Blank | Math Performance | 0.238 | 0.102 | 0.010 | 0.038 | 0.437 | 2.338 | 0.019 |
| Huang and Mayer 2019 | Blank | Math Performance | 0.204 | 0.103 | 0.011 | 0.001 | 0.407 | 1.973 | 0.048 |
| Im 2012 | Blank | Math Performance | 0.210 | 0.103 | 0.011 | 0.008 | 0.411 | 2.042 | 0.041 |
| Kereluik 2014 | Blank | Math Performance | 0.212 | 0.103 | 0.011 | 0.010 | 0.414 | 2.059 | 0.040 |
| Kohen et al. 2019 | Blank | Math Performance | 0.274 | 0.098 | 0.010 | 0.082 | 0.466 | 2.799 | 0.005 |
| Rakoczy et al. 2019 | Blank | Math Performance | 0.226 | 0.107 | 0.011 | 0.016 | 0.435 | 2.112 | 0.035 |
| Snipes 2015 | Blank | Math Performance | 0.192 | 0.102 | 0.010 | -0.008 | 0.392 | 1.879 | 0.060 |
| Tintera 2004 | Blank | Math Performance | 0.132 | 0.087 | 0.008 | -0.038 | 0.302 | 1.523 | 0.128 |
| Wilkins 2014 | Blank | Math Performance | 0.226 | 0.105 | 0.011 | 0.019 | 0.432 | 2.139 | 0.032 |
| Zimmerman et al. 2011 | Developmental | Math Performance | 0.199 | 0.103 | 0.011 | -0.003 | 0.401 | 1.928 | 0.054 |
| Zimmerman et al. 2011 | Introductory | Math Performance | 0.201 | 0.104 | 0.011 | -0.004 | 0.405 | 1.926 | 0.054 |
| | | | 0.214 | 0.100 | 0.010 | 0.018 | 0.411 | 2.135 | 0.033 |



## B.3 Further Exploratory Sensitivity Analysis Results

Intervention Type: The studies were divided according to the theoretical basis of the interventions. Including only studies (k = 6) derived from social cognitive theory (SC) (2, 5, 6, 8, 10, 12, 14) produced a non-significant negligible mathematics performance effect size with *g* = 0.07, CI[-0.23, 0.38], Z = 0.46, p = 0.65. The distribution of studies was significantly heterogeneous: Q = 32.11, df = 6 ($p<0.00001$), $Tau^2 = 0.12$ and $I^2 = 81\%$. Subgroup differences was also statistically non-significant: Q = 0.92, df = 1 (p = 0.34), $I^2 = 0\%$.

Instrument Type: Nine studies (2, 3, 5, 7, 8, 9, 11, 13, 19) were included in the analysis to investigate instrument type influence. These studies measured mathematics performance with standardised tests, national exams or using scales with reliability information There was a minimal reduction in the mathematics performance effect size g= 0.15, 95% CI[-0.13 , 0.44] The test for subgroup differences was not significant Q = 0.21, df = 1 (P = 0.65), $I^2 = 0\%$.

Intervention Duration: The analysis found including only studies with durations of more than four weeks (n = 8) gave a negligible non-significant negative mathematics performance effect size *g* = -0.11, CI[-0.45 , 0.22], Z = 0.65 (p = 0.51). There was significant heterogeneity: Q = 92.49, df = 7 ($p < 0.00001$); $Tau^2 = 0.20$; $I^2 = 92\%$.

Age: As there was no consistent reporting of age, a sensitivity analysis on the mathematics performance outcome was performed to only include students in schools (n = 13). There was a minimal reduction in the non-significant mathematics performance effect size *g* = 0.14, CI [-0.07 , 0.35]. There was significant heterogeneity: Q = 207.20, df = 13 ($p < 0.00001$); $Tau^2 = 0.14$; $I^2 = 94\%$.

Publication Type: A sensitivity analysis on the mathematics performance outcome was performed to only include studies in peer-reviewed journals (n = 8). There was a minimal reduction in the non-significant mathematics performance effect size *g* = 0.17 CI [-0.04,0.38]. There was significant heterogeneity: Q = 78.72, df = 8 ($p < 0.00001$); $Tau^2 = 0.08$; $I^2 = 90\%$.

Appendix B

Sample Size: Excluding studies with small sample sizes produced a significant but negligible effect size $g$ = 0.01, 95% CI = [-0.23,0.25], z = 0.10 (p=0.92) Q = 23.64, df = 2 (p<0.00001); $Tau^2$ =0.04; $I^2$=92%.

**Table 11**

*Exploratory Sensitivity Analysis Results*

| | | | Effect size and 95th confidence interval | | Test of null | | Heterogeneity | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Studies (n) | *g* | 95%CI | z-value | p-value | Q | $df_q$ | $\tau^2$ | $I^2$ |
| 1. | Study Design (excluding CRTs) | 19 (4851) | 0.18 | [-0.02, 0.39] | 1.74 | 0.08 | 185.90 | 18 (p < 0.00001) | 0.17 | 90 % |
| 2. | Instrument Type | 9 (5024) | 0.15 | [-0.13 , 0.44] | 1.05 | 0.29 | 156.94 | 8 (p < 0.00001) | 0.16 | 95 % |
| 3. | Intervention Type (SCT) | 7 (2251) | 0.07 | [-0.23, 0.38] | 0.46 | 0.65 | 32.21 | 6 (p < 0.00001) | 0.12 | 81 % |
| 4. | Intervention Duration | 8 (1915) | -0.11 | [-0.45, 0.22] | -0.66 | 0.51 | 92.49 | 7 (p < 0.00001) | 0.20 | 92 % |
| 5. | School setting (age-related) | 13 (6656) | 0.14 | [-0.07 , 0.35] | 1.29 | 0.20 | 207.20 | 13 (p < 0.00001) | 0.14 | 94 % |
| 6. | Publication Type | 8 (4682) | 0.17 | [-0.04, 0.38] | 1.59 | 0.11 | 78.72 | 8 (p < 0.00001) | 0.08 | 90 % |
| 7. | Sample size | 3 (3548) | 0.01 | [-0.23 , 0.25] | 0.10 | 0.92 | 23.64 | 2 (p < 0.00001) | 0.04 | 92 % |

*Note.* g – Hedges' g measure of effect sizes, CI – Confidence Interval, z – test for overall effect, Q - Cochran's Q measure of heterogeneity, $df_q$ – degrees of freedom, τ2 – Tau squared indicating between-study variance, $I^2$ percentage of variation across studies due to heterogeneity.

# Appendix C Chapter 2: Background Information

## C.1 Education System in the UK

| Phase | Age | School | Year | Key Stage | Exams/ Qualifications | Qualification Level Equivalent | Education Providers |
|---|---|---|---|---|---|---|---|
| Nursery | 3 | Nursery | Foundation | Nursery | | | Nursery |
| Primary | 4-11 | Reception | Year 1 - 6 | Key Stage<br><br>1 - 2 | SAT | | Infant school then Junior School<br>or<br>Primary school |
| Secondary | 11-15 | Secondary | Year 7 - 9 | Key Stage 3 | | | Secondary School |
| | 15-16 | | Year 10 - 11 | Key Stage 4 | GCSE | Level 1 (Grades 1 – 3) or D – G) or Level 2 (Grades C or 4 above) | Secondary school |
| | 16 - 18 | | Year 12 -13 | Sixth Form | A-Levels<br><br>Applied learning (e.g. BTech Diplomas)<br><br>Technical qualifications/ (e.g. T Levels) | Level 3 | Secondary school<br>or<br>Sixth Form College<br>or<br>Further Education college |

*Note.* SAT: Standard Assessment Tests that measure students' achievement at the end of primary education. GCSE: General Certificate of Secondary Education, a national exam for secondary school students. The exam usually consists of nine subjects. A-levels: Advanced Levels, a national exam sat at the end of secondary education usually consisting of three subjects. BTEC: Business and Technology Education Council qualifications in a range of work-related subjects. T levels: a technical qualification launched in September 2020 to meet the needs of the industry.

# Appendix D Chapter 2: Analysis Information

## D.1 Participants Demographics

**Table 12**

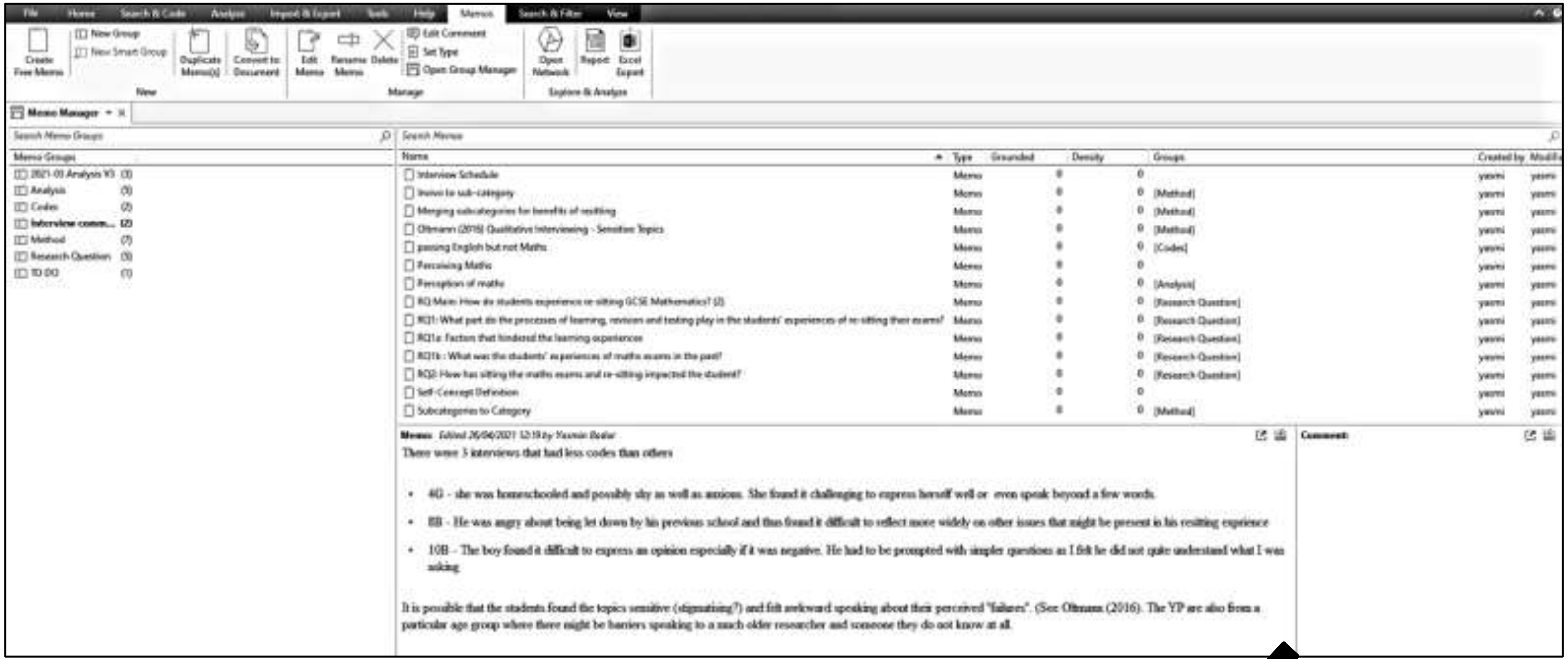
*Participants Demographics and Characteristics*

| Pseudonym | Age | Gender | Ethnic Background | English Fluency | Number of resits | Student status | If a student has SEN | Description of (SEN) | Anything else that might affect the student in exams | Description of additional needs |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Anusha | 17 | Female | Asian or Asian British - Indian | I am not a native speaker, but I speak English fluently at college and at home. | Twice – this is my 2nd resit | Full-time student | No | (Not answered) | none | none |
| 2. Jack | 16 | Male | White - British | I am a native English speaker | Once – this is my 1st resit | Full-time student | Yes | Prefer not to say | Uses a word processor and has extra time | none |
| 3. Lara | 16 | Female | White - British | I am a native English speaker | Once – this is my 1st resit | Full-time student | Yes | Yes | none | none |
| 4. Beth | 18 | Female | White - British | I am a native English speaker | Twice – this is my 2nd resit | Full-time student | Yes | (See note) | (Not answered) | Dyslexia |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. | Rita | 17 | Female | Asian or Asian British - Indian | I am not a native speaker, but I speak English fluently at college and at home. | Twice – this is my 2nd resit | Full-time student | No | No | none | none |
| 6. | Sarah | 16 | Female | Asian or Asian British - Indian | I am a native English speaker | Once – this is my 1st resit | Full-time student | No | No | none | none |
| 7. | Joe | 17 | Male | White - British | I am a native English speaker | Twice – this is my 2nd resit | Full-time student | No | No | Exam in a smaller room | none |
| 8. | Danny | 16 | Male | White - British | I am a native English speaker | Once – this is my 1st resit | Full-time student | Yes | Dyslexia | Has extra time | Dyslexia |
| 9. | Chandran | 17 | Male | Asian or Asian British - Indian | I am not a native speaker, but I speak English fluently at college and at home. | Twice – this is my 2nd resit | Full-time student | No | Yes | none | none |
| 10. | Ahmed | 16 | Male | Mixed - White & Asian | I am a native English speaker | Once – this is my 1st resit | Full-time student | No | No | Has reader in exams | none |
| 11. | Jane | 16 | Female | White - British | I am a native English speaker | Once – this is my 1st resit | Full-time student | No | No | none | none |

*Note.* SEN: Special Educational Needs. Demographic categories were taken from UK census categories (https://www.ethnicity-facts-figures.service.gov.uk/style-guide/ethnic-groups). Details of the SEN for student 4 (Beth) was not included as her specific condition would risk identifying her.

## D.2 Memo example in Atlas.ti



There were 3 interviews that had less codes than others

- 4G - she was home-schooled and possibly shy as well as anxious. She found it challenging to express herself well or even speak beyond a few words.
- 8B - He was angry about being let down by his previous school and thus found it difficult to reflect more widely on other issues that might be present in his resitting experience
- 10B - The boy found it difficult to express an opinion especially if it was negative. He had to be prompted with simpler questions as I felt he did not quite understand what I was asking

It is possible that the students found the topics sensitive (stigmatising?) and felt awkward speaking about their perceived "failures". (See Oltmann (2016). The YP are also from a particular age group where there might be barriers speaking to a much older researcher and someone, they do not know at all.

## D.3 Excerpt of the Codebook with the "Approaches to Learning" Index

**Table 13**

*Excerpt of the Codebook with the "Approaches to Learning" Index, Related Categories, Sample Codes and Quotations*

| Index/Code/Categories | References | Comment | Participant: In vivo codes number | Quotations |
|---|---|---|---|---|
| 5 %APPROACHES TO LEARNING | | | | |
| 5.1 @Re-engaging with learning | | Students talking about things that are helping them to focus on learning and resitting | | |
| 5.1.1 : Keeping focus on learning: | 3 | Students describing the issues they experience in trying to focus on their learning. | 5:91 focus more on my learning | I just need to start remembering, stop being on my phone, just focus more you know. I know that I have like my travel stuff to do but I just need to focus more on my learning. |
| | | | 5:107 definitely going to focus | keep to yourself is what I'm going to say, like that's what I'm definitely going to focus on this year, |
| | | | 7:28 got to condition myself | I just need to you know focus on the one thing, it's just something I've got to condition myself to do you know. |
| 5.1.2 : Becoming more positive about mathematics and revision: | 6 | Students commenting on being more positive about revising | | |
| 5.1.3 : Choosing to go to college: | 11 | Students describing how they chose to go to college | | |
| 5.1.4 : Trying to find self-motivation: | 9 | Students talking about how they motivate themselves | | |

| | | | | |
|---|---|---|---|---|
| 5.1.5 : Being mature and independent: | 8 | Students who feel more independent now they are in college | | |
| 5.1.6 : Experiencing better personal circumstances: | 8 | Students for whom circumstances have improved since last year | | |
| 5.1.7 : Making changes in myself: | 18 | Students describing changing how they are approaching things this year | | |
| 5.2 @Individualised approach to learning | | Using a variety of strategies to learn and commenting on their usefulness | | |
| 5.2.1 : Making maths fun: | 5 | How students feel learning mathematics can be made fun | 1:38 fun activities along with the math | cos' if you sit for two hours then you get really bored with the this topic with the stuff they teach so what they can do just do one hour of learning and the other hour of quizzes and fun activities along with the mathematics involved some way or so that you are like doing it as well |
| | | | 2:14 make the lessons more fun | we can make the lessons more fun so which like umm understand it more, we can apply it to the test” |
| | | | 3:44 it sticks in my head if it's a game | we go back and revise and play all these games cos I find it easier to work through games because it sticks in my head if it's a game |
| | | | 4:7 make the class a bit more fun | Probably … I don’t know … probably like make the class a bit more fun by like … because in our other class that I |

| | | | | |
|---|---|---|---|---|
| | | | | did last year, we did a few Cahoots(?) …” |
| | | | 4:10 there is less pressure | So even though Cahoot is quite a fast game, there is less pressure than just having to be serious and read things and … |
| 5.2.2 : Learning with visual strategies and resources: | 4 | Students talking about how visual strategies help them learn | 2:41 write it down so the students can visualise<br>4:13 I quite like visual things<br>4:38 Make it like a bit more visual<br>11:34 harder to learn like that | |
| 5.2.3 : Learning maths from online resources: | 24 | Students who learn with their other students and friends | | |
| 5.2.4 : Learning with peers: | 15 | Students who learn with their other students and friends | | |
| 5.2.5 : Preferring more active lessons: | 10 | Students talking about lessons being more active and engaging | | |
| 5.3 @Using revision strategies | | Descriptions of how students manage time, revise and use strategies to revise | | |
| 5.3.1 : Using the same revision strategies: | 3 | Students using the same strategies as last year | | |
| 5.3.2 : Learning from textbooks: | 8 | How students use textbooks to learn and their thoughts about this | | |

| | | | |
|---|---|---|---|
| 5.3.3 : Revising independently: | 4 | What students do to revise independently from family, friends and school/college | |
| 5.3.4 : Revising by doing practice tests: | 7 | | |
| 5.3.5 : Revising using flashcards: | 7 | | |
| 5.4 @Positive Coping Strategies | | | |
| 5.4.1 : Reflecting on the benefits of resitting: | 3 | Students talking about the pros and cons of resitting | 1:6 gonna help me on my CV<br>7:16 a stepping-stone<br>7:48 a step in the right direction |
| 5.4.3 : Using exam strategies: | 8 | What students do in exams to help do the exam | |
| 5.4.4 : Trying calming strategies: | 7 | | |
| 5.4.4 : Reframing my situation: | 10 | | |

*Note.* % - Index; @ - categories; colon denotes initial codes; for x:yy, xx denote the participant number, yy denote code number in the transcript

## D.4 Framework Matrix example showing excerpts from two participants

**Table 14**

*Framework Matrix example showing excerpts from two participants "Jack" and "Beth"*

| Participant number and pseudonym | Framework Matrix Indices | | | | | |
|---|---|---|---|---|---|---|
| | A : % Difficulties Experienced | B : % Feelings and Perceptions | C : % Learning and Exam Challenges | D : % Relationship and Interactions | E : % Strategies and Approach to Learning | F : % Supportive Factors |
| 2 : 02-10 B Jack | So if like I start getting a problem wrong I start getting discouraged<br><br>OK so umm I'm not too good at maths really so that's why I have to resit it<br><br>*I don't really find maths too enjoyable*<br><br>*my Maths teacher was actually on uh paternity leave ..while we were doing textbook* | To be honest, I wasn't too shocked because I was expecting to get a bad grade because I was panicking and so I pretty much did get a bad grade<br><br>*At first I felt discouraged, I thought I wouldn't be able to get a job but then came to college and then they said yeah you can resit your maths which I thought was* | the extra 15 minutes ...could mean the difference<br><br>I basically will forget the answer more because I'm panicking so I'm basically stressing about trying getting it all down<br><br>*I forget steps and get it wrong ...and just end up forgetting or writing the same thing over and over again because I just* | *they like to push me*<br><br>it's better cos' it's more relaxed um and you can joke about teachers more than you can in school | they would balance with messing about and learning into the the same lessons which I actually got information into my brain more.<br><br>we can make the lessons more fun so which like umm understand it more,<br><br>have more interactive activities ... and get like a prize or something | I would describe myself as um a hard working student like all students who occasionally slacks off but not too often.<br><br>they would say I am hard-working but once things start going wrong and I start to lose focus.<br><br>*I've also been tested here um to say that I um might be positive for dyslexia and dyspraxia, so I* |

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| | *work people were learning the more important basics ...so we were more losing out*<br><br>*I would rather have a quiet room, where um it's just like a group of people so that I don't feel alone*<br><br>*I did have the big groups that would disrupt the lesson*<br><br>*I would like to say that maths is hard*<br><br>*most of my friends actually pass their maths but just barely,*<br><br>I've seen loads of people that were basically discouraged by the maths, I was like it in Year 11 | *actually pretty cool.*<br><br>*I can get my Maths GCSE, I can get the get job that I want... I can do what I in the future now.*<br><br>I feel pretty confident at the moment, I feel I can get a pass and then go on to the A levels I want to do.<br><br>basically said yeah, I am going to do this, this year. I'm not gonna let myself resit again<br><br>*I keep switching between umm different jobs say, at the moment I want to be an actor with the umm ...It just keeps changing.* | *panic and it's just this thing I can't get over*<br><br>*I don't like when the examiner shout out what time we have left ...because it then make me think I need to rush to get finished.*<br><br>I basically couldn't really focus ... panicked in the exam again so I basically lost out on a load of easy marks<br><br>I'm also gonna get a load of practice questions offline ....<br>I wasn't really remembering them because I wasn't practicing them.<br><br>I don't really want to do the | | we all did um textbook work which was more boring, we didn't really learn anything<br><br>so my English teacher she said to basically sit there for about five minutes with your eyes closed<br><br>I'd say friends helped me because if I didn't understand anything<br><br>not really worrying about it too much ... if I resit a few more times, then I might start worrying it a bit more.<br><br>Just reading over a book on how to do it, it's not really my thing. ... I'd say the | *have extra time now to have with that.*<br>*... the extra time helped because I use the first five minutes to basically get my head in the exam*<br><br>*I'm basically going to give them to one of my family members or a friend so basically quiz me*<br><br>my sister tries to help but she doesn't really understand maths too much either she got a pass so she didn't know too much about Maths so she couldn't really help but she does try.<br><br>No, I'm pretty happy what college is like |

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| | why some students might failed because ummm my class was all right because we all we were all focused and we actually wanted to learn and pass. But there was a classroom next to us that everyone messed about and no one cared and | And I could have been in A-levels at the moment but because they didn't do that I'm now pushed back a year. | exams I'd rather do coursework, but I can't really change that. *I'd rather do coursework cos i can sit there and take it... at m... at my own pace ..., I'd probably get a higher mark than.. than if I did an exam.*<br><br>Well, I didn't get extra time in school ...they didn't really do any assessments or anything *...made me annoyed ...I could have had extra time ... and I could have got higher marks and better grades. And I could have been in A-levels at the moment but because they didn't do that I'm now pushed back a year.* | | teachers the like write it down so the students can visualise<br><br>like in school where we can basically push each other and like talk about how to visualise it<br><br>think of as a backup but still try as hard as you can .<br><br>I am going to do this, this year. I'm not gonna let myself resit again so I'm basically try and stay confident and not lose... umm courage. | right now.<br><br>pretty much all in the same boat. Umm but then there are a few friends have to resit it with me so we basically help each other as well.<br><br>*It's only happened in college, I basically went to the extra support team ...I think I need extra time because I run out of time in exams...the college started saying that you might be positive for this and that, it started to click together* |

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| 4 : 04-11 G Beth | I don't really talk to anyone in class because I prefer to just get on with it<br><br>I was home schooled, so I didn't really know the difference.<br><br>*I don't know, like the different methods that they would use, because I would use like different methods* | … I said that I want to do it because I want to be a SENCO at school.<br><br>I feel a bit alright about it but I don't know … it's just when the exam come round, I think I'll feel like a bit anxious again<br><br><u>I just want to pass really, so I can move on to what I want to do, because if I don't, I've got to do it again next year, yeah.</u><br><br><u>Because I can't move on without having a four or above in maths.</u><br><br>I was fine about it because I know that I'm gradually getting there because I got | : I was quite anxious because like … I … completely forgot what we were doing.<br><br><u>I like forgot the methods because I … I don't like being under pressure</u><br><br>… how long we had left and that, I didn't … yeah, I don't like where the time, like the time that you have.<br><br>Yeah, I think it's anxiety about time, yeah.<br><br>tend to get questions a lot more wrong,... Like I forget the method.<br><br>...I need to stop panicking? | I got bullied, that was the reason, yeah.<br><br>they were a bit like … upset but it was like, you don't need to really worry because I know you can do it. | when they like put like work on My Maths or something, like I didn't really like that...I'm like more of a … I'd rather write down on paper than be on the internet<br><u>I just don't like it like when the teacher was showing me it, I was just like no.</u><br><u>We're using Maths Watch at the moment, I quite like that,</u><br><br>we had like things that the teacher would put on the table, so it was quite like visual and I quite like visual things.<br>Visually, like write … I put like flash cards on the table and like … read and then | They say I work hard … if there's something that like an expectation, I'd like meet that for them,<br><br>*<u>A really hard-working person</u>*<br><br>Probably like going to support classes that my college has and a bit of … like learning at home<br><br><u>My friends would help me, saying like it will be over in like however long, they got me through it, so they were quite supportive</u><br><br>*Going to support classes and they give me like bits of sheets and stuff and that helps me, and they give me* |

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| | more than I got last year.<br><br>Yeah, because I want to get there, no matter what.<br><br>No, because I'm doing like the course that I want to do anyway, so it doesn't really impact. | | like do a question that I've like wrote on the back<br><br>I just use flash cards... I'd find it more easier to do them than read out of the book.<br><br>my friends would say where I went wrong and then we'd go through it together and then I'd get the hang of it<br><br>Textbooks don't really help.<br><br>make the class a bit more fun by like … because in our other class that I did last year, we did a few Cahoots … So even though Cahoot is quite a fast game, there is less pressure than just having | *mock papers as well.*<br><br>Because like … I got a question wrong the other day... So she like showed me how to do it<br><br>My dad, he … if I have any questions he'd be like … I'd just go and sit next to him and he would explain it to me and he would do like the method that I would do and he would show me how to do it.<br><br>*They was like if you don't … they told me last year, if you don't pass it this year, you've got next year to do it and you don't need to panic about it.* |

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| | to be serious and read things<br><br>some students know things that some other students don't, and they would like help each other out | Well the people that I've talked to were like, yeah, I feel the same way about it. |

*Note.* %- Index. Underlined excerpts were chosen for the paper. Italics were quotes from the Atlas.ti thematic network diagram. Rest were from NVivo framework matrix.

## D.5 Theme, Code and Excerpts Examples

**Table 15**

*Theme, Code and Excerpts Examples*

| Initial Codes | Participant pseudonym, and line number | Example excerpt |
|---|---|---|
| | | Theme One: Struggling with Mathematics |
| Positive about mathematics in primary school | Lara: 57 | Maths in primary was amazing, I had the most amazing teachers, they were just so amazing. I loved primary school |
| Struggling to understand teachers' explanations | Sarah: 44-51 | In year 7, I enjoyed maths because my class was really good and the teacher, he explained everything really well, and I used to find maths really easy then…. I got the same teacher in year 9, 10 and 11 and I think it's the way that she was teaching us, it wasn't right…. So, she wouldn't explain it properly and she would teach like really, difficult ways. . |
| Having special needs: | Lara: 133 | Yeah, she comes to me all the time. Cos like sometimes I need help with like hearing sort stuff and like seeing cos sometimes the board isn't clear at all and I can't read it so she is very helpful. |
| Having phones and other distractions | Joe:111 | I'll put my phone on silent, turn it off, maybe listen to a bit of music, just tell my family when I'm at home just let me you know, try not to … like interrupt me for thirty minutes, an hour. |
| | | Theme Two: Learning That Works |
| Learning with peers: | Anusha:210 | I really didn't know how to do until the other day, when my … like the whole class was contributing and the people around me were sitting, and I was like … that's not hard you know to do it. |
| Learning from textbooks | Jack: 132 | Just reading over a book on how to do it, it's not really my thing. But if I need one specific thing, and that it's in the book and that I can read them then I will be fine with it. But if it's more than one, then I can't really remember any of it. |
| Learning with peers: | Sarah:138 | Once we've done the answers, we compare it to each other, and if it's the same then obviously it's right, but then if it's different, I would ask her how she got hers and she would ask me how I got mine |
| | | Theme Three: Relying on Others |
| Having negative relationships with teachers | Lara: 93 | My teacher she don't like me so she would never really help me. She would always go to other people and then come to me… my teacher's horrible to me like my dad had to phone up and make a complaint because she just wasn't helping me which is why ended up having my one-to-one |
| Having good relationships with teachers in college | Joe: 128 | My maths teacher currently, she's encouraging you know as a teacher like … she kind of like … she wants us to succeed you know, as did my other maths teachers probably but … she's a very different maths teacher you know. And yeah, I mean she's strict when she needs to be, but I mean like strict but fair like. |

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| Having supportive parents: | Ahmed: 205 | If I'm stuck, I ask my mom and then she, she is, good at maths. Say she, she explained in an easier way and like a good method. Yeah ,my dad not that much cos he's like busy with other stuff. |
| | Theme Four : Being Left Behind | |
| Perceiving myself as the same as everyone else: | Joe:150 | I've always thought myself just a very normal student, you know, kind of not being like you know, the brightest kid in the class or the most disruptive kid, you know, kind of trying to do it by the books. |
| Perceiving myself as a hard-working: | Ahmed:17 | I'm really like hard, kinda hard-working, independent. If I've some ideas, I like, some share them like in groups, and I'm not really talkative that much ….And I'm really like kind and friendly like human being. |
| Others perceiving me negatively: | Rita:389-393 | I literally think that they think we're dumb!... I would agree with them, but I'm like … but I know more you know, I know other things…. sometimes I get it from my sister…. But I've gotten used to it. But I'm like, no, I'm not really dumb, I do know it, but you just don't know how to use it, you know? |
| Feeling unhappy about having to resit: | Danny: 174-176 | I'm seventeen in a mainly sixteen environment, so I'm kind of like, I don't know, like a year behind in a sense…. just kind of like take it like I was on a bit of a gap year or something… It's just something that needs to be done, you know, I'm not too worried about it. |

# Appendix E Chapter 2: Study Materials

## E.1 Interview Schedule

| |
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| Introduction (RQ1)<br>Read: These questions are about your experiences learning mathematics before coming to college |
| How would you describe yourself as a student?<br>How would your friends describe you as a student?<br>How would adults around you describe you as a student? (parents, teachers)<br>Tell me about your past experience of learning Mathematics<br>What was studying Mathematics like for you at school?<br>What helped you?<br>What did not help you?<br>Tell me about your past experience of sitting for Mathematics examinations<br>What was it like at school?<br>What helped you?<br>What did not help you?<br>What about the environment around you? (School, home, neighbourhood)<br>What has helped or did not help you? |
| Informational (RQ1)<br>Read: ***These questions are about you as a student at this college*** |
| What has led you to re-sitting GCSE Mathematics?<br>What happened?<br>What decisions were made?<br>Who made the decisions?<br>How did you feel about resitting your GCSE Mathematics?<br>How has it for you been studying Mathematics at this college/school?<br>Describe how you prepare for your Mathematics exams resits?<br>What kind of things do you do?<br>How do these preparations compare to what you did before coming to college?<br>What helps you?<br>What does not help you?<br>What do other people do that helps you?<br>Friends? Teachers? Parents? |

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| What do other people do that does not help you? Friends? Teachers? Parents?<br>What about the environment around you? (School, home, neighbourhood) – what helps or does not help you?<br>What would you like to change (if anything) about your situation now? For example<br>resitting your exams<br>being at this college/school |
| Reflective (RQ2)<br>Read: ***These questions are about how things are for you now*** |
| What would you like other people to know about your experience of GCSE maths resit?<br>What would you tell other students about your experience?<br>What would you tell teachers about your experience?<br>What would you tell your parents about your experience?<br>What needs to change to make a difference to you?<br>Who could help make that change? You/parents/teachers/others<br>What have you learnt about yourself as a student? |
| **1) Feelings (RQ2)** |
| How do you feel about resitting your GCSE maths?<br>Does it matter to you?<br>How do you handle this situation?<br>How does this compare to how your friends are?<br>How do your parents/family feel about you resitting your GCSE maths?<br>How do you feel about your future?<br>What has changed? (if anything)<br>How has resitting your Maths exams influenced your plans?<br>What impact has it had on your life if any? |
| **2) Ending**<br>Read: ***I've just got a few more questions before we end*** |
| Is there anything else you can tell me about your experience of resitting GCSE Mathematics?<br>Is there anything else I should have asked you but didn't? |

*Note.* Change to the interview schedule is highlighted. RQ denotes research questions 1 and 2

## E.2 Demographics Questionnaire

Student Demographic Questionnaire

Please answer the questions as best you can.

Please tick only ONE answer unless instructed otherwise.

1. What's your age?
   - ☐ 16
   - ☐ 17
   - ☐ 18
   - ☐ 19
   - ☐ Prefer not to say
2. How would you describe your gender?
   - ☐ Male
   - ☐ Female
   - ☐ Other (please specify if you wish): ……………………
   - ☐ Prefer not to say
3. Which of these groups do you consider you belong to (tick ONE only)?
   - ☐ White - British
   - ☐ White – Irish
   - ☐ White – East European
   - ☐ White - Any other White background
   - ☐ Black or Black British - Caribbean
   - ☐ Mixed - White & Black Caribbean
   - ☐ Black or Black British - African
   - ☐ Mixed - White & Black African
   - ☐ Black or Black British - Any other Black background
   - ☐ Asian or Asian British - Indian
   - ☐ Asian or Asian British - Pakistani
   - ☐ Asian or Asian British – Bangladeshi
   - ☐ Asian or Asian British - Nepalese
   - ☐ Asian or Asian British - Any other Asian background
   - ☐ Mixed - White & Asian
   - ☐ Mixed - Any other Mixed background
   - ☐ Arab or Middle Eastern
   - ☐ Chinese
   - ☐ Other (please specify if you wish): ……………………
   - ☐ Prefer not to say
4. How would you consider your fluency in English?
   - ☐ I am a native English speaker
   - ☐ I am not a native speaker, but I speak English fluently at college and at home.
   - ☐ English is not my first language, and I am still learning
5. Prefer not to say

   How many times have you sat for GCSE Mathematics before?
   - ☐ Once – this is my 1st resit
   - ☐ Twice – this is my 2nd resit
   - ☐ Three – this is my 3rd resit
   - ☐ More than three times (please specify how many resits): ……………………
   - ☐ Prefer not to say
6. What is your student status at college?
   - ☐ I come in once a week just for Mathematics
   - ☐ Part-time student
   - ☐ Full-time student
   - ☐ Other (please specify if you wish): ……………………

☐ Prefer not to say

7. Do you have Special Educational Needs?
   ☐ Yes (please specify if you wish): ………………………  ☐ No  ☐ Prefer not to say

8. Do you experience anything else that might affect you in exams? (For example dyslexia, dyscalculia, ADHD, depression, anxiety, physical disabilities)
   ☐ Yes
   (please specify if you wish): ………………………
   ☐ No
   ☐ Prefer not to say

Thank-You

## E.3 Participant Information Sheet

**Study Title**: The Experience of Students Re-sitting GCSE Mathematics Examinations

**Researcher**: Yasmin A.K Bador

ERGO number: 4724

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 form.

What is the research about?

I am a Trainee Educational Psychologist in my Second Year on the Educational Psychology Doctorate course at the University of Southampton. I am conducting a study on the experiences of students who are re-sitting GCSE Mathematics. This study will contribute to my thesis, which is part of the academic qualification of the Doctor of Educational Psychology.

I am aiming to conduct a grounded theory study of the experiences of students who are resitting GCSE Mathematics at college. I would like to increase my knowledge of what is happening for the students like you and to develop a theoretical understanding of the process of re-sitting the exams.

Why have I been asked to participate?

You have been asked to participate as you are a student who is re-sitting GCSE Mathematics

What will happen to me if I take part?

Your college/school has been asked to invite students to take part in this study. I intend to interview twenty students only; so, I may not be able to interview all students who are interested in taking part. If you are selected, you will be invited to meet me for an interview at the college/school. I will ask you to complete the Student Demographics Form which is a questionnaire about yourself and to sign the Consent Form if you agree to take part. The interview will take about thirty minutes to complete. You will be given a £10 voucher at the end of the interview.

Appendix E

I am interested in knowing about students' experiences resitting GCSE Mathematics. To help me be systematic, I will have a list of questions that I have already prepared. I am interested in certain topics to do with your learning experience, but I will be guided by what you think is relevant to you.

You will also be invited early next year (in 2020) to join other students.in a group discussion on how students experience of resitting GCSE Mathematics This discussion will involve you and the other students doing a card-sorting exercise followed by a group discussion. If you are selected for this group discussion and agree to participate, I will ask you to sign a Focus Group Consent form. The group discussion will be for 50 minutes and the whole process will take about 90 minutes in total to complete. You will be given a £10 voucher at the end of the group discussions.

All the interviews and discussions will be audio-recorded. No personal information will be included so that you cannot be identified. I will transcribe the audio recording so that I can analyse what you have told me and compare it with what I have collected from other sources. The recording will be deleted after the transcription has been completed.

Are there any benefits in my taking part?

You will be helping improve the current understanding of Educational Psychologists and other professionals of what it is like for students to re-sit GCSE Mathematics exams. You will be given a small gift voucher to say thank you for participating.

Are there any risks involved?

There may be a very small risk that you could experience discomfort in discussing your experience. You will be given information about your college's support and counselling services for you to contact if needed.

What data will be collected?

I will collect data on your gender, race, fluency in English, how many times you sat for your Maths exams, how many times you attend college and if you have any Special Educational Needs or experience anything that may affect you in exams. This will be done via the Student Demographic Form that you fill in before the interview starts. This data is used to understand the student population at your college. You may choose to not answer parts of or the whole questionnaire.

I will be recording your interview and the focus group discussions, but no personal information will be included in the audio recording. The recording will be deleted after the transcription has been completed. I will also take photos of the results of the group working together on the card-sorting activity. I will not take any photos of you or the other students.

Any personal data will be handled securely, during collection, analysis, storage and transfer, e.g. using encryption and password protected access, or in lockable cabinets for hard data. Any personal data and consent forms will be kept separate from non-identifiable data. Coding will be used to reduce the risk of identification.

I will need to store contact details for the duration of the study to allow me to maintain contact with you during the study. This data will be stored in a computer drive that has been encrypted and password protected. The information will be destroyed after the study has been completed.

Will my participation be confidential?

Your participation and the information we collect about them during the period of the research will be kept strictly confidential. Confidentiality cannot be guaranteed in focus group setting as many people will be hearing each other views but all participants will be requested to respect the confidentiality of each other and not repeat anything discussed outside of the group. No names will be used in the study and information that could identify you or any other student will be pseudonymised or deleted during the process of transcription.

Whilst we cannot assure anonymity in the study, we make every effort to maintain confidentiality by giving each student a unique number code. You will be allocated a number code that will appear in the Consent and Student Demographics forms. This number code will be allocated at the end of each Consent Form by the researcher. The codes only are known to the researcher and supervisor. The printed forms will be stored by the researcher in secure locked cabinets.

Only members of the research team and responsible members of the University of Southampton may be given access to data about you and other students 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 require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential

Do I have to take part?

No, it is entirely up to you to decide whether or not to take part. If you decide you want to take part, you will need to sign a consent form to show you have agreed to take part. The consent forms will be collected by me personally or sent to me via self-addressed envelopes provided.

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. You can contact me on the details below.

Your participation is voluntary, and you may withdraw your responses at any time for any reason without your rights being affected. You can contact me to request that your data is not used before December 31, 2019.

What will happen to the results of the research?

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.

The results will be written in a thesis to be submitted to the University of Southampton. The results will also be included in presentations to other trainees, Educational Psychologist, and other professionals. The project will be submitted for publication to professional and academic journals.

The participating colleges will also receive a summary of the findings of the project.

Where can I get more information?

The contact details the research team who could answer any questions you may have after reading this information sheet is as below.

What happens if there is a problem?

If you have a concern about any aspect of this study, you should speak to the researchers who will do their 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

Yasmin A.K. Bador (Trainee Educational Psychologist) Email:

Dr Julie Hadwin (Research Supervisor) Email:

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.

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 10years 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).

Any data will be pseudonymised through key-coding and removal of personal identifiers. Each participant will be given a participant number, and only the researcher and project supervisor will have access to the codes. The data linking the code with individuals will be encrypted and password protected with access only to the researcher and project supervisor. Pseudonymised data can help reduce privacy risks by making it more difficult to identify individuals.

Thank you.

## E.4 Consent Form

**Study title**: The Experience of Students Re-sitting GCSE Mathematics Examinations

**Researcher name**: Yasmin A.K. Bador

ERGO number: 47247

Please initial the box(es) if you agree with the statement(s):

| | |
|---|---|
| I have read and understood the Participant Information Sheet version 7.0 dated 27th September 2019] 1and 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 that taking part in the study involves audio recording, which will be transcribed and then destroyed for the purposes set out in the participation information sheet. | |
| I understand no names will be stored with any documents other than the consent form. Instead a number code will be allocated to my name and data at the bottom of this consent form. Only the researcher and project supervisor will have access to the number codes. The consent forms will be stored by the researcher in lockable cabinets. | |
| I understand that my participation is voluntary, and I may withdraw my responses at any time for any reason without my rights being affected. I understand that I can contact the researcher to request that my data is not used before December 31, 2019. | |
| 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). | |

| |
|---|
| Name of participant (print name) |

Appendix E

| | |
|---|---|
| Participant's college/school email (please do not put private email address): | |
| Signature of participant | |
| Date | |
| Name of the researcher (print name) | |
| Signature of researcher | |
| Date | |
| For Researcher Only | Participant code |

THANK YOU

## E.5 Recruitment Poster

UNIVERSITY OF Southampton

HELP US UNDERSTAND :

# What is it like to re-sit GCSE Mathematics?

**Got a £10 Amazon gift voucher**

WHAT IS THIS STUDY ABOUT?

I am a trainee Educational Psychologist at University of Southampton. I would like to understand what is it like for students like you who are re-sitting their GCSE Mathematics exam. I am interested in what helps students do well in Maths exams

**Contact:** Yasmin Bador
yakb1n17@soton.ac.uk

**The Faculty of Environmental & Life Sciences**
Committee reference: ERGO 47247
Date: 26/06/2019
Document Version: 3.0
Supervisor: Dr Julie Hadwin J.A.Hadwin@soton.ac.uk

WHAT HAPPENS IF I TAKE PART?

You will be asked for your consent and questions about your gender, race, fluency in English, how many times you sat for your Maths exams, how many times you attend college and if you have any Special Educational Needs or experience anything that may affect you in exams. I will then interview you for 30 minutes on what is it like for you to re-sit GSCE mathematics.
The interview will be audio recorded. Your details and any identifiable information are replaced by codes so that you cannot be identified. You will also be asked if you would like to participate in a focus group at a later date.

**To participate you must be:**

**1) Aged between 16 – 19 years**

**2) Currently resitting GCSE mathematics**

**3) Speak and understand English well**

**4) Able to attend the interview during college hours**

WHY SHOULD I HELP?

You will help teachers and other professionals understand what is like to be a student like you. We hope this study could help change how teachers teach and it may help other students in the future.

WHAT HAPPENS NEXT?

Please use your *college email* to contact me. I will send you a Participant Information Form and a Parental Information Form which have more information on the study. If you would like to participate, we will arrange a time and date to meet for an interview.

***Please take my details from the strip below.***

***You will receive a £10 gift voucher after the interview and a £10 gift voucher for participation in the focus group***

Yasmin Bador yakb1n17@soton.ac.uk

Yasmin Bador yakb1n17@soton.ac.uk
Yasmin Bador yakb1n17@soton.ac.uk
Yasmin Bador yakb1n17@soton.ac.uk
Yasmin Bador yakb1n17@soton.ac.uk
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Yasmin Bador yakb1n17@soton.ac.uk
Yasmin Bador yakb1n17@soton.ac.uk

## E.6 Ethics Approval

Details

**Status** Approved
**Category** Category A
**Submitter's Faculty** Faculty of Environmental and Life Sciences (FELS)

The end date for this study is currently 30 April 2021

Request extension

*If you are making any other changes to your study please create an amendment using the button below.*

Latest Review Comments

04/02/2020 15:00:55 - RIG: Approved

Comments:

Dear Yasmin,

Thank you for your amendment which I am happy to approve.

Please note that if you would like your new research assistants to have access to ERGO II, they would need to be added as Coordinators. If you would like for this to happen, please email rgoinfo@soton.ac.uk with the information, and my colleague will be able to do it for you.

Good luck with your research.

05/02/2020 08:44:35 - RIG: Approved

*No comments*

Amendment History

**Latest Version 47247.A2** (Created 25/11/2019)
Amendment 47247.A1 (Created 01/09/2019)
Original Submission 47247 (Created 18/01/2019)

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