# GCSE Mathematics Resit Learners Engaging with Word Problems in Further Education: Experiences of Struggle, Confusion and Hope

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# Declaration

I, Despoina Boli, confirm that the work presented in my thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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# The EdD Journey Reflection Statement

**The pursuit of learning**

I recently realised that, since starting my journey in education at around six years old, I have never really stopped studying and, I work in education. Until finishing school, I didn't really have a choice: I had to go. But what was it that made me continue pursuing further studies? What was I really looking for? I began with studies in mathematics, though I was particularly drawn to modules with an educational, pedagogical, or philosophical focus. This led me to an MA in Mathematics Education, followed by an MA in Philosophy of Education, and finally, a doctorate in Education. Looking back, I realise that each step was driven by curiosity and an ongoing need to question, understand, and explore current educational systems. Mathematics gave me a structured way of thinking, but it was the educational and philosophical aspects that truly inspired me. I found myself drawn to the deeper questions: How do we learn? What makes education meaningful? What role does knowledge play in shaping individuals and societies? With each stage of study, my perspective expanded. The MA in Mathematics Education allowed me to examine the teaching and learning of mathematics beyond the technical skills and gave me a better understanding of the cognitive processes, the misconceptions and the pedagogical approaches. Then, the MA in Philosophy of Education shifted my focus again, encouraging me to reflect on the underlying values, assumptions, and principles that shape educational systems and practices. I found myself drawn to ideas that challenge traditional, rigid views of knowledge and focus on dialogue, critical thinking, and giving students a sense of control over their learning.

Now, as I complete the EdD, I see how these different strands have come together. My academic journey has not been a linear path but rather a continuous and 'lumpy' process of refining my understanding, questioning assumptions, and engaging with complex ideas. It has been both challenging and rewarding, reinforcing my belief that education is not just about acquiring knowledge but about critically engaging with it. At the same time, my professional experience has played a crucial role in shaping my studies. Working in education while pursuing advanced research has given me a dual perspective, one that is both theoretical and practical. I have seen first-hand how research translates (or sometimes fails to translate) into practice, and how the realities of teaching and learning often challenge, and can inform, theoretical frameworks. This interplay between theory and practice has been a recurring theme throughout my studies and remains central to my reflections on education. For example, as a teacher, I wanted to better understand how I could create a positive learning environment for my resit learners. I explored research on the importance of teacher-student relationship and the impact they can have on shaping a student's engagement with a subject. As a result, I worked hard to build trust with my students and support their 'new' mathematical journey. In the first term, I focused heavily on getting to know my learners through what I called 'non-mathematical starters.' These involved a series of personal and reflective questions at the start of each lesson, designed to help us get to know each other better. However, as a manager, I was unable to use research effectively to convince my senior leaders that a two-year resit programme, with an exam only in the second year, would likely benefit some resit learners' mathematical development and final performance. Funding constraints prevented this from happening, reflecting a broader tension between evidence-based practice and institutional or policy requirements.

**Finding my research identity**

The start of my EdD journey was filled with excitement, enthusiasm, and the belief that my research could have a significant impact on my everyday practice, that of my colleagues, and, of course, on my students. Ultimately, my underlying hope was to influence wider change in the teaching of GCSE Mathematics in Further Education.

The first module, *Foundations of Professionalism*, prompted deep reflection on my own identity - who was I at the time? A teacher? A mathematics teacher? A student? A future researcher? This module raised many questions, some of which I could begin to answer, while others remained open. I explored the multiple factors that shape the professional identity of a Further Education mathematics teacher, an area I now recognise as being highly complex. At the time, I lacked the confidence to be critical of the literature I engaged with, and this was evident in my writing. I struggled to position myself within academic discourse, finding it difficult to critique the work of established scholars who, in my mind, had already found their professional grounding. Reflecting on this now, I realise that part of my struggle stemmed from a lack of self-confidence and an effort to locate my own sense of professionalism. How could I critically evaluate others when I was still uncertain about my own professional identity?

There are still times when I doubt my identity, but I now have a clearer sense of who I am: a researcher-educator who uses research and personal experience to refine her practice and contribute to the development of both students and teachers.

The two modules that followed, *Methods of Enquiry I* and *Methods of Enquiry II*, provided me with a deeper understanding of how research is conducted. *Methods of Enquiry I* was focused on writing a research proposal, which at the time felt like a daunting task. I had to refine my ideas, justify the relevance of my research, and engage critically with literature in a structured way. My study proposal aimed to explore how Socratic questioning could improve problem-solving skills among GCSE Mathematics resit students in Further Education. In drafting the proposal, I found myself struggling with methodological choices: quantitative, qualitative, or mixed methods? What kind of data would give me the best insights? These were challenging questions, but they helped me clarify the theoretical and practical foundations of my research. *Methods of Enquiry II* moved beyond proposal writing into practice, requiring me to conduct a small-scale study. This step was very important, as it introduced me to the realities of data collection: ethical considerations, participant recruitment, and, perhaps most importantly, the unpredictability of research in real-world educational settings. I designed a study investigating students' attitudes towards GCSE Mathematics resits, using an online questionnaire to explore their confidence, enjoyment, and learning strategies. Analysing the responses, I saw first-hand the limitations of a small sample size but also the potential of research to uncover meaningful insights. It was after these two modules that I began to realise that I am more of a qualitative researcher, someone who seeks to view things from different perspectives, listen to others' stories, and understand who they are, how they have developed, and why they behave the way they do. My students' voices had a lot to tell me about their mathematical experiences.

One of the key challenges I faced was moving beyond my identity as a teacher and stepping into the role of a researcher. As a practitioner, I had strong beliefs about the struggles of resit students and the challenges of mathematics education in FE. However, conducting research forced me to take a more objective stance, to let the data guide my conclusions rather than my assumptions. I also became more aware of the ethical complexities involved ensuring anonymity, minimising bias, and respecting the voices of my participants. Looking back, these modules helped me bridge the gap between theory and practice. They provided me with the tools to engage with research in a more systematic and critical way, shaping how I would approach my IFS and later my EdD thesis. The process of refining research questions, designing research studies, and analysing data has been invaluable, not just for my academic work but also for my professional development as an educator.

**Conducting and defending my research**

The *Institution-Focused Study* (IFS) was a defining stage in my EdD journey, offering the opportunity to conduct in-depth research. It was both an academic and professional milestone as it was my first chance to undertake a substantial, independent research project within my own educational setting. My study focused on *GCSE Mathematics resit students' narratives of their relationship with mathematics*, an area that had intrigued me throughout my teaching career in FE. I had the impression that GCSE resit students were often characterised by widespread disengagement, each with their own unique experiences, yet many seemed to share deeply rooted negative attitudes towards mathematics. I was eager to listen to their stories and what brought them in their current states. I wanted to understand how their past educational experiences shaped their current engagement with mathematics and whether identifying these factors could inform more effective pedagogical approaches.

I adopted a *narrative research approach*, a methodology that allowed students to tell their own mathematical stories. Through semi-structured interviews, seven students shared their journeys, reflecting on their experiences in both primary and secondary education and how these shaped their current dispositions towards the subject. Analysing these narratives, I identified several key themes influencing their engagement, including their relationship with their maths teachers, the set they had been placed in and the focus on procedural approaches to teaching. Conducting this study was a deeply reflective educational experience. As a teacher, I had been aware of some of the challenges faced by resit students, but listening to their narratives brought a new level of understanding. It reinforced my belief that addressing mathematical disengagement in FE requires more than just curriculum adjustments. It demands a deeper appreciation of students' past experiences, their sense of mathematical identity, and the emotional barriers they face.

I wrote my IFS dissertation during the first year of the Covid-19 pandemic. This was a period of mixed emotions, there was a sense of isolation, yet at the same time, an unusual kind of freedom. With lockdowns in place, the usual distractions of daily life were stripped away, giving me the time and space to focus on my writing. However, the isolation also meant fewer opportunities for spontaneous discussions with friends, peers and colleagues, which made the process feel more solitary and it was difficult to get a productive 'distance' from my project. I found myself deeply engaged with my work, but at times, I missed the sense of connection and shared experience that comes with in-person discussions. Looking back, makes me realise that it is ultimately a journey that requires self-motivation, perseverance and discipline, but also an awareness of when to reach out for support.

The findings from my IFS directly informed my thesis research. The IFS provided a foundation for exploring engagement in GCSE Mathematics resit classes and helped refine my research questions. The themes that emerged, particularly those related to student-teacher relationships, peer influences, and self-perception, were important to the development of my doctoral thesis. The IFS not only strengthened my research skills but also had a direct impact on my practice. It made me more attuned to the individual journeys of my students, encouraging me to create learning environments where past failures do not define future potential. It also reinforced my confidence as a researcher, demonstrating that meaningful educational research does not have to be detached from practice but can emerge directly from the classroom.

**Overcoming challenges and growth**

The thesis journey took longer than I had initially expected. As I began planning my research, refining my questions, selecting methods, and preparing for data collection, I found myself navigating an unexpected challenge. Returning to in-person teaching after a prolonged period of remote work, I realised that the college environment had shifted. Staff changes created instability, students seemed disconnected, and attendance was inconsistent. Illness frequently disrupted both teaching and learning, making it difficult to maintain continuity. Amidst this, I took on a new role as Curriculum Manager for mathematics, which brought new responsibilities and required my full attention. With all these factors at play, I made the difficult but necessary decision to interrupt my research for a year. When I was finally able to begin, I approached my study with renewed focus. Conducting pilot studies allowed me to test and adjust my approach, ensuring that the data I gathered would be as insightful as possible. For example, during the pilot stage of my focus groups, my students expressed that they did not wish to take part in small group interviews and would prefer one-to-one settings instead.

However, I wanted to retain a group element, as I believed there could be a positive impact on their self-image if they heard others reflecting on similar mathematical journeys. This led me to the idea of running a workshop to collect data, as this would feel more familiar and comfortable for them. This stage was both exciting and demanding, requiring constant adaptation and reflection.

After completing my data collection, I made the bold decision to leave my job, hoping that a break from work would give me the time and space to fully dedicate myself to writing my thesis. This decision was also influenced by the challenging working conditions I had experienced in my role as curriculum manager for maths. A series of changes in senior leadership had significantly altered the managerial approach to the maths and English department. Decisions were made by leaders who seemed disconnected from the specific needs of GCSE resit students, adopting a more business-driven, profit-focused perspective instead. This approach conflicted strongly with my own views, which emphasised student-centred strategies and tailored support for resit learners. Stepping away felt necessary to regain focus and reflect on my values as an educator. However, I quickly realised that I had underestimated just how much time, effort, and mental energy it takes to produce a strong, well-structured piece of research. There were moments of self-doubt, times when I felt overwhelmed by the large scale of the task. Fortunately, I had incredibly supportive supervisors who grounded me, reminded me of my capabilities, and helped me regain perspective whenever I felt lost.

At some point, I came to an unexpected realisation, I wasn’t just procrastinating; I was hesitant to finish. Submitting my thesis meant closing a chapter that had defined me for so long. For years, I had been a student, immersed in learning, questioning, and growing. The idea of stepping into the next stage, whatever that might be, felt both exciting and unsettling. Relinquishing the structure and identity that had shaped me throughout this journey is a daunting prospect. Despite these uncertainties, I keep going. With each draft, I see my work take shape, and with each revision, I feel a little more ready to bring this journey to a close and embrace the next stage of my professional life, enriched by the insights I've gained, the challenges I've faced, and the resilience I've developed along the way.

**Looking back, moving forward**

Looking back on my EdD journey, I see a path shaped by challenges, perseverance, and transformation. What began as an aspiration to improve my practice gradually evolved into a deeper engagement with research, critical inquiry, and the broader field of mathematics education. Each stage of the process, from my initial reflections on professionalism to conducting my *Institution-Focused Study* and finally completing my thesis, challenged me in different ways, pushing me to refine my thinking and strengthen my research skills.

Beyond my thesis, this journey provided me with incredible opportunities to share and develop my work within the academic community. I had the privilege of presenting my research findings at BSRLM conferences and writing proceeding papers, contributing to the book *This Worked for Me! – For Teachers of Students Resitting GCSE Mathematics* and receiving the *BSRLM New Researcher's Award 2024*. These experiences not only validated my research but also reinforced the importance of collaboration and knowledge exchange in education. All contributions to conference proceedings or other publications can be accessed in Appendix G.

While this journey has been demanding, it has also been deeply rewarding. It has shaped my identity as both a researcher and an educator, showing me that meaningful change in education begins with a willingness to question, reflect, and persist. As I move forward, I carry with me not just the knowledge I have gained, but also a renewed sense of purpose and a commitment to further contributing to the field.

# Abstract

In England, approximately one-third of 16-year-olds do not achieve a 'standard pass' in GCSE Mathematics; most continue studying towards that level post-16 as a condition of funding, usually with low 'success' rates and negative accompanying narratives. Despite recently-increased attention to these learners, there remains a gap in fully understanding the challenges they face. GCSE Mathematics requires successful engagement with word problems, arguably a threshold skill for both a GCSE 'pass' and for mathematical thriving in adulthood.

The thesis study makes a range of theoretical, methodological and pedagogical contributions. It used a novel exploratory approach to probe the experiences and approaches that GCSE mathematics resit learners in a London further education college have developed around word problems. An initial survey (n=5) established college teachers' perspectives on the teaching and learning of word problems, and a learner revision workshop evidenced initial insights into students' (n=12) experiences and approaches. Analysis of workshop data informed the design of an online student survey, distributed to all GCSE mathematics resit learners in two Further Education colleges in London (n=149 completed surveys). Analysis was via descriptive statistics or reflexive thematic analysis, as appropriate.

Findings suggest that broadly, participant student and teacher approaches correlate. Sample first-time resit learners enjoy higher engagement with, and motivation towards, word problems than persistent (multiple-resit) low attainers, whose responses revealed a growing disaffection with mathematics. Most participants' conception of word problems remained mathematically rudimentary. However, in contrast to the generally limited progression in GCSE grades attained, the range of participants offered positive narratives about their mathematics learning in college. Many suggested they had made good progress in their attitudes towards mathematics and willingness and confidence to engage with mathematical contexts. The findings underscore a need to understand and respond to resit learner backgrounds, to provide more appropriate and authentic post-16 mathematics experiences, and to value progress beyond examination results.

# Impact Statement

This research makes an important contribution to understanding the experiences and approaches of GCSE Mathematics resit learners. By identifying two different groups of learners, first-time resit learners and persistent low attainers (PLAs), the study addresses an area that has not been explored in detail before. This distinction has important implications for teaching, educational policy, and future research. The study's findings are particularly useful for Further Education (FE) institutions, where GCSE Mathematics resit learners are common. The research shows that first-time resit learners tend to be more positive and engaged, while PLAs are often less motivated due to repeated failures. By recognising this difference, the study suggests that teaching strategies should be adjusted to better meet the needs of these groups.

In practical terms, the research recommends targeted support for these learners. This could include extra workshops, mentoring, and other personalised support to help fill knowledge gaps and build confidence. The study also highlights the importance of creating a positive learning environment that encourages persistence and helps learners feel more confident in their mathematical ability. One important finding relates to how resit learners approach word problems (WPs). While many learners remembered strategies they had been taught in school, they often relied too much on spotting keywords rather than understanding the underlying mathematical ideas. This suggests that teaching should focus more on helping learners develop a deeper understanding of mathematical concepts rather than just following set procedures. Such changes could improve learners' problem-solving skills and overall confidence.

Another key contribution of the study is the use of a revision workshop as a method for collecting data. This approach not only provided an ecologically valid setting for gathering information but also gave participants a chance to reflect on and improve their WP strategies with their peers. This method could be useful in future educational research that aims to combine data collection with meaningful learning experiences. The research also explores gender differences in resit learners' experiences (widely explored in other studies but not for these learners). Female learners were more likely to report feeling anxious when faced with WPs, even when they had a positive view of themselves as mathematics students. Teachers could adopt strategies that promote positive female role models, celebrate female achievements in mathematics, and provide additional support to reduce anxiety and build confidence. This study has led to several practical recommendations for educational institutions and policymakers. These include offering flexible curriculum pathways that extend the resit course over two academic years for some learners, allowing for more time to develop understanding. The study also recommends further teacher training to ensure educators are equipped with the skills needed to support resit learners effectively.

In conclusion, this research challenges the common belief that GCSE Mathematics resit learners are generally disengaged and unmotivated. By showing that these learners have different needs and offering practical suggestions to support them, this study contributes to improved learning experiences and outcomes for resit students, ultimately helping them develop stronger mathematical skills and greater confidence.

# Acknowledgements

Completing this thesis has been an incredible journey, and I am very thankful to those who made it possible.

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# Abbreviations

| | |
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| AO | Assessment Objective |
| ASCL | Association of School and College Leaders |
| CfEM | Centres for Excellence in Maths |
| CPD | Continuing professional development |
| DfE | Department for Education |
| ESOL | English for Speakers of Other Languages |
| FE | Further Education |
| FS | Functional Skills |
| GCSE | General Certificate of Secondary Education |
| HE | Higher Education |
| IFS | Institution-focused study |
| MEI | Mathematics in Education & Industry |
| PBL | Practice-based learning |
| PLAs | Persistent low attainers |
| PS | Problem solving |
| RTA | Reflexive thematic analysis |
| WPs | Word problems |

# Chapter 1: Rationale and Background

GCSE Mathematics, along with GCSE English (Language or Literature) is a key gatekeeper qualification in English education. Since 2014, post-16 funding regimes in England have incentivised continued study for these GCSEs for those students who enter post-16 education without having achieved a grade 4+ in one or both. In the mixed ecology of institutions through which post-16 study is organised, many such 'resit' students are studying in Further Education colleges, often with a vocational focus to their main studies. This context for the focus study is further explored in chapter 2.

It is crucial for the reader to understand the reasons that led me to undertake the study presented in this thesis. I begin by discussing my personal experience as a mathematics teacher and curriculum manager in further education (FE) colleges in London, working predominantly with learners resitting the GCSE Mathematics qualification. Some of the challenges these learners encounter in mathematics sparked my curiosity and inspired a desire to understand the underlying causes of these difficulties. I then highlight the importance of placing the voice of the learners at the centre of my research and the impact this had on designing my institution-focused study. This, in turn, drew my attention to the need for further research into the challenges resit learners face with word problems (WPs). Finally, I interrogate the notion of word problems as an integral part of mathematics education and explore some of the challenges mathematics students have faced over the years.

With no prior experience of teaching mathematics in FE, initially I was not aware of what I later came to perceive as exceptionally low engagement levels, a diverse range of prior knowledge and an irregular attendance in mathematics lessons. After a year working with resit learners, one thing was certain: these learners required time to re-experience mathematics learning and to reshape their self-image within the subject. However, time is not flexible when it comes to resitting GCSE Mathematics. In most FE colleges teachers are given one academic year (essentially September to May) to not only help students improve their mathematical skills to achieve the desirable 'standard pass' (grade 4 or above) in preparation for the examination but also rebuild their foundational understanding and confidence in the subject.

National 'standard pass' rates for over 16s who are mostly, but not exclusively, GCSE resit learners, echo the challenge teachers and learners face: 16.4% in 2023, 20.1% in 2022, and 21.2% in 2019 (with 2020 and 2021 grades being teacher or centre-assessed due to the Covid-19 pandemic) (Camden, 2023). This study gathered data from two FE colleges in London, anonymised as College A and College B. Excluding the pandemic years, in College A pass rates have generally been below national average while in College B they are above national average. Additionally, in certain instances, resit learners find themselves resitting the qualification on multiple occasions. These statistics and my classroom and managerial experience led me to contemplate what measures a teacher and a department can take to assist these learners in achieving the coveted grade 4 (or above) and minimising the number of times they might resit the qualification.

This study was designed and took shape while I was working in College A. From my arrival in FE in January 2017, my colleagues and I had experimented with various teaching strategies such as flip learning and Socratic questioning, focusing a lot on providing a learning experience that help them re-experience mathematics. However, the end of year results did not always reflect the effort and dedication invested by both teachers and learners. In 2019, this prompted me to search for the answers within the learners themselves. What in my opinion had been lacking in our annual planning was the voice of the resit learners. Having been in touch with teachers and managers from other FE colleges through conferences or continuous professional development days, I realised that we shared similar concerns about the teaching and learning of resit learners. Most of us would talk about a general profile that these learners seemed to share, but do we really know these learners? Who exactly are resit learners? What past experiences do they bring into the classroom? What are their aspirations? How do they perceive the idea of resitting mathematics? Questions of this nature continued to arise in my mind.

I believe that gaining a deeper understanding of resit learners will bring us closer to finding a solution to how we can assist them in their journey of learning mathematics. My aim as a GCSE Mathematics teacher and simultaneously as a curriculum manager, was twofold: (1) to help resit learners improve their mathematical skills so they can attain the GCSE qualification by the end of their studies in FE; and (2) to provide them with the opportunity to improve their mathematical skills and reconstruct their relationship with the subject. Eventually, what I am looking for is ways to supporting the development of a robust foundation for productive engagement with mathematical aspects of their future personal, societal and employed lives.

In March 2020, as part of the EdD programme, I conducted a small-scale institution-focused study (IFS). My intention was to explore the past and present experiences of my GCSE Mathematics resit learners in relation to the subject. The aim was to gain a more profound comprehension of the factors that shaped their attitudes towards mathematics and to understand how these experiences might had impacted their achievement and levels of engagement. For that study, I adopted a narrative approach with seven learners adding several common themes (Boli, 2020). One significant theme revolved around the nature of the questions in formal examinations, often referred to as the 'wordy' ones. Frequently, these learners mentioned that they find themselves struggling to demonstrate their knowledge in exams as effectively as they would in the classroom. They also expressed dissatisfaction with the lack of guidance they felt they had in lessons around solving more complex word problems such as those that appeared towards the end of a GCSE Mathematics examination paper. They noted that the emphasis predominantly centred on preparing them to answer the one or two step procedural questions or identifying key words that would enable them to collect the necessary marks to achieve a 'standard pass'.

Working in FE for now more than eight years, I have directly witnessed the challenges that many resit learners encounter when solving mathematical WPs. Grasping the mathematical concepts that are applicable and relevant within a contextual framework is pivotal for success in both examinations and real-life applications. However, both the literature presented in Chapter 2 and my own experience indicate that WPs pose particular challenges for mathematics resit learners. This situation motivated me to further explore the concerns voiced by my learners regarding WPs, to validate their voices and to ultimately develop strategies to aid them in comprehending and solving WPs with confidence. To accomplish this, my first step was to understand how their existing relationships with mathematics and the approaches used to solve WPs had evolved over the years and what triggered their learning attitudes in a resit classroom.

In the literature, a variety of definitions can be found for the meaning of word problems (e.g. Boonen et al., 2016; Verschaffel et al., 2020.). For the purpose of this study, the definition put forth by Vondrová and colleagues (2019) was adopted:

> Word(ed) problems can be seen as problems which include some context (real, real-like or imaginary) within which some numerical data are given and others not, and a question (questions) is (are) posed for pupils to answer using the data, relationships between them inferred from the problem statement, their mathematical knowledge and out of-school experience (p. 184).

This definition accurately describes the type of WP questions that learners encounter in GCSE Mathematics examinations, which are the focal point of this study.

WPs have a critical position within mathematics education. Kintsch (1988) argues that from the perspective of knowledge integration, WPs are ideal due to their incorporation of not only mathematical knowledge but also linguistic and situational knowledge for comprehending the context of the problem. Through engaging with WPs, learners can develop their understanding of a situation being described, strengthen their problem-solving skills, combine knowledge from different mathematical areas, cultivate logical and critical skills, and bridge the gap between formal and informal processes. Solving WPs is in a sense a 'threshold' skill that supports learners moving from employing techniques to accumulate sufficient marks during examinations, to becoming much more empowered users of mathematics.

Research over the past 50 years has highlighted various difficulties learners encounter when solving WPs, including comprehension issues, linguistic complexity, challenges in transitioning from informal to formal mathematics, vocabulary deficiencies, and learners' beliefs and motivational levels (Verschaffel et al., 2020; Ramirez et al., 2019; Shoenfeld, 2016; Fischer & Shaki, 2014; McLeod & Adams, 2012). Various types of interventions aimed at addressing the challenges learners encounter with WPs have been trialled over the years to improve performance and mathematical understanding (Verschaffel & De Corte, 1997; Montague et al., 2003; Kajamies et al., 2010). This body of work demonstrates that certain long-term interventions seem to have a positive impact on WP challenges. Reinki (2019) argues, for instance, that the incorporation of context in WPs can act as an anchor that enhances understanding and recall of mathematical concepts. Furthermore, Hoogland and colleagues (2018) suggest that the utilisation of depictive representations of WPs resulted in a slight percentage increase in learners' performance. However, on the other hand, the short-term interventions rarely yield any noticeable impact on learners' performance (Pongsakdi, 2017).

The group of learners I work with, the GCSE Mathematics resit learners, have received little previous attention in research, although FE is a key sector of mathematical underperformance that is costly to individuals and society (Smith, 2017). The nature of this group is particular to English education and over the years they have been impacted by several policy developments, which is presented in detail in Chapter 2. It was only after 2017 that this group of learners attracted enhanced interest in educational research, possibly due to the high-stakes nature (for individuals, colleges, and the government) of the GCSE resit policy, triggered by exceedingly low success in national high grade rates (grades 4-9) for post-16 education. Nevertheless, there is currently very little research available regarding resit learners' perspectives on the challenges affecting their engagement and performance with WPs.

A substantial proportion of the current literature concerning *student voice* emphasises the benefits it has to offer in educational research and reform for enhancing theoretical and professional understanding (Cook-Sather, 2006; Robinson & Taylor, 2007; Harfitt, 2014). In my IFS study (Boli, 2020), resit learners offered previously unexplored insights into crucial influences on their mathematical progression and further expressed that they felt affirmed by their perspectives being valued. The voice of the learners who, for various reasons, have not attained a 'standard pass' during their 5-16 education is significant (Kozol, 1991). In the UK, this is the *forgotten third* referred to in the ASCL (2019) report: "they are 'forgotten' not only in the sense that they are never the ones pictured jumping for joy in local newspapers, but because their chances of progression are diminished in further study, future careers, and, ultimately, in life" (p. 1). Amplifying the voices of these learners contributes to equalising the power dynamics between learners and educators and creates a platform for democratic dialogue to emerge (Cook-Sather, 2006).

The significance of learner voice in education, particularly for learners who have encountered repeated challenges in mathematics, cannot be overstated. Learners who have encountered setbacks and not achieved the desired outcomes in mathematics deserve a platform to express their insights and perspectives. Their experiences provide valuable insight into the factors that hinder their learning and the obstacles they confront. Incorporating their voices into educational discussions and decision-making processes not only acknowledges their struggles but also empowers them to shape the solutions that directly impact their educational journey. This collaborative approach fosters a more inclusive and responsive educational environment that seeks to address the specific needs and concerns of those who have previously struggled. Ultimately, by valuing and amplifying student voices, the education system can work towards a more equitable and supportive learning experience for all learners, irrespective of their past challenges in mathematics.

This study does not set out with pre-defined overarching research questions or sub-questions. The decision was intentional and reflects the exploratory nature of the research. At the outset, the aim was to investigate GCSE Mathematics resit learners' experiences with word problems and to gain insights into the approaches they had developed during their schooling and in further education. Alongside this, the study aimed to build a deeper understanding of who these learners are: their needs, their differences as individuals within a resit group, and the ways in which they think about and act within mathematics. Given the limited body of research focusing on this learner group, a flexible and inductive approach was necessary in order to remain open to the perspectives and themes that emerged directly from learners' voices. In this sense, the study is about understanding how resit learners describe and make sense of their experiences with word problems, what strategies they recall using, and how these are shaped by their educational histories. It is not about measuring attainment in word problems or evaluating the effectiveness of a single teaching intervention. By adopting an exploratory approach, the study was able to evolve through successive stages of data collection with each stage building on insights gained previously. This design ensured that the research remained grounded in learners' lived experiences, while at the same time allowing new lines of inquiry to develop organically.

Having outlined the rationale and background for this study, the following chapters provide a comprehensive exploration of the key themes underpinning this research. Chapter 2 reviews relevant policies and existing literature, offering an overview of the post-16 GCSE

Mathematics resit landscape, the challenges faced by resit learners, and the significance of word problems in mathematics education. Chapter 3 details the methodological framework, explaining the study's ontological and epistemological positioning, the exploratory approach adopted, and the research design, including data collection and analysis methods. Chapter 4 presents the findings from the teacher survey, the student workshop and the online student survey, focusing on participants' self-perceptions, experiences with mathematics, and approaches to word problems. Chapter 5 discusses these findings in relation to existing literature, highlighting key themes, implications, and contributions to knowledge. Finally, the chapter concludes with recommendations for policy, curriculum development, and further research to enhance the learning experiences of GCSE Mathematics resit students in Further Education.

# Chapter 2: Review of Background Policies and Existing Literature

Because of the limited literature regarding GCSE Mathematics resit learners compared to the research attention primary, secondary or A-Level mathematics students in England have received (Foster & Inglis, 2019; Marks et al., 2021), this chapter differs from a more traditional literature review chapter. It draws significantly from a range of policy and other 'grey' literature to provide a context that aims to help the reader understand the factors that contributed to the design and conduct of the current study. It also makes use of the academic literature around areas such as student affect in mathematics education, the challenges faced by learners in various stages of schooling when working on mathematical WPs and efforts made by other researchers to address them, and problem solving as a core element of mathematics in English education. Since this study was planned, conducted, and first drafted, the field of research on resit learners has seen significant developments and continues to evolve rapidly, as outlined in the following sections.

This chapter begins with an examination of the development of current policies regarding the continuous study of GCSE Mathematics in post-16 English education. Following this, an overview of the existing literature on GCSE Mathematics resit learners is presented, identifying gaps in research and highlighting a sub-cohort of learners who have received limited attention thus far, referred to herein as *persistent low attainers*. The core nature of this study involves research surrounding mathematical WPs. Hence, this chapter also presents research findings on WPs and the related challenges faced by learners in various stages of education. I draw on literature regarding WPs in primary and secondary education as there is no research focusing on resit learners' work with WPs in mathematics. I argue, however, that aspects of the primary and secondary phase research are transferable to FE resit students, as they have previously experienced these stages of education, though the unique needs of FE learners must also be taken into account. Subsequent sections explore affective issues in mathematics education, including self-perception and its connection to academic performance and subject engagement. Appendix E presents the rationale for the selection of literature themes, and the decisions regarding their inclusion.

## 2.1 Policy context: GCSE Mathematics in post-16 education in England

### 2.2.1 The need for mathematics in post-16 FE sector

In England, the discovery of a strong correlation between limited numeracy skills and unemployment marked the initiation of reforms in mathematics education within the FE sector (Parsons & Bynner, 2005; Wolf, 2011). In response, the government started to implement a series of initiatives aimed at enhancing the mathematical proficiency of vocational learners, emphasising practical applications of mathematics in both daily life and the workplace (Greatbatch & Tate, 2018). Over the past two decades, a variety of post-16 mathematics qualifications, including Key Skills, Adult Numeracy, Functional Mathematics, and Entry Level certification, have been introduced in an attempt to strengthen the mathematical competencies of vocational learners (Greatbatch & Tate, 2018).

### 2.1.2 The 2014 reform

The 2014 reform placed the continued study of mathematics as a condition of funding for every learner who enrols in an FE institution and does not already hold a GCSE grade 4 or higher. This decision typically offered three teaching hours of mathematics to those learners' timetables per week. The 2024 update to this reform added an additional teaching hour of mathematics for resit learners, requiring a total of four hours of mathematics per week (ESFA, 2014-2024). Prior to this and after the impact of the 2021-2022 Covid-19 pandemic on learning, the DfE was funding FE colleges and other educational providers to provide extra hours for small group tuition to their students so they could catch up with what had been missed. The additional fixed hour was triggered because of the learning loss occurred during the pandemic and the findings from a DfE-funded project (Centres for Excellence in Maths - CfEM) that aimed to better understand the needs of resit learners and FE mathematics teachers. Both areas are further explored in subsequent sections. Before the change in policy in 2014, learners mostly opted for mathematics courses when their primary vocational programmes demanded a significant but basic understanding of mathematics, such as in business or science studies (Dalby & Noyes, 2018). FE colleges play a pivotal role in equipping these 'lower attaining' students with the essential mathematical skills needed to advance in either higher education or employment.

It is important to note that the 2014 reform does not restrict resit learners to enrolling only in GCSE Mathematics since other options such as Functional Skills qualifications, ranging from Entry Level 1-3 to Level 1-2, are also available, and arguably more suitable for the needs of many learners. Typically, FE colleges consider learners' qualifications on entry before placing them on a suitable mathematics course. The aim is usually that each resit student will have the opportunity to retake the GCSE Mathematics examination at some point within their post-16 education, even if initially they first have to go through lower-level courses to improve their mathematical skills. This approach makes Functional Skills qualifications to level 1 a stepping stone to GCSE for learners with grade 2 or below in GCSE Mathematics. A recent study showed that although resit learners seem to understand the journey required to enhance their mathematical skills, many feel that it can be a lengthy process and that some of the levels they have to go through before reaching GCSE are 'too easy' (Norris, 2023). Although a Functional Skills level 2 qualification is considered equivalent to GCSE, for instance, GCSE is more widely acknowledged by employers, resulting in increased funding for FE colleges who might promote participation in GCSE Mathematics over other mathematics courses offered (ESFA, 2019). A small-scale survey (Davies et al., 2020) of employers (n=15) suggested that although FS qualifications are not 'unknown' to them, GCSE qualifications in maths and English have better recognition, while another, larger-scale, survey showed that GCSE qualifications are more valued by employers when recruiting for entry and admin roles (Pye Tait, 2019 in Davies et al., 2020). My own professional interactions with employers, through college fairs, have also shown that GCSEs are a 'known brand', while FS or Entry level qualifications are commonly less well-recognised or understood in terms of their functionality and applicability to the workplace. Since September 2019, there have been reforms to Functional Skills qualifications to align more closely with employers' requirements in terms of the skills and knowledge that they would value from learners (Ofqual, 2018; Beach, 2019). Nevertheless, with the continued study of mathematics now being a funding requirement, national data show that GCSE Mathematics has become the dominant choice among FE colleges and holds a higher internal standing than similar qualifications.

### 2.1.3 Conclusion

Thus far, my intention has been to present the policies and procedures that have led to the current position of GCSE Mathematics in post-16 education and the roles that FE colleges in

England have taken to provide resit learners with the space, time and resources to adequately enhance any underdeveloped mathematical skills. The review of existing literature suggests that although there is a wide range of practices and approaches aimed at enhancing provision and outcomes in post-16 GCSE resits, there are relatively few pre-packaged interventions tailored specifically for this particular group and context, although efforts to reach that point have started to emerge (e.g. the additional weekly one hour of mathematics in FE, the work of CfEM, and the addition of a Mastery specialist course for FE maths teachers led by NECTM).

To further comprehend the nature and purpose of this study, it is necessary to outline what is already known about resit learners and what efforts have been made to better understand and address their needs. In the following sections, most of the studies presented have student voice as their main approach to gaining a deeper insight into resit students' learning experiences while in FE. I also pay attention to a subgroup of resit learners who for various reasons have resat the GCSE Mathematics qualification multiple times. I use the term *persistent low attainers* when referring to them to indicate that even though they have sat the qualification several times they have not yet achieved the desired 'standard pass'.

## 2.2 Resit learners' context: Current knowledge of GCSE Mathematics resit students and their learning experiences

### 2.2.1 The forgotten third

The term 'forgotten third' was introduced by the ASCL (2019) to refer to learners who do not achieve a 'standard pass' in mathematics and/or English by age 16. This term stems from two key observations. Firstly, every year, approximately one-third of GCSE cohorts in England do not attain a standard pass in GCSE Mathematics and/or English. This raises important questions about whether this phenomenon is a facet of the learners themselves or of the assessment system or of the broader educational system in which they sit. While one interpretation might suggest that this third of learners lacks the skills needed to achieve a standard pass, another perspective is that the structure and content of the GCSE assessments may not adequately reflect or cater to the diverse learning needs and contexts of all students. For instance, the design of GCSE examinations often emphasises specific types of knowledge and skills that may disadvantage certain groups of learners, particularly those who have developed alternative ways of understanding or approaching mathematics. Furthermore, systemic factors such as teaching quality, socio-economic background, and resource disparities could also play a role in shaping these outcomes. This raises critical questions about whether the assessment system itself inadvertently perpetuates educational inequities and fails to support or recognise the full potential of all learners. There is therefore a need to re-evaluate both the content and aims of GCSE assessments, as well as the support provided to learners who face challenges in meeting these standards.

Secondly, this one-third of learners had, at least until recently, not received sufficient attention to thoroughly understand their needs and make informed decisions regarding mathematics (and/or English) in post-16 education (ASCL, 2019). This oversight may stem from a combination of systemic factors and research gaps. Traditionally, educational policy and research have focused on improving the success rate for a grade 4 or above rather than analysing and addressing the diverse educational experiences and needs of learners who fall short of the 'standard pass'. Consequently, these students are often perceived as 'underperforming' without a deeper analysis of the systemic challenges they face or the pedagogical adjustments that might better support them. Responsibility for this situation lies partly within policy frameworks that prioritise standardised assessment outcomes and partly within drivers for educational research. Since 2015, though, increased research around these learners has supported a deeper understanding of the factors that contribute to their low achievement in mathematics and especially efforts aimed at improving the teaching and learning of GCSE Mathematics in English FE (e.g. Smith, 2017; Wake et al., 2023).

#### *2.2.1.1 The voice of resit learners in educational research*

Some research studies, including this one, have centred on giving a voice to resit learners and attempting to grasp the systemic and pedagogical changes required, from their perspectives. It is crucial to understand how they have experienced the learning of mathematics both before and during their time in FE so that the teaching of mathematics can be redirected according to their needs, to eventually improve attainment in post-16 education. Previous studies have been prompted by the significant disengagement, low motivation and continuous string of academic setbacks that resit learners have often faced (Dalby & Noyes, 2015; Hough et al., 2017; Smith, 2017). These have often been observed and commented on anecdotally by FE mathematics teachers and have been reported through research. Below, I present what is currently known about the characteristics and needs of resit learners. The research studies that I have identified have sought to open a discussion about the issues and challenges concerning students who are resitting the GCSE Mathematics qualification.

#### *2.2.1.2 Resit learners' educational progress*

Bellamy (2017) sought to understand the impact of 'forced' GCSE Mathematics resits on learners and their lives by giving resit students the opportunity to voice their perspectives. Note that resitting GCSE Mathematics is not technically compulsory, but as mentioned above, it is effectively required for many resit learners through their colleges' decisions. In Bellamy's 30 interviews, resit learners shared their views on resitting the GCSE qualification and talked about their past experiences with mathematics. When considering their prior educational backgrounds, it becomes evident that the attainment sets in which resit learners were placed in primary and/or secondary school had, to some extent, shaped their relationship with mathematics and their perceived roles within it (Bellamy, 2017; Hough et al., 2017). The practice of having attainment sets or ability groups is commonplace in English primary and secondary education (Dracup, 2014). Francis and colleagues (2020) conducted a systematic review of the literature on ability grouping and concluded that placing learners in sets based on their 'ability' did not demonstrate any academic benefits, but it did often show negative impact, including on pedagogy and expectations, when learners were placed in lower sets. The OECD (2013) advised against placing learners in ability groups as it can have a negative influence on their long-term achievement and performance.

According to Watson (2021), learners placed in lower sets are typically only taught GCSE Foundation level curriculum topics, which can impact on their self-image when compared to 'higher' attaining peers. These learners usually encounter prejudicial experiences regarding their ability to understand mathematics at school (Klusmann et al., 2021) and tend to describe their time in secondary mathematics classroom as frustrating and damaging (Rashid, 2022). On the other hand, exposing them to the breadth of the Higher-level curriculum in an attempt to offer equity of access, or even access to an 'easier' route to a grade 4+, can result in repeated failure to thrive, and very low levels of attainment on GCSE High level papers (e.g. Pearson GCSE Mathematics examiner reports).

The narratives of participants in my IFS study (Boli, 2020) echoed these mixed findings, revealing the adverse effects that ability grouping had on their self-image as mathematics students. They felt that once they were placed in a low ability group it was difficult to move to a higher one, and that the attention paid to them by their teachers was limited. Two of the seven participants, though, identified benefits from learning with students of similar prior attainment when the teacher was interested in their progress (Boli, 2020). General experiences with mathematics were also explored in the present study to understand the relationship resit learners had experienced with mathematics before FE (see Chapters 4 and 5).

##### *2.2.1.3 Resit learners' attitudes and behaviours*

Findings from Bellamy's (2017) study show that all her participants recognised that being successful in maths requires self-motivation and commitment. Bellamy, however, argues that this belief contrasts with their learning behaviour in a mathematics class. This is something I have observed over the years while teaching GCSE Mathematics to resit learners. In discussions with these learners, they seem to know in principle what they need to do to have a successful year, such as having a growth mindset, maintaining a consistent study schedule, engaging with homework on a weekly basis, attending lessons, and asking for help. Although there are moments in my lessons when some resit learners appear motivated and actively engaged with the content of the lesson, this motivation often proves to be short-lived and cannot sustain their full engagement until the end of the academic year. Such conundrums are further explored in this study's research data, as presented in later chapters.

Nixon and Cooper's (2020) findings suggest potential reasons why this short-term motivation tends to fade away. They explored the experiences of three GCSE Mathematics resit learners. Their objective was to gain insights into the learners' perspectives regarding what it takes to excel in mathematics, their perceptions of an effective mathematics curriculum, and to identify the factors that both facilitate and obstruct the success of a mathematics learner. Their findings revealed that learners who had previously faced challenges in mathematics tend to doubt themselves even when performing well in their FE mathematics classes. These doubts are influenced by their prior learning experiences and probably cause the development of short-term motivation phases (Crisp et al., 2023). Such learners are prone to attribute past failures to an inaccurate reflection of their potential and view success as a matter of luck, especially if they are female (Nixon & Cooper, 2020). To regain confidence in their mathematical abilities, whether in the context of GCSEs or beyond, they may need to unlearn these beliefs and be supported to build new learning habits.

Another relatively recent and more robust investigation, conducted by Noyes and Dalby (2020b), explored the perceptions of FE mathematics resit learners and their experiences in learning the subject within FE colleges. Their study (the Mathematics in Further Education Colleges project: Mathematics in Further Education Colleges (MiFEC) - Nuffield Foundation) sampled 32 general FE colleges and a total of 388 FE learners. The findings of their research revealed important key points, providing a clearer picture of resit students' mathematical learning experiences in FE. Noyes and Dalby (2020b) suggest that resit learners frequently struggle with low confidence and anxiety, emotions that stem from past experiences in schools and are sometimes compounded by ongoing struggles in the classroom or during examinations. Resit learners in their study appreciated individualised attention from approachable and understanding teachers, but they often found it challenging to comprehend the colleges' organisational systems for mathematics lessons. These challenges may include inconvenient or 'chunked' timetabling, disruptions to classes, and ineffective measures to address poor attendance.

#### *2.2.1.4 Relevance of mathematics*

In her findings, Bellamy (2017) argues that the integration of GCSE Mathematics into a college's vocational curriculum is insufficient. Learners often struggle to discern the relevance of GCSE Mathematics within their chosen field of study. Noyes and Daldy's (2020b) findings show that resit learners' motivation is dependent on the perceived value of the GCSE qualification for advancing to further study or career development (the exchange value of mathematics). However, the same study suggests that learners struggle to identify the practical relevance of the mathematics they are learning to their daily lives, careers, or vocational studies (the use value of mathematics). This perceived lack of practical relevance raises questions about who determines what is 'relevant' in the curriculum.

The GCSE qualification carries significant 'exchange value', and learners who attain the standard pass have a competitive edge in job and Higher Education markets. In reality, only a small minority of resit learners meet this standard, and many others experience increasingly negative attitudes towards mathematics and diminished opportunities to apply mathematical skills in real-life contexts (Dalby & Noyes, 2021). Participant resit learners expressed a preference for an alternative approach to improving their mathematical skills and knowledge, one that does not entail resitting GCSE Mathematics but is more directly linked to their specific vocational areas (Noyes & Dalby, 2020b). While educational policymakers and curriculum developers aim to define a standard set of mathematical skills and knowledge, these may not always align with learners' perspectives or practical needs in real-world contexts. Consequently, there is a gap between the curriculum's intended relevance and students' lived experiences, suggesting that further investigation is needed into how mathematical relevance is conceptualised and communicated within FE settings.

#### *2.2.1.5 Wider lives of resit learners*

Over a quarter of the participants who took part in Bellamy's study (2017) had more than ten hours of caregiving responsibilities, and nearly half worked for more than ten hours per week. Additionally, 55% of learners did not have access to a quiet study space at home, and another 48% lacked the space to store their books and notes. Velthuis and colleagues (2018) also showed that a large proportion of resit learners come from disadvantaged socioeconomic backgrounds. According to data gathered every year by both College A and College B in my study, a significant proportion of resit learners receive bursaries for travel expenses so they can attend lessons and are eligible for free college meals and technological equipment such as laptops or Internet vouchers. Adverse out of college conditions pose challenges for resit learners' engagement with both their main course of study and mathematics (Bellamy, 2017). This issue merit further exploration as it may provide a clearer understanding of the broader socioeconomic factors that impact a resit learner's overall engagement with education.

#### *2.2.1.5 Conclusion*

The studies mentioned above provide valuable insights into the characteristics of learners retaking GCSE Mathematics in English FE colleges. Most of these studies, whether on a small or large scale, identify similar areas of potential challenge. It is evident that a significant proportion of these learners come from disadvantaged socioeconomic backgrounds. Moreover, emotional factors such as lack of motivation, low self-esteem, previous 'failure' and, sometimes, mathematics-related anxiety significantly can affect their overall engagement and progress with mathematics in FE colleges.

The following section focuses on a subgroup of resit learners who have received no specific attention in academic research to date. These are the resit learners who have resat or continue to resit the GCSE Mathematics qualification multiple times, with many of them not managing to gain a 'standard pass' at the end of the two or three years of FE study (Noyes et al., 2020b, 2020c).

### 2.2.2 Persistent low attainers in GCSE Mathematics resit courses

It is worth noting that two-thirds of resit learners will take the GCSE qualification multiple times until the age of 19 without improving their examination performance (Boli & Golding, 2024). After turning 19, these learners are no longer required to resist the GCSE Mathematics qualification. However, colleges continue to receive funding to offer GCSE Mathematics courses to adults (19+), providing an option for those who wish to pursue further study in mathematics.

Only about a third of persistent low attainers remaining in FE every year will make positive measured progress, let alone achieve a grade 4+ at the end of any resit year (Noyes & Dalby, 2020b; Belgutay, 2019). This outcome, while concerning, reflects underlying tensions and mismatches in the educational experiences, values, and beliefs between students and the structures within which they learn. For instance, while educational policy emphasises the importance of achieving a 'standard pass' (grade 4), many learners struggle to perceive the relevance or applicability of the mathematics they are required to master. Additionally, classroom dynamics, teaching approaches, and assessment demands may not always align with the needs and motivations of these learners, creating further barriers to their engagement and success. Exploring these mismatches can provide valuable insight into why low attainment persists despite multiple resit attempts.

About a quarter of resit learners will attain a 'standard pass' by the age of 19 - excluding the pandemic years, during which overall national grade 4+ rates for resit learners by the age of 19 exceeded 35%, thought to be due to the use of 'teacher' or 'centre' assessed grades (DfE, 2023). The cumulative impact of continuous failures in mathematics can further erode resit learners' interest and engagement with the subject and create false perceptions about their ability to perform well in mathematics (Johnston-Wilder et al., 2015; ASCL, 2019).

The overall entry 'success' rate (achieving grade 4+) for older students (17+) in England, standing at approximately 16.4% (Golding, 2023), is not promising. However, a breakdown of these figures by age for 2023 is enlightening, revealing a decline in participation across ages 17-19 as students attain their grade 4+, with significant participation from individuals aged 20 and over being predominantly women (Golding, 2023) (see Figures 1 and 2, taken from Golding, 2023).

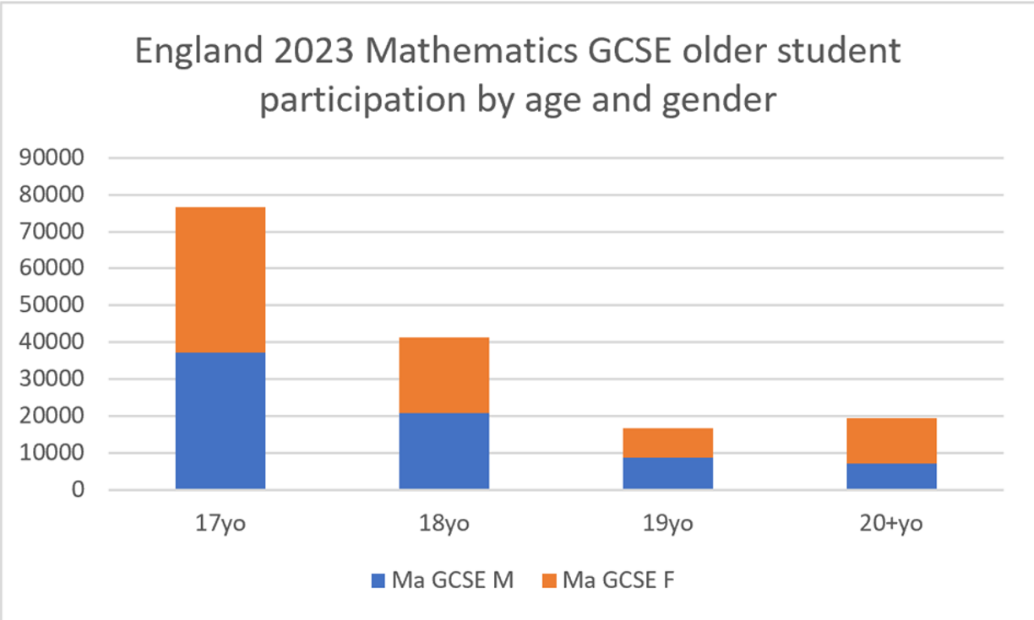



*Figure 1: Participation in GCSE Mathematics 2023 by age and gender*

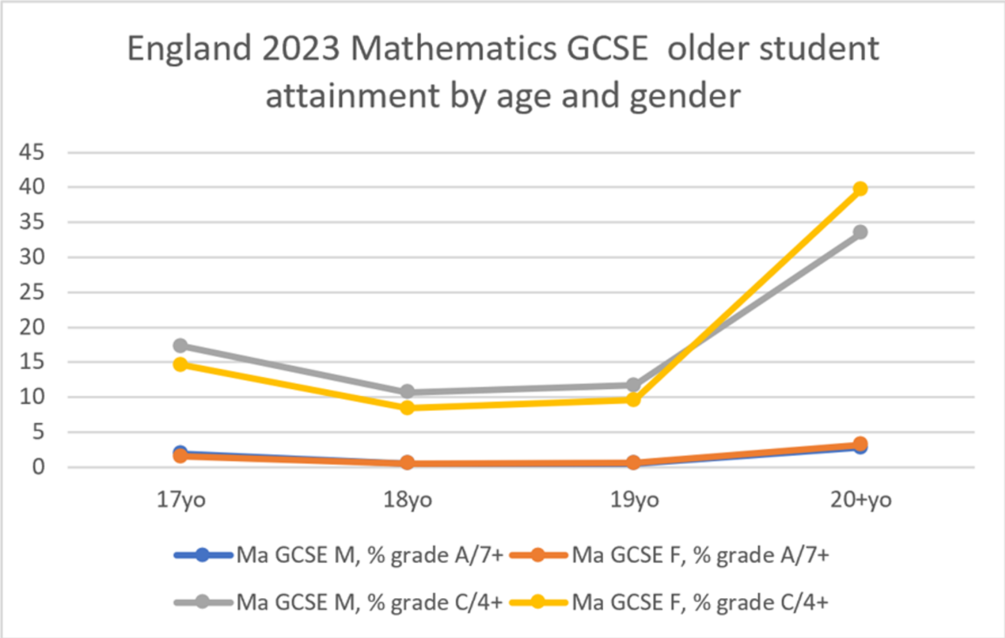



*Figure 2: Attainment in GCSE Mathematics 2023 by age and gender*

In 2023 in England, young male students were slightly more likely to achieve a grade 4+ at ages 17-19, while young female students exhibited a much higher likelihood of 'success' as mature learners, despite their significantly larger participation (Golding, 2023). The characteristics and aspirations of this mature Mathematics GCSE cohort warrant further investigation. Similar trends were observed in 2022 and preceding years. Excluding learners aged 20+, the overall 'success' rate for 16–19-year-olds in England in 2023 was 15.2% (16.3% for 16-19 male and 14.2% for 16-19 female students).

Unfortunately, beyond statistical information about 'success' rates for older resit learners (aged 17+), there is a notable lack in research dedicated to persistent low-attaining resit learners. These individuals are likely the ones who suffer the most due to continuous cycles of examination failures and the development of negative self-perceptions. Recurring experience of failure often manifests as a fixed mindset, leading to various obstacles that hinder the willingness to learn, improve and engage with the subject (Dweck, 2006).

Some of these PLAs make headlines in the news almost every year after GCSE results day. The experience of having to resit the GCSE Mathematics qualification multiple times attracts the attention of news agencies, leading to comments from these learners and statements such as the following (The Standard, 2023; BBC News, 2017):

> *"I've failed my maths GCSE four times. It's horrible because you feel like you're stupid".*
>
> *"You feel like there's something wrong with you. I'm 18, and I'm being put into a class with 15-year-olds [referring to students much younger to the person being interviewed]".*
>
> *"I'm so close and it's so frustrating".*
>
> *"It's almost a slight bit of torture. […] I've tried so hard just to get a letter on a piece of paper"*.

These learners not only exist but also constitute the majority of each year's GCSE Mathematics resit cohorts. My view is that there is a moral imperative for FE providers and policymakers to investigate the factors that lead to a significant number of learners retaking the qualification multiple times as it represents a waste of human potential. Policy makers and curriculum developers should take thoughtful, evidence-based measures considering the potential consequences this cycle may inflict on the well-being of PLAs and their future decisions regarding education and careers.

The focus of the next section is to understand how the GCSE Mathematics curriculum fits into FE and how it currently functions. Another area that is explored is the importance of mathematical word problems in the current GCSE Mathematics curriculum.

## 2.3 Curriculum context: GCSE Mathematics in English further education

### 2.3.1 A review of the 2014 reform

In 2023, Crisp and colleagues published a review of post-16 GCSE resit practice to evaluate the progress of the 2014 policy (Crisp et al., 2023). Some of their findings suggest implications that require further investigation and development. Firstly, the primary obstacle to ensuring resit learners receive high-quality teaching lies in the capacity of FE institutions to attract, retain, and cultivate a highly skilled workforce: effective teaching of these previously 'unsuccessful' students is complex (Dalby and Noyes, 2021). Secondly, the data regarding curriculum coverage and emphasis, along with the inclination towards either a targeted or core curriculum approach, is significant for designing effective interventions for resits. According to Crisp and colleagues' review (2023), while there is widespread acknowledgment of the significance of formative assessment, and various practices, systems and ideas are employed to facilitate assessment for learning, no distinct patterns emerged regarding specific techniques, tools, or assessment systems utilised by FE colleges and maths departments. As a result, maths teachers in FE end up teaching to the test due to limited time and access to resources designed for resit students. However, the CfEM project addressed this issue by designing a set of lesson plans and resources following the teaching for Mastery approach and the needs of resit learners (Wake et. Al, 2023). Lastly, the literature and evidence gathered from Crisp's et al. review highlight the importance of addressing resit learner needs and any negative prior learning experiences by effectively blending academic and socio-emotional approaches (Crisp et al., 2023).

When considering the teaching of GCSE Mathematics in FE colleges, a report from Ofsted (Ofsted, 2012) revealed that due to the limited timeframe of approximately 30 weeks for resit courses, most FE mathematics teachers opt to concentrate their teaching on 'popular' examination topics since the primary goal is to enhance learners' chances of achieving a standard pass. It appears that the emphasis was placed on rote memorisation of mathematical facts and the acquisition of basic mathematical procedures as the primary means to collect marks and achieve a grade 4. This approach is further evidenced in Ofsted (2023) and suggests that high-stakes exams often promote a 'teaching to the test' approach, potentially lacking depth and cohesiveness. This is where the CfEM project's resources have the potential to provide a 'new' approach to teaching mathematics in FE and help teachers rethink about their current practices (CfEM resources can be found here: Research lessons - The Education and Training Foundation).

The tension between 'teaching to the test' and fostering deep mathematical learning is particularly acute in the GCSE resit context. On one hand, the high-stakes nature of the qualification and the short time available encourage a focus on exam practice, procedural fluency, and topic coverage aimed at maximising the likelihood of achieving a grade 4. On the other hand, this emphasis often limits opportunities for learners to engage with mathematics as a meaningful, connected discipline. Word problems exemplify this tension: learners may be trained to identify key words or rehearse set methods in order to collect marks, but this strategy rarely supports the kind of sense-making needed to interpret the context, evaluate the mathematics involved, and transfer knowledge across situations. As Schoenfeld (2016) and Li and Schoenfeld (2019) argue, true problem solving requires grappling with the structure and meaning of mathematical situations rather than applying memorised routines. In this sense, teaching to the test can enable short-term gains but may reinforce the very barriers that resit learners face with word problems. However, approaches that give time and attention to understanding the context of a problem, and to making sense of the underlying mathematics, are more likely to foster the kind of resilient problem-solving skills that learners need both for examinations and for mathematical functionality in everyday life.

### 2.3.2 The need for a reformed curriculum

The debate about the suitability of the current GCSE Mathematics curriculum for resit learners has been a longstanding issue (ACME, 2012; Smith, 2017, Davies et al., 2020). In 2014, a report from the Education and Training Foundation argued for the necessity of an adapted mathematics curriculum in FE that would enable learners to better comprehend and retain mathematical information (ETF, 2014). Although this curriculum would resemble a Level 2 'core maths' qualification, to date no significant changes have been implemented.

A project funded by the Nuffield Foundation and led by Mathematics in Education & Industry (MEI) sought to determine the most appropriate mathematics curriculum for students entering FE without a standard pass in GCSE Mathematics by the age of 16 (Davies et al., 2020). This new curriculum would emphasise mathematics relevant to everyday life and work while maintaining the status and comprehensiveness of the foundation tier GCSE Mathematics. It was built on four key themes: motivation and confidence, progression, relevant content and skills, and the qualifications landscape. It drew upon existing qualifications at the same level, incorporating elements like financial understanding, working with measurements and shapes, activity planning, and interpreting quantitative information (Davies et al., 2020). The project has now been concluded, but it appears that no further action has been taken in response to its recommendations (see A new maths GCSE curriculum for post-16 resit students – MEI). It is worth noting that discussions about the necessity for a more appropriate curriculum for resit learners continue to gain momentum among FE mathematics teachers and educators (Smith, 2017; Noyes & Dalby, 2020a; Norris, 2023). However, the question of which mathematics courses these learners should pursue remains unresolved, and there remains ambiguity concerning the positioning of the various mathematical pathways, such as GCSE or Functional Skills, among these learners (Norris, 2023).

### 2.3.3 Centres for Excellence in Maths

A recent development in FE mathematics has been the introduction of the Centres for Excellence in Maths (CfEM) project in 2018. This research initiative was funded by the Department for Education and overseen by the Education and Training Foundation. Its primary aim was to address challenges related to the teaching and learning of Level 2 Mathematics and assist teachers who teach students resitting GCSE Mathematics in post-16 education. Teachers from 147 FE colleges took part in action research studies which prompted them to try different teaching approaches and explore the struggles of resit students by conducting research, analysing data, and eventually gaining a better understanding of the needs of their resit students. The goal was to support these teachers in adopting new teaching methods that followed the principles of the teaching for Mastery approach (Wake et al., 2023). Teachers from different colleges had the opportunity to work together to conduct these studies and share insights from their own experiences. The project ended in March 2023 and all resources and research outcomes are accessible online for teachers of GCSE Mathematics resit learners to use and adapt in their teaching (CfEM resources and evidence hub - The Education and Training Foundation).

An important outcome of the CfEM project is the development of a free FE Maths CPD course, funded by the Department for Education and available to all teachers of learners aged 16 to 19 years who are working towards achieving grade 4 or higher by resitting GCSE Mathematics or studying Functional Skills Maths (MEI, 2023) (FE Maths CPD Programme - MEI). Another outcome is the inclusion of FE teachers within the Maths Hubs, which now offer training for post-16 GCSE and Functional Skills Mastery specialists (Post-16 GCSE and FSQ Mastery Specialists | NCETM).

The CfEM project was the first robust effort to better understand the needs of resit learners and address the challenges that FE mathematics teachers face. The introduction of a Mastery approach in the teaching of GCSE Mathematics for resit learners aimed to bring fresh ideas, open discussions about pedagogical approaches, enhance the confidence in teachers' subject knowledge and improve learners' mathematical understanding (Wake et al., 2023). However, there is still a long way to go in fully understanding the characteristics of resit learners, particularly those who persistently resit GCSE Mathematics. The promoted Mastery approach, for instance, has been present in the primary and the secondary landscape since around 2014, and it is important to remember that resit learners may have experienced elements of this approach in the past without necessarily being aware or remembering they did. Careful planning is essential when introducing it into the FE mathematics classrooms as teachers need to consider the prior experiences of resit learners and the exposure they previously might have had to various learning approaches. While there is potential promise in applying the Mastery principles and practices (or principles from other approaches) to post-16 contexts, further understanding is needed on how to effectively adjust and implement them in post-16 resit scenarios (Crisp et al., 2023).

### 2.3.4 Word problems as a threshold in GCSE Mathematics

The focus of this section is on word problems (WPs) and their significance in the GCSE Mathematics curriculum. It has been shown that the ability to solve WPs is a core skill for achieving the desired 'standard pass' in examinations. In the National Curriculum of 2014, problem solving had a renewed emphasis at the heart of the curriculum in all stages of mathematics education in England. Adopting a problem-solving approach to teaching and learning mathematics, along with embracing a certain level of struggle, are crucial elements in achieving a broader perspective on school mathematics (Jonas et al., 2020; Hiebert & Grouws, 2007; Schoenfeld, 1985), with implications for learners in FE. However, many learners still appear to have a limited view of mathematics, often associating it solely with procedural tasks and rote memorisation rather than meaningful problem-solving (e.g. Ofsted, 2023). This restricted perspective may stem from an overemphasis on skill drills and exam preparation in traditional mathematics instruction, which can lead students to view mathematics as a set of isolated techniques rather than as a tool for real-world problem-solving (Aquilina et al., 2024). Consequently, when students encounter word problems that require interpretation, reasoning, and a deeper engagement with the material, they may struggle, as these differ significantly from the routine tasks they are accustomed to.

A narrow view of mathematical concepts taught in school has significant implications. It not only affects students' success in exams that require problem-solving but also limits their engagement and motivation in mathematics as they may find difficult to see its relevance to their lives (Li & Schoenfeld, 2019). Developing a richer perspective on mathematics could help learners connect mathematical ideas to various contexts, fostering both skills and confidence (Caviola et al., 2022). Addressing these limitations requires a teaching approach that emphasises conceptual understanding and encourages exploration, positioning mathematics as a dynamic and applicable discipline rather than a series of fixed rules (Golding, 2018).

#### *2.3.4.1 Defining word problems*

From a young age, learners of mathematics are taught to solve word problems of some sort although the definition of those is debated in the literature. Mayer (1982) for instance defines a word problem as a mathematical task that requires the reader to understand a textual description and translate it into a mathematical representation to find a solution. Schoenfeld (1985) on the other hand offers a different perspective, viewing a word problem as an exercise involving the application of cognitive and metacognitive strategies, often requiring heuristics and self-regulation. A more contemporary view by Lesh and Doerr (2003) describes a word problem as a task that involves constructing a mathematical model to represent a real-world situation, thus bridging theoretical mathematics and practical applications. Lastly, Verschaffel and colleagues (2000) define a word problem as a verbal description of a problem situation, where one or more questions are posed, and the answers can be obtained by applying mathematical operations to the numerical data provided.

While various definitions exist for word problems, this study adopts the one proposed by Vondrova and colleagues (2019):

> Word(ed) problems are problems which include some context (real, real-like or imaginary) within which some numerical data are given and others not, and a question (questions) is (are) posed for pupils to answer using the data,

relationships between them inferred from the problem statement, their mathematical knowledge and out of-school experience (p. 184).

This definition was chosen because it aligns closely with the types of WPs learners encounter in GCSE Mathematics assessments. It captures both the contextual aspect of WPs and the integration of mathematical knowledge with contextual reasoning, elements central to this study's focus on how learners react to and approach WPs.

The selection of this definition has several purposes for this research. Firstly, it captures the complexity of WPs in GCSE Mathematics by highlighting the need for students to use reasoning beyond purely procedural skills, thus providing a lens to investigate learners' struggles with this type of question. However, it should be noted that this definition may not fully address cases where context itself becomes a barrier to understanding, or where the distinction between routine and non-routine problems could affect learners' perceptions and strategies. Routine problems can be defined as tasks where students apply known methods to solve problems (Foster, 2023). These are predictable and often used in traditional mathematics teaching. On the other hand, non-routine problems are those for which the solution method is not recognised in advance (Foster, 2023). These require students to engage in problem-solving, as they cannot rely on memorised procedures. When considering the problems students encounter in a GCSE Mathematics examination, the majority would be classified as routine problems with a limited number of non-routine problems appearing mainly on the Higher tier papers.

In the literature on problem solving (PS), a 'problem' is generally defined as a task for which the student lacks a readily available method leading to a confident solution (Schoenfeld, 1985). Such tasks are typically unfamiliar, complex, or possess limited structural clarity. The classification of a task or a question as a problem is thus contingent upon the individual student's perspective and competence (Jonas et al., 2020). However, the term is sometimes employed in a broader sense to denote any mathematical task/question, although with less rigorous criteria. In consequence, the related literature needs careful scrutiny to understand the definitions being used.

### *2.3.4.2 Word problems within the GCSE Mathematics curriculum*

The Department for Education states in all its study programme reports that "the national curriculum of mathematics aims to ensure that all pupils can solve problems by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions" (DfE, 2013a, 2013b, 2014, pp.2-3). The development of this skill through Key Stage 1-4 is essential for learners' preparation for GCSE assessment at the age of 16.

The questions included in a GCSE Mathematics assessment are aimed at examining three fundamental areas: learners' ability to use and apply standard techniques; learners' ability to reason, interpret and communicate mathematically; and learners' ability to solve problems within mathematics and in other contexts (DfE, 2013c, p.13). **Error! Reference source not found.** displays the percentage of assessment questions that assess each of these three areas. For this study, I focus solely on the foundation tier as the resit learners who participated in my study were working on that level.

*Table 1: GCSE Mathematics assessment objectives (DfE, 2013c, p.13)*

| Assessment Objectives (AO) | | Weighting | |
|---|---|---|---|
| | | Foundation | Higher |
| AO1 | **Use and apply standard techniques:**<br><br>Students should be able to accurately recall facts, terminology and definitions; use and interpret notation correctly; accurately carry out routine procedures or set tasks requiring multistep solutions. | 50% | 40% |
| AO2 | **Reason, interpret and communicate mathematically:**<br><br>Students should be able to make deductions, inferences and draw conclusions from mathematical information; construct chains of reasoning to achieve a given result; interpret and communicate information accurately; present arguments and proofs; assess the validity of an argument and critically evaluate a given way of presenting information.<br><br>**Where problems require candidates to 'use and apply standard techniques' or to independently 'solve problems' a proportion of those marks should be attributed to the corresponding Assessment Objective.* | 25% | 30% |

| | | | |
|---|---|---|---|
| **AO3** | **Solve problems within mathematics and in other contexts:**<br><br>Students should be able to translate problems in mathematical or non-mathematical contexts into process or a series of mathematical processes; make and use connections between different parts of mathematics; interpret results in the context of the given problem; evaluate methods used and results obtained; evaluate solutions to identify how they may have been affected by assumptions made.<br><br>**Where problems require candidates to 'use and apply standard techniques' or to 'reason, interpret and communicate mathematically' a proportion of those marks should be attributed to the corresponding Assessment Objective.* | 25% | 30% |

As previously mentioned, achieving the standard pass on the GCSE Mathematics assessment requires achieving grade 4 or above. While assessment boundaries undergo modest annual fluctuations and exhibit disparities across different examination boards, it is observed that in recent years, a foundation tier GCSE candidate is generally required to secure a percentage within the range of 45-60% to attain at least a grade 4.

Referring to **Error! Reference source not found.**, WPs would fall under the second and third AO, although AO2 questions are not all 'problems' according to much of the literature as some require the knowledge of a fixed method or procedure to be solved. Solving WPs demands a range of skills, including reading and mathematical comprehension, problem-solving strategies, the capacity to analyse and break down the problem into smaller steps, making inferences and drawing conclusions based on the given information, and being able to present the solution clearly and concisely (Kirkland & McNeil, 2021; Powell et al., 2020; Njagi, 2015).

Chief examiners' reports often mention the lack of proficiency in approaching WPs. They highlight that learners often manage to secure one or two marks for procedural steps but tend to overlook marks associated with AO2 and AO3 (e.g. Pearson reports, 2017-2023). At Foundation level, students are typically unlikely to acquire the requisite number of marks for a 'standard pass' without being able to adequately answer a range of WPs, and will similarly not feel themselves mathematically competent. Answering WPs therefore represents a 'threshold skill' for the target learners; inevitably FE mathematics departments are responsible for ensuring that resit learners develop this core skill. However, WPs are also 'threshold' in the sense that it is not possible to engage successfully with them without being able to 'make sense of' the corresponding mathematical situation, and that 'sense-making' is key to effective mathematical functioning in adult every day, societal and employment contexts (e.g. Schoenfeld, 2016).

The idea of WPs as a 'threshold skill' in GCSE Mathematics needs to be unpacked. On one level, word problems act as a gatekeeper: learners must show they can work with mathematics in context if they are to achieve a standard pass and progress to the next stage of education or employment. This makes them a high-stakes element of the exam. At the same time, describing them as a threshold skill can risk presenting them as just another barrier to overcome by using techniques such as spotting key words or rehearsing set procedures, rather than truly understanding the mathematics involved. There is therefore a tension between using mathematics in a performative way to 'get through' the exam and developing the deeper understanding that allows learners to use mathematics, and more specifically mathematical thinking, more confidently in life and work. While in some cases exam success may be possible through procedural approaches, this does not mean learners have crossed a genuine threshold of understanding. In this study, the term 'threshold skill' is used with this tension in mind: word problems are both a necessary condition for passing GCSE Mathematics and a potential bridge to deeper mathematical sense-making. Recognising this duality is important for interpreting learners' responses to WPs, and for thinking about how teachers balance the need for procedural efficiency with the need for conceptual growth.

The tension between procedural competence and conceptual understanding is well documented in mathematics education research. Hiebert and Grouws (2007) note that while a focus on procedures can support short-term performance, without links to underlying concepts it may limit deeper learning. Findell, Swafford and Kilpatrick's (2001) framework of mathematical proficiency similarly distinguishes between 'procedural fluency' and 'conceptual understanding', both of which are essential if learners are to progress. More recent research reinforces these distinctions. Ofsted's mathematics research review (2021) and subject report (2023) warn that teaching in England can sometimes over-emphasise exam preparation and routine procedures, at the expense of reasoning and problem-solving. Foster (2023) also highlights the importance of distinguishing between routine and non-routine problems, arguing that success in mathematics depends on developing domain-specific tactics rather than relying solely on general strategies. In addition, Corrêa (2021) extends Findell et al.'s framework, emphasising that all strands of proficiency, including conceptual understanding, procedural fluency, strategic competence and adaptive reasoning, must be developed together to support genuine mathematical growth. Taken together, this research emphasises that while GCSE success may sometimes be achieved through procedural approaches alone, such approaches do not necessarily enable learners to cross the deeper conceptual threshold.

### 2.3.5 Historical research on word problems

In this section, the focus is on the review of the existing literature regarding word problems and the challenges faced by students in the different stages of schooling. The studies I draw upon have predominantly looked at challenges and interventions implemented either in primary or secondary educational settings. No research has specifically explored these issues in a post-16 setting, particularly among learners resitting GCSE Mathematics. However, insights from existing studies may provide valuable context for understanding the challenges resit learners face. It is essential to consider that resit learners have already progressed through earlier stages of the schooling system; thus, many of the difficulties they encounter likely originated years before entering post-16 education. Moreover, it is likely that these challenges were either unaddressed or even unrecognised during those earlier stages.

#### *2.3.5.1 The significance of word problems in mathematics curriculum*

Word problems have consistently held an important position within the realm of mathematics education on a global scale. The long-standing status of WPs raises questions about the values underpinning mathematics education: why has the ability to engage with problem-solving maintained such a high status across time and cultures? Historically, access to mathematical knowledge and specifically to word problems, was often limited to certain societal groups, reflecting broader educational and social hierarchies (Nasir & Cobb, 2007). The content and language of these problems may have been designed in ways that favoured particular learners while excluding others, aligning with the specific needs and skills valued by different societies. Considering who historically had access to these problems and those who did not offers insight into the societal role that mathematics and problem-solving in particular, has played and the ways this legacy might still influence educational practices today.

Over the last five decades, mathematical WPs have been a central focus of research within the field of mathematics education (Riley et al., 1983; Cummins, 1991; Verschaffel et al., 2000; Vincente et al., 2008). These problems are typically recognised as mathematical tasks where relevant information is presented in textual form rather than mathematical notation and the solution can be found by applying mathematical operations to numerical information presented in the problem statement or generated from it, although as above, definitions vary (Daroczy et al., 2015; Verschaffel et al., 2020). They manifest in diverse formats, ranging from simple verbal descriptions of fundamental mathematical operations to more complex problems (Strohmaier et al., 2021).

*Complex WPs* in the literature are those mathematical challenges that typically employ a syntax that is not a direct reflection of the underlying mathematical task, incorporate information that may be redundant or superficial, utilise multiple representations, and are set within a context that serves a functional purpose in the problem-solving process (Strohmaier, 2020). In contrast, *simple WPs* refer to mathematical word problems that adhere to a straightforward, linear syntax and are relatively concise, often consisting of approximately three main sentences, usually seen in primary and low secondary level. These problems frequently pertain to one of the four basic arithmetic operations. While they may contain contextual elements, unlike complex word problems, the context does not play a functional role in solving the problem (Strohmaier, 2020). Examples of complex and simple WPs, constructed by me, are presented in **Error! Reference source not found.**.

*Table 2: Examples of simple and complex Word problems as interpreted by the researcher*

| | |
|---|---|
| **Examples of Simple Word Problems** | A train travels at a speed of 60 miles per hour. How far will it travel in 2.5 hours?<br><br>Tom bought 3 packs of pencils. Each pack contains 12 pencils. How many pencils does Tom have in total?<br><br>A cake recipe requires 200 grams of sugar. If Emily wants to make half of the recipe, how much sugar does she need?<br><br>A group of friends shares a £48 restaurant bill equally. If there are 6 friends, how much does each person pay? |

| | |
|---|---|
| **Examples of Complex Word Problems** | Sarah is decorating a rectangular garden that is 12m long and 8 meters wide with stepping stones. Each stone is circular with a diameter of 0.5 metres. If she needs to space the stones 1m apart, how many stones will she need to cover the entire length of the garden?<br><br>A car rental company charges £30 per day plus an additional £0.20 per mile driven. If Daniel rents a car for 3 days and drives 150 miles, what will his total cost be?<br><br>A farmer has a field in the shape of a trapezium. The parallel sides are 120m and 80m long, and the height is 50m. If he plans to cover the field with fertilizer that costs £0.05 per square metre, how much will it cost to cover the entire field?<br><br>Ahmed needs to mix a cleaning solution that has a concentration of 20% bleach. He currently has 300 ml of a solution with 10% bleach and an unlimited supply of pure bleach. How much pure bleach should he add to achieve the desired concentration? |

#### *2.3.5.2 Word problem challenges over time*

Verschaffel and colleagues (2020) conducted a comprehensive review of the research literature that has evolved over the last 50 years, highlighting several key subjects, inquiries and discussions surrounding the learning and teaching of WPs. The primary research areas have revolved around: (1) the understanding of WPs and how learners interpret the linguistic elements employed; (2) the strategies used to solve WPs; (3) the application of cognitive and metacognitive strategies in tackling complex WPs; (4) the significance of graphical representations in WPs; (5) the link between performance in WPs and broader cognitive abilities, such as working memory capacity and inhibitory skills; and (6) the association between traditional word problems and genuine mathematical modelling tasks.

In the 1980s, research primarily focused on gaining insights into how primary-level students engage with WPs and identifying the challenges they may face. During this period, researchers identified three categories of basic additive arithmetic word problems: those involving change, combination, and comparison (Vincente et al., 2008). Within each category, distinctions were further made based on the nature of the action (increase/decrease) or relation (more/less) and the characteristics of the unknown set (Riley et al., 1983).

Researchers concluded that for younger learners in kindergarten and the early years of primary school, the difficulties in solving these straightforward arithmetic word problems stemmed from limitations in both their conceptual understanding and linguistic proficiency. These limitations hindered their ability to establish connections between the given problem and the requisite mathematical concepts. Notably, these younger learners did not encounter computational challenges; instead, their struggles were attributed to the linguistic complexity of WPs and the incorporation of formal mathematical relations within them (Cummins, 1991).

Participants in my IFS study (Boli, 2020), involving seven GCSE Mathematics resit learners aged 16-18, reported that they were facing similar issues related to linguistic expressions and conceptual comprehension, which contributed to their own difficulties. While much of the literature may not be directly applicable to resit students, since many studies have focused on either primary or secondary learners, it points to experiences they might have encountered previously but not overcome, which may be indicative of possible resit-related challenges.

From the 1990s, research on challenges and issues with WPs developed further to include older primary and/or secondary learners, and consideration of non-routine problems was included (Pongsakdi, 2017). Researchers aimed to identify the challenges that learners face when they are tasked with using non-routine thinking processes for solving WPs. Many had noticed that students were using superficial strategies such as the ‘key word approach’ but could not successfully solve non-routine WPs (Verschaffel et al., 2009). While this strategy may initially appear helpful, it often leads to misunderstandings and incorrect solutions because it oversimplifies the problem-solving process and bypasses the need for genuine comprehension (Riccomini et al., 2016). Similarly, an over-reliance on rote memorisation, where students focus on memorising procedures without understanding the underlying concepts, can limit their ability to apply knowledge in new contexts, resulting in a superficial grasp of mathematics (Liljedhal et al., 2016). In general, some learners display a tendency to adhere to classroom instructions, memorise strategies and try to identify commonalities based on previously learned procedures so they can apply them to non-routine WPs.

The impact of these approaches on learners can be significant. Ineffective strategies often lead to persistent misconceptions and frequent errors, with students struggling to transfer their knowledge to varied or more complex problems (Santos-Trigo, 2024). As a result, they may experience a loss of confidence, particularly if they repeatedly fail to solve problems correctly due to ineffective methods. This loss of confidence can contribute to mathematics anxiety and foster a negative attitude towards the subject (Verschaffel et al., 2009). Furthermore, these approaches fail to cultivate critical thinking or problem-solving skills, making students dependent on specific cues or procedures and leaving them ill-prepared to tackle open-ended or non-routine problems. Over time, such methods can make learning mathematics feel tedious and uninspiring, ultimately reducing students' overall engagement and motivation (Liljedahl et al., 2016).

#### *2.3.5.3 'Real' word problems*

Mathematics WPs are often designed to simulate 'real-world' scenarios, encouraging students to apply classroom learning to practical situations. However, these problems frequently present a simplified or artificial version of reality, sometimes requiring students to disregard certain aspects of the context to arrive at a correct solution. This artificiality raises questions about what constitutes a 'real' problem and whether students genuinely perceive these problems as relevant or applicable. Students frequently overlook their own knowledge about the real world, leading to responses that do not make sense. Numerous studies have highlighted this trend across different schooling levels and countries, where students provide nonsensical answers like "31 1/3 buses are needed" or "4.5 balloons can be bought" (Silver et al., 1993 in Kirland & McNeil, 2021). Some student groups, particularly those facing challenges in mathematics, may struggle with suspending their understanding of reality for the sake of solving the problem. This may have implications for GCSE resit learners, as the ability to navigate or overlook such faux contexts could impact their problem-solving success.

Cooper and Dunne (1998) examined how social class shapes children's responses to mathematics problems within the context of national curriculum testing in the UK, focusing on performance and interpretation disparities among children from different social backgrounds. The study revealed notable differences in how children from various social classes responded to 'realistic' mathematics problems. Working-class children often face greater challenges with these types of questions compared to their middle-class peers, suggesting that test performance may be influenced not solely by mathematical ability but also by cultural and contextual understanding. Their research highlighted that working-class children were less likely to interpret the problem contexts as intended by the test designers, which subsequently affected their performance. This discrepancy did not necessarily reflect a gap in mathematical ability but instead pointed to differences in cultural familiarity with the scenarios presented in the test questions.

Other studies from various countries found that students often disregard the realistic context of word problems while solving them (Kirland & McNeil, 2021). Instead of utilising and applying the knowledge they already have about the world, students typically approach traditional word problems by identifying keywords and then performing computations without fully considering the problem's context (Greer, 1993). This approach persists throughout mathematics instruction (Fitzpatrick et al., 2019; Verschaffel et al., 2010). However, this strategy is unsuccessful when students encounter 'problematic problems' (e.g. A car travels at a constant speed of 150 km/h. How long will it take to travel 600 km if the car never needs to stop for fuel, traffic lights, or any other interruptions?) or non-routine WPs, which deliberately challenge traditional problem-solving methods by creating unrealistic scenarios (Kirland & McNeil, 2021; Verschaffel et al., 1994). Students' struggles with problematic problems are attributed not to developmental limitations but to a classroom culture that promotes a disconnect from the problem's context (Schoenfeld, 1991; Verschaffel et al., 2000). In debriefs following such tasks, students have admitted to either disregarding the context altogether or providing answers simply because it is the expected norm in their mathematics classrooms (Kirland & McNeil, 2021; Verschaffel et al., 2000).

An essential aspect contributing to a deeper comprehension of the text within WPs is the capacity to construct a comprehensive and cohesive mental representation encompassing all relevant elements derived from the problem's context (Boonen et al., 2016; Pape, 2003; Hegarty et al., 1995). In other words, individuals solving WPs need to employ a problem-model strategy, wherein they translate the problem statement into a qualitative mental representation of the underlying problem situation embedded in the text (Van der Schoot et al., 2009). This mental representation subsequently facilitates the formulation of a solution plan and the execution of the necessary mathematical operations. While strong WP solvers often employ such a problem-model strategy by using their mental representation abilities, less proficient WP solvers frequently resort to an impulsive, superficial direct translation strategy. This approach involves solely focusing on selecting the presented numbers, which then serve as the basis for their mathematical computations (Boonen et al., 2016).

#### *2.3.5.4 Numbers versus text*

Empirical research convincingly demonstrates that the semantic structure of WPs significantly influences their difficulty and the problem-solving strategies employed by young children (Pongsakdi et al., 2019). Semantic structure refers to meaningful relations within the known and unknown information given in a (word) problem. The literature indicates that many young children struggle with comprehending the sentences in a WP, whereas older students' difficulties may stem from the overall challenge of forming an integrated representation of the situation described in the text (Pongsakdi et al., 2019).

Numerical factors, including properties of numbers, necessary operations, and the number of solution steps, also contribute to difficulty. For instance, Koedinger and Nathan (2004) (cited in Pongsakdi et al., 2019) explored the influence of decimal numbers on students' performance in solving WPs, finding that problems involving whole numbers are notably easier than those with decimals. However, this difficulty is not exclusive to word problems; research indicates that arithmetic tasks involving decimals pose greater cognitive demands than those with whole numbers in both numerical and word-based formats (Hickendorff, 2021). Additionally, the type of operation required (e.g., addition and subtraction; multiplication and division) affects children's solution approaches and varies significantly in difficulty (Pongsakdi et al., 2019). Different types of arithmetic errors can arise depending on the operation required (Kingsdorf & Krawec, 2014). Furthermore, the number of steps involved in solving a problem also impacts its difficulty. Some problems, for instance, demand mathematical reasoning beyond basic arithmetic, such as combinatorial reasoning, which has been shown to be challenging for young children (English, 2005).

Pongsakdi and colleagues (2019) examined the characteristics of WPs by looking at individual differences in text comprehension and arithmetic abilities, and their connections to solving mathematical WPs. Their study involved 891 fourth grade elementary students aged 9-10 in Finland. The findings revealed a significant correlation between WP-solving performance on both simple and complex WPs and proficiency in text comprehension and arithmetic skills. For simple WPs, students with weaker text comprehension but stronger arithmetic abilities outperformed those with stronger text comprehension but weaker arithmetic skills. However, there were no differences in WP-solving performance on complex items between these two groups, indicating that tackling more challenging WPs necessitates proficiency in both skills.

#### *2.3.5.5 Steps in solving word problems*

Solving WPs can be overwhelming for learners who face mathematical difficulties (Swanson, Orosco & Lussier, 2014). WPs often involve several steps, like reading and understanding the problem, working out which mathematics operations to use, solving the problem, and checking if the answer makes sense (Verschaffel et al., 2000). Without proper instruction, many learners might just look for keywords in the problem and add or subtract without really understanding the mathematics involved (Van Dooren, De Bock & Verschaffel, 2010; Verschaffel et al., 2000).

Less successful learners in mathematics may also struggle with irrelevant information in the WP (Jarosz & Jaeger, 2019). They might pick the wrong mathematics operation and make mistakes in calculations (Sharpe, Fults & Krawec, 2014). WPs become even more challenging when multiple steps or operations are needed (Boonen et al., 2016). Due to these difficulties, some learners often benefit from targeted interventions and instructional strategies designed to improve problem-solving skills (Schumacher, Zumeta Edmonds & Arden, 2017). Such interventions include explicit strategy instruction, where students are taught to break down word problems into manageable steps, and schema-based instruction, which helps learners identify the underlying structure of different types of problems to determine the appropriate solution path (Verschaffel et al., 2020). Additionally, visual supports like diagrams or graphic organisers can aid in organising information, reducing cognitive load, and enhancing comprehension of multi-step problems. Explicit teaching, however, when not carefully implemented, can indeed lead to a rigid application of learned procedures without fostering deeper understanding or adaptability.

The process of solving WPs is complex, often involving several distinct phases, as indicated by existing research (Montague et al., 2014; Verschaffel et al., 2000). In their review, Depaepe and colleagues (2015, cited in Pongsakdi, 2017) analysed various descriptions of the word problem-solving process provided by different scholars (Blum & Niss, 1991; Burkhardt, 1994; Mason, 2001; Verschaffel et al., 2000) and concluded that it essentially consists of six phases that may not always be performed in the below sequence: 1) comprehending and defining the problem situation, leading to the creation of a situational model; 2) formulating a mathematical model based on the established situational model; 3) executing the mathematical model to derive mathematical outcomes; 4) interpreting the outcomes in relation to the original problem situation; 5) assessing whether the interpreted mathematical result is suitable and logical for the intended purpose; and 6) conveying the obtained solution for the initial word problem.

Intaros, Inprasitha and Srisawadi (2013) investigated the strategies six first-grade learners followed when asked to solve open-ended WPs and share their approaches in whole class discussion. Their results showed that participants used one or more of the following strategies: working backwards, finding a pattern, adopting a different point of view, solving a simpler or similar problem, using visual representations, using approximation, organising the data, using logical reasoning, and accounting for all possibilities. Each of these strategies, while valuable, introduces unique challenges that can become stumbling blocks for learners, especially as they move from one stage of schooling to the next. Chen and Kalyuga (2020) argue that effective instruction should explicitly teach each strategy as part of a teaching routine, emphasising when and how to use each approach based on the context of the problem. Scaffolded practice, where learners receive support in choosing and switching between strategies, can help develop adaptability and a deeper understanding of problem-solving methods. For learners who may not have encountered such diverse strategies, introducing these approaches gradually and reinforcing their practical applications in varied contexts can foster confidence and versatility in problem-solving (Singh et al., 2023).

#### *2.3.5.6 Conclusion*

The necessity for further research concerning GCSE Mathematics resit students and the WP learning experience they receive while in FE is evident. While efforts have been made to understand their characteristics, greater attention is required to understand the factors that contribute to a continuous cycle of examination failures. My study seeks to contribute to filling this gap by investigating the approaches employed by these students when working towards solving WPs, which are recognised as pivotal skills when it comes to examination performance.

In the next chapter, I will outline the methodology adopted to explore this question in the context of my own FE college.

It is important to highlight that most existing research on WPs and the challenges learners encounter has focused on primary-level students, with increasing attention given to secondary-level learners. While the findings of these studies may not be directly applicable to my research, they do shed light on potential sources of difficulties that resit learners may encounter, particularly if they have experienced inadequate development of mathematical understanding during earlier stages of their education. My experience as a classroom teacher of resit learners and discussions with colleagues indicate that the target group presents limited arithmetic and linguistic skills and has not developed the internal processes required to solve demanding WPs.

Through my review of the literature, it is evident that there is a notable absence of research addressing the difficulties experienced by individuals who are resitting a mathematics qualification, both within an English and an international educational context. This is an area that requires further exploration as solving WPs is a threshold skill for the GCSE Mathematics examination.

In the last two decades, researchers have increasingly shifted their focus towards exploring the significance of beliefs and motivational variables that might influence learners' performance in WPs. It is now widely acknowledged that learners' beliefs about their ability to solve problems and their motivation levels have a significant influence on mathematical learning and problem-solving (Schoenfeld, 1991; Jiménez & Verschaffel, 2014, Hannula, 2018). These aspects and their impact on learning are further explored below.

## 2.4 Self-perceptions and affective issues in mathematics education

Since the 1980s, there has been a significant upsurge in the exploration of attitudes, beliefs, motivation, and identity within the field of mathematics education. Extensive efforts have been made to formulate comprehensive definitions of these interconnected concepts and to grasp their influence on learners' mathematical learning (Hannula et al., 2016). Initial comprehensive research into the emotional aspects of mathematics, particularly mathematics anxiety, can be traced back to the 1970s, originating within the domain of social psychology

(Hannula, 2014). This increased interest and research have allowed educators to gain a deeper understanding of the psychological factors at play in mathematics education, helping them to develop more effective strategies for teaching and supporting learners.

### 2.4.1 Self-image and self-efficacy

The significance of self-related perceptions or beliefs in education research has grown considerably due to their influence on students' engagement with learning and academic achievements (Yan et al., 2023). A learner's self-perceptions include various facets of their self-conception within an educational context. These facets involve their self-image, which pertains to how they view themselves in the learning environment; their self-efficacy, reflecting their belief in their abilities in specific subject areas; and their self-esteem, which denotes the level of confidence they hold regarding their competence in those subjects. These self-perceptions play a pivotal role in shaping a learner's overall experience and performance within the educational system.

Additionally, they influence a learner's motivation, willingness to tackle challenges, and their ultimate academic and personal growth. The beliefs that children form, develop, and believe about themselves play a crucial role in determining their achievements or setbacks in all aspects of life (Pajares & Schunk, 2002; Hannula, 2018). This is especially significant for educators, as these self-beliefs can influence a learner's performance in school, leading to either success or failure.

Self-efficacy refers to an individual's confidence in their ability to perform the actions required to achieve certain performance goals (Bandura, 1997). It represents the belief in one's capability to influence their own motivation, actions, and interactions with others. These self-beliefs around one's abilities affect various aspects of the human experience, such as the goals a person pursues and the effort they invest in reaching those goals. Self-esteem, on the other hand, can be described as the extent to which learners experience satisfaction with themselves and feel valuable and worthy of respect (APA, 2023). Both self-esteem and self-efficacy are essential for encouraging learners to engage with positive learning behaviours and to recover from setbacks and challenges (e.g. this research's target group).

Research presented in previous sections has shown that resit learners encompass low motivation and have a negative self-image as mathematics students, which impacts their engagement with mathematics and acts as barriers for further progression. There are indications that students may be avoiding involvement with mathematics to shield themselves from the potential consequences of repeated failure without feeling personally empowered or in control (Ashcraft & Krause, 2007). Mathematics anxiety has been identified as a noteworthy factor contributing to both academic underperformance at all educational levels and a reluctance to pursue further studies in mathematics (Caviola et al., 2021; Johnston-Wilder et al., 2015). In certain extreme instances, parents have insisted on their children being removed from post-16 mathematics courses due to the distress experienced at home (Johnston-Wilder et al., 2015).

When self-esteem is low or confidence is lacking, learners tend to question their capacity to succeed, leading to hesitancy in engaging in the learning process and taking necessary academic risks (APA, 2023; Zhao et al., 2021). Building and reinforcing self-esteem often occurs through engaging in commendable actions and accomplishments, even those of a small scale, and leads to increased motivation. A learner's motivation can be shaped in part by their past educational experiences, previous examination results, and their future aspirations (Cook & Artino Jr., 2016).

Mathematics self-perceptions reflect the personal beliefs of students. These beliefs are not only tied to their mathematical performance throughout their lives but, once established, also have a significant and autonomous influence on the ongoing development of their mathematical skills and competencies (Pitsia et al., 2017; Hannula et al., 2016; Bandura, 1997). While these beliefs are somewhat influenced by a learner's past performance in mathematics, they also shape how learners approach mathematical challenges and engage with the subject (OECD, 2013).

How learners perceive themselves and their emotions significantly shapes their behaviour, especially when they encounter challenging situations (Hannula et al., 2016; Bandura, 1997). Mathematics self-perceptions have a multifaceted impact on learning and performance, affecting various aspects including cognition, motivation, emotions, and decision-making. In relation to resit learners, these perceptions determine how effectively they motivate themselves and persist when they face difficulties, impact their emotional well-being, and influence the choices they make regarding engagement with coursework, avoidance in attending classes, and even their future educational and career paths.

### 2.4.2 Mathematics anxiety

Skemp (1987) argues that anxiety undermines the effectiveness of mathematical cognition. It functions as a 'mental blockage' or 'mental paralysis', preventing individuals from making any progress on the mathematical tasks on which they are working. Research has demonstrated that the transition from primary to secondary school is accompanied by the highest levels of anxiety, with mathematics being the primary source of concern during this transition (Carey et al., 2019; Noyes, 2007). Numerous empirical studies have identified a consistent association between mathematics anxiety and academic performance, suggesting that mathematics anxiety tends to result in reduced performance when individuals engage in mathematical reasoning or problem-solving tasks (Zhang et al., 2019).

### 2.4.3 Anxiety and academic performance

The research findings of my IFS study revealed that students' feelings of anxiety extend beyond the classroom, resulting in mental blockages that hinder performance during formal examinations (Boli, 2020). Participants mentioned that while they experience a sense of progress when working on class assignments, they struggled to apply what they believed they had learned during examinations. Based on my experience with resit learners, it is evident that it is not only mathematics anxiety that contributes to mental paralysis, but gaps in knowledge and an underdeveloped capacity to solve mathematical problems can further hamper examination performance. These two states can feed each other, placing students in a vicious cycle of persistent low attainment.

Denscombe (2000) found that examinations were a primary source of stress for young people, even more than other worries they faced at that stage in their lives. This examination-related stress was linked to psychological problems. When young people experienced this stress, they became more anxious, more prone to neurotic behaviour, and had physical symptoms like high blood pressure (Matthews, Deary & Whiteman, 2003). Beilock (2008) noted that stress could hinder cognitive abilities, reducing the amount of working memory available for tasks during an examination. This condition might cause individuals to forget information and feel less prepared for the examination (Chamberlain et al., 2011 in Roome & Soan, 2019). In addition to external sources of exam-related stress, it is important to consider internal factors. GCSE learners observe that such examinations, along with their outcomes, are seen as a measure of who they are, essentially serving as a self-concept indicator (Denscombe, 2000). Reay and Wiliam (1999), drawing on data from focus groups and individual interviews with pupils in the term leading up to Key Stage 2 National Curriculum tests, highlight how assessments can significantly impact children's self-perceptions and identities, with many students viewing the results of these tests as definitive statements about their abilities and worth.

Harlen and Deakin-Crick's (2002) review concluded that the educational curriculum and classroom activities aimed at preparing learners for examinations could increase the stress associated with examinations. This increased stress, in turn, could discourage and demotivate students from learning (Roome & Soan, 2019).

### 2.4.4 Teachers' beliefs and behaviours

Teachers' beliefs and their use of WPs in mathematics classrooms are regarded as another factor contributing to learners' superficial problem-solving strategies when neglecting real-world knowledge and realistic considerations in the modelling/solving process (Verschaffel et al., 1997). It is presumed that teachers' beliefs and their actions in mathematics lessons play an essential role in encouraging or hindering students to see the importance of learning mathematics in context and to take realistic considerations into account (Pongsakdi, 2017). However, since the reforms of the late 1980s, the utility of mathematics and the importance for students to learn to apply it in everyday life have been emphasised in the National Curriculum (Morgan & Tang, 2016), even if they have not been fully reflected in GCSE examination papers.

Research suggests that teacher beliefs influence not only whether WPs are valued in lessons but also how they are presented to learners. Teachers who view WPs mainly as tools for practising calculations often simplify them to extracting numbers, which can reinforce superficial strategies (Depaepe, Verschaffel & Kelchtermans, 2016). On the other hand, teachers who see value in realistic reasoning are more likely to support learners in drawing diagrams, estimating, or comparing approaches, which provides richer opportunities for problem-solving and sense-making (Boaler, 2002; Schoenfeld, 2016).

These differences in practice show how teachers' pedagogical approaches directly shape classroom culture. When WPs are reduced to routine procedures, students may perceive them as irrelevant or disconnected from real life. However, when teachers emphasise reasoning and modelling, learners are more likely to experience WPs as meaningful applications of mathematics. This balance between procedural focus and contextual understanding remains a central challenge in mathematics education and is particularly important for resit learners, who may already have limited confidence in applying mathematics outside of formal procedures.

Moreover, a study conducted by Li, Bergin and Olsen (2022) revealed that learners demonstrate higher engagement with academic subjects when their teachers exhibit soft skills, including kindness, compassion, and a genuine concern for others, in addition to teaching the conventional hard skills of reading, writing, and numeracy. The same study utilised archived data from a teacher evaluation system in the United States, showing that positive teacher-student relationships not only lead to increased student engagement but also encourage teachers to invest greater effort in delivering high-quality lessons, thereby enhancing the overall learning experience of their learners (bidirectionality between positive teacher-student relationships and high-quality teaching practices). The findings from my IFS study indicate that when teachers express confidence in their learners' mathematical abilities and convey a sense of care, it motivates learners to invest effort and be more inclined to improve their mathematical skills (Boli, 2020).

Taken together, these findings suggest that teacher beliefs, classroom practices, and relationships work in combination to influence how students experience WPs. Beliefs about the purpose of mathematics guide classroom choices. Practices determine whether problems are used as opportunities for reasoning or simply for procedural calculations (Swan, 2006). And finally, teacher-student relationships shape how learners respond to the demands of the task. In the resit classroom, this triad of factors becomes especially significant, as teacher expectations and care can either reinforce negative prior experiences of mathematics or help to challenge and reshape them (Noyes, 2009). This means that teachers' approaches towards WPs are not just background factors but play a central role in enabling or constraining learners' opportunities to rebuild confidence and develop more resilient problem-solving approaches.

## 2.5 Conclusion

This chapter demonstrates several gaps in understandings of GCSE Mathematics resit learners, particularly those enrolled in Further Education. It is evident that there is limited research focusing specifically on the challenges faced by resit learners when engaging with WPs. While primary and secondary education contexts have been extensively studied, there is very limited data addressing the post-16 resit learners' experiences and strategies in dealing with WPs, a key component of the GCSE Mathematics curriculum.

Additionally, the subset of learners identified as persistent low attainers – those who resit the GCSE Mathematics examination multiple times without achieving a standard pass – has not received sufficient research attention. This group represents a significant proportion of the resit cohort, yet their specific educational trajectories, emotional responses, and coping mechanisms remain underexplored. Understanding these learners' interactions with the mathematics curriculum and their affective responses, such as self-efficacy and anxiety, is crucial for developing targeted interventions.

Without understanding the specific challenges faced by resit learners, particularly in relation to WPs, educational strategies may remain generic and ineffective. This oversight potentially leads to cycles of failure, contributing to disengagement and negative self-perceptions among learners. Moreover, the lack of focus on persistent low attainers means that educational policies and practices may not be adequately tailored to support those who struggle the most, thereby missing opportunities to break the cycle of low attainment.

My study aims to address these gaps by looking at some of the challenges resit learners encounter with WPs, examining their problem-solving strategies, and exploring the affective dimensions that influence their learning experiences. Through an exploration of these areas, this research will provide insights into the educational needs of resit learners. It will contribute to the field by highlighting the necessity for tailored pedagogical approaches and informing policy recommendations that can enhance the effectiveness of resit programmes in FE settings.

By focusing on these under-researched areas, this study will not only expand the existing body of knowledge but also offer practical implications for educators and policymakers who aim to improve outcomes for GCSE Mathematics resit learners. The insights gained will be instrumental in shaping interventions that are both empathetic to the learners' experiences and effective in fostering their academic success, thereby underscoring the value of this work to the broader educational community.

# Chapter 3: Methodology

In this chapter, I first set out the ontological and epistemological lenses underpinning my research, which are framed within an interpretivist paradigm. This provides the foundation for my research design, with a particular focus on the centrality of learner voice to this study. I also explain the adoption of an exploratory approach with short narratives. I then show how the research design evolved, analysing each of its components in turn, and describe how I approached the analysis of the resultant data. Finally, I discuss the related ethical considerations and the approach I adopted to address them.

## 3.1 Ontological and epistemological lenses through interpretivism

My choice of methods was shaped by my ontological and epistemological beliefs – specifically, my understanding of reality as socially constructed and my view that knowledge is developed through individuals' interpretations of their experiences. Rather than seeking to establish causation, I value understanding experiences, attitudes, and approaches, recognising that multiple subjective realities exist. Given this, it is crucial to capture resit learners' perceptions and narratives to better understand their experiences, actions, and needs in mathematics education.

Interpretivism, which underpins this research, emphasises how individuals construct meaning through interactions with their social world (Glesne, 2016). In this study, I explored the experiences, attitudes and approaches related to WPs that GCSE Mathematics resit learners in two FE colleges have developed throughout their educational journey in England, as well as the views of teachers about the teaching of WPs and their understanding of their students' challenges with WPs. The experiences shared by student and teacher participants – through surveys and a revision workshop – reflect their personal interpretations of these experiences.

Rooted in the belief that knowledge is co-constructed, interpretivism provides a lens for examining the complex realities of the post-16 GCSE Mathematics resit education landscape. Conversations with learners, colleagues, and fellow researchers have reinforced my understanding that perceptions of a situation can vary significantly from person to person, shaped by both internal and external influences. In this sense, social and educational realities are not fixed but emerge through the meanings individuals ascribe to them (Zajda & Zajda, 2021). My adoption of an interpretivist approach aligns with this perspective, enabling a deeper exploration of how resit learners navigate their mathematical learning journeys.

As an interpretivist researcher and curriculum manager, I seek to recognise the unique interpretations and meanings that the research participants and people I work with give to their experiences and interactions with others and situations. If any relationships or patterns exist my aim is to try to elucidate the ways in which they manifest and the conditions under which they occur (Lin, 1998). My goal is not to uncover universal, context-independent knowledge and truth, but rather to understand something of how individuals interpret and make sense of the social phenomena they engage with (Rehman & Alharthi, 2016). My emphasis using an interpretivist's lens is on the human experience, its richness, variety, complexity, and subjectivity and volatility. In my role as a manager, this means valuing the perspectives of my team members and fostering an environment where their experiences and insights are not only acknowledged but actively shape decision-making processes. I approach management with the belief that understanding the diverse realities of individuals, whether students, teachers, or colleagues, is key to creating meaningful and effective solutions to the challenges we face. The interpretivist lens has provided me with a unifying approach to both of my roles, enabling me to prioritise understanding and meaning-making in both my professional and academic work.

Additionally, the subjective nature of this approach, which can heavily depend on qualitative methods, introduces the potential for researcher bias (Hassan, 2023). The interpretation of the data from the workshop and the surveys was almost certainly influenced by my own perceptions, beliefs, and assumptions, thereby affecting the replicability of the research. This is something that as an interpretivist researcher I fully recognise and take into consideration when presenting the findings; steps taken to enhance the trustworthiness of the research are discussed below. Exploratory research tends to lack the rigour associated with more structured methodologies, such as experimental research, so raises questions about the validity and reliability of the outcomes (Hassan, 2023) or their qualitative counterparts. Instead, 'trustworthiness' (Amin et al., 2020; Anfara et al., 2021) is privileged in this research (as expanded on in 3.6.4).

In this research, participants shared their experiences with mathematics and WPs as they perceived and interpreted them. At each stage of the study, open questions were used to stimulate their thinking and memories without leading their responses. There was no specific hypothesis, only an underlying understanding that GCSE Mathematics resit students often struggle with solving WPs. As I further explain in 3.4, a multiple-methods approach was employed to collect data even though my underlying approach used an interpretivist lens. This approach was chosen to build a robust contextual understanding of who the sample resit students are, why they behave the way they do, and how they respond to the challenges of solving WPs. Surveys, closed questionnaires, and numerical data alone are sometimes insufficient because they cannot explore the complexities and dilemmas of the highly complicated social world in which we live (Richards, 2003) – but they can serve as the basis for further exploration, and findings can also be indicative of wider patterns and generalities.

As with any research paradigm, interpretivism has limitations and has faced considerable criticism. It is often contrasted with positivism, which relies more on a quantitative research approach. The primary limitations – and thus the criticisms – stem from its lack of unproblematic generalisability, its subjective nature, and the difficulty in establishing causality (Nickerson, 2022). However, I would argue that interpretivists do not usually aim to produce generalisability but rather seek to understand a specific phenomenon within its contextual framework; that understanding might or might not be indicative of wider situations. To gain a deep understanding of the target phenomenon, it is essential to consider the subjective interpretations of its participant but also the subjectivity of the researcher. Finally, this approach is particularly well-suited for exploring 'how' and 'why' questions, rather than identifying 'what' causes a particular phenomenon (Denzin et al., 2023). To address these concerns, I followed the framework proposed by Guba and Lincoln (1985), which provides a comprehensive analysis of the trustworthiness criteria researchers should consider when conducting qualitative research - credibility, transferability, dependability, and confirmability – in section 3.6.

## 3.2 The importance of learner voice

An early concern in my research was to place students at the centre and listen to their version of the 'story'. It was important for me to understand how they had experienced certain aspects of mathematics education and to explore how and why they believe they behave the way they do when it comes to solving WPs. It was therefore crucial to prioritise the student voice and provide them with the space and time to share their experiences as they lived and perceived them.

Over the past five years of conducting research, my focus has revolved around my learners' perspectives. I have a genuine desire to gain a deeper understanding of how they perceive the learning of mathematics, the assumptions they have formed regarding the significance of education, and the roles they have assigned themselves within the mathematics classroom. Drawing from my experience, I am aware that as an educator, I have employed various pedagogical and interpersonal strategies over the years to help my resit learners engage with mathematics and cultivate more effective learning habits. What has contributed significantly to the success of some of these strategies is the input I have received from my learners. Typically, in my experience, learners are willing to contribute to resolving the challenges they encounter when they are asked to be actively involved. Therefore, learner voice was at the core of my research methodology.

The authentic voice of learners themselves is a powerful and often underutilised resource in mathematics education research, particularly in the FE space. The current academic literature regarding learner voice places a strong emphasis on its potential benefits in educational research and reform, ultimately enhancing both our theoretical knowledge and practical insights (Cook-Sather, 2006; Robinson & Taylor, 2007; Harfitt, 2014). I argue that the voice of those learners who, for various reasons, have not been able to attain a 'standard pass' (GCSE Grade 4+) during their educational journey, is of great importance. Learner voice can offer the invaluable insights, experiences, and opinions of those at the heart of the educational process – the learners. Learners can shed light on their perceptions of teaching methods, curriculum design, and classroom dynamics in a way that quantitative data alone cannot always capture (Bragg, 2021).

Learner voice in educational research is essential for several reasons. First, actively involving learners in the research process fosters a sense of empowerment and engagement, which can lead to increased motivation and ownership of their educational journey (Walker & Longan, 2008). This involvement also enables educational practices and policies to be more effectively tailored to meet the specific needs of learners, potentially resulting in improved academic outcomes and personal development (Walker & Longan, 2008; Bragg, 2021).

Second, incorporating learner perspectives ensures that decision-making in education becomes more inclusive and democratic, contributing to a more equitable learning environment where all voices are acknowledged and valued (Cook-Sather, 2006; Bragg, 2021; Gillet-Swan & Baroutsis, 2024). For educators, listening to learners offers valuable insights into teaching practices, promoting reflective practice and enabling adjustments to improve the learning experience (Gillet-Swan & Baroutsis, 2024). Finally, learner voice initiatives have the potential to shape educational policy and practice, making them more responsive to the actual needs and experiences of students (Cook-Sather, 2006).

I have shown in chapter 2 that the needs and characteristics of GCSE Mathematics resit students remain underexplored. Engaging these students in the process of understanding their learning identities, their perceptions of their educational journey (both mathematical and otherwise), and their specific needs for improving their mathematical skills and knowledge is crucial for developing effective solutions and addressing their challenges. The findings of this study aim to contribute to the existing academic knowledge and help shape future educational decisions within the FE sector.

Since my aim was to contribute to the limited existing knowledge surrounding post-16 GCSE Mathematics resit learners and their experiences, attitudes and approaches towards WPs, an exploratory approach in designing my research study allowed me to explore, discover and generate insights rather than test specific hypotheses or establish causation (Swedberg, 2020). I set out to better understand the experiences and challenges resit learners have in solving WPs as a critical ‘threshold skill’ at GCSE level. These challenges had not been clearly and comprehensively evidenced or analysed by the research community at the time this research study was conducted. Therefore, my purpose was both to contribute to the limited knowledge in this area and to directly contribute to enhancing the teaching and learning of the GCSE Mathematics resit programme in the college where I was employed at the time.

## 3.3 An exploratory approach with short narratives

The exploratory approach stands as a dynamic and transformative methodology that can bring fresh insights and perspectives to the forefront (Swaraj, 2019). Rooted in the spirit of curiosity and a commitment to uncovering novel facets of educational phenomena, the exploratory approach offers researchers a powerful lens through which to view complex educational issues, including that of GCSE Mathematics resit learners and the challenges they might have faced throughout their mathematical learning. It is a journey of discovery, where the destination is not predetermined but is illuminated by the pursuit of knowledge and the desire to gain a better understanding (Smith & Rebolledo, 2018). The exploratory approach is characterised by a small number of in-depth data collection events that explore the selected area and suggest possible commonalities as well ranges of experiences, followed by a larger-scale approach that analyses the degree and patterns of prevalence of such findings (Swedberg, 2020).

According to Mbaka and Isiramen (2021) exploratory research is appropriate when a phenomenon is not well understood, or a research problem lacks clear definition. They suggest that while this approach often generates ideas or hypotheses, it is primarily used to gain a deep understanding of human behaviour, experiences, attitudes, intentions, and motivations. This understanding is based on observation and interpretation, aiming to uncover how people think and feel.

In my case, the challenges faced by GCSE Mathematics resit students with WPs represented a research phenomenon that had not been previously explored. As highlighted in Chapter 2, most of the existing literature focuses on primary and secondary education concerning students' challenges with WPs. Exploration of this issue in an FE college required careful steps to first understand its origins and ultimately find ways to address it.

I first reviewed the current research, which although limited for my target group, suggested a possible research methodology. Next, I turned my focus to the students in college A, exploring their experiences with mathematics and WPs as well as their behaviour patterns when working on WPs. I also approached the FE mathematics teachers in the college, inquiring about their teaching approaches regarding WPs and the challenges they believe their resit students encounter in the classroom.

This process involved the collection of data through a small-scale student workshop, a teacher survey, and a larger-scale student survey. Each method was preceded by a pilot version to enhance its quality. The information gathered from the teacher survey and the workshop informed the development of the learner survey, which incorporated both quantitative and open-ended questions to balance breadth with depth. For reasons explained below, aspects of the approach were then replicated in College B. The selection of methods was guided by the paradigm of interpretivism and the importance of bringing the learner voice to the forefront of the research. As a result, the findings are not unproblematically generalisable but are likely to be indicative of a range of experiences and challenges for learners in similar contexts elsewhere. Adopting an exploratory research approach inevitably involves certain limitations. One of the primary concerns is, as suggested, the limited generalisability of the findings (Hassan, 2023). Given that this exploratory research was conducted in only two FE London colleges, the results may not be applicable to a broader population but could give an indication of further studies needed.

The data were collected in two London FE colleges, College A (in March 2023) and College B (in March 2024). My role in both colleges was to manage the provision of Functional Skills and GCSE Mathematics. The initial design included participants from College A but my employment in College B in January 2024 highlighted the value of involving College B –for example in exploring commonalities and differences between the two in the focus area. After receiving further ethical approval from IOE, teacher and student participants from College B were only asked to answer the teacher and student surveys, respectively.

In College A, a small-scale revision workshop was also conducted to gather initial data and lay the foundation for developing a larger-scale student survey. A portion of the workshop was designed to allow participants to share short narratives, either verbally or in written form, about their experiences with mathematics and their approaches to solving WPs. Further details about the design and purpose of the revision workshop are provided in section 3.4. I chose to include students' narratives because they can provide a rich and contextualised lens through which to explore the complexities of mathematical learning, teaching, and identity formation (Boaler, 2002; Sfard & Prusak, 2005).

Just as there are multiple ways to solve a mathematical problem, there are multiple voices and narratives within any sub-field of mathematics education. By embracing this multiplicity, I recognise that diverse perspectives enrich our understanding of educational phenomena and help us find solutions to improve our teaching practice and make learning more approachable (Cohen et al., 2018). My intention was to uncover nuanced and personalised, perhaps idiosyncratic accounts of relationships with WPs, thus primarily qualitative methods were initially appropriate. Nevertheless, I adopted a multiple-methods approach with a primary emphasis on the qualitative component as presented in the following section.

## 3.4 Research Design

**Error! Reference source not found.** presents the timeline for data collection and analysis of this study.

*Table 3: Timeline of research methods*

| Time Period | Action | Comment |
|---|---|---|
| October 2022<br>(College A) | **Planning for the Focus Group Semi-Structured Interviews**<br>• Recruitment and selection of participants from GCSE resit teaching groups.<br>• Pilot conducted and questions refined for the focus group. | Plans to run a focus group were cancelled after students expressed discomfort with participating in group discussions about their experiences in mathematics. Instead, a revision workshop was developed to replace the focus group, providing a more familiar and comfortable setting for students to discuss their experiences with mathematics and word problems. |
| November – December 2022<br>(College A) | **1. Researching on the use of workshops for collecting data**<br><br>**2. Online Teacher Survey (n=5)**<br>• Distribution of teacher survey.<br>• Analysis of teacher survey. | 1. A paper by Treloar and colleagues (2017) on nursing, was identified and used as a guide for developing the student revision workshop.<br><br>2. Five out of six teachers responded to the survey and their responses informed the development of the online student survey. |

| Time Period | Action | Comment |
|---|---|---|
| January – February 2023 (College A) | **Planning and conducting the revision Workshop (n=12)**<br>• Pilot workshop was conducted with a GCSE resit group.<br>• Text message was sent to all GCSE resit students advertising the workshop.<br>• Revision workshop was conducted.<br>• Workshop data analysed.<br>• Online student survey developed. | The revision workshop was open to all GCSE resit students, with a threefold purpose: to collect data for research, present various methods for solving word problems, and provide practice on exam questions. |
| March 2023 (College A) | **Online Student Survey (n=112)**<br>• Pilot student survey conducted with a GCSE resit teaching group.<br>• Pilot data analysed.<br>• Final version of student survey refined.<br>• Fina student survey distributed to the remaining GCSE resit groups. | The online student survey was distributed during lesson time, in agreement with the teachers, to maximise participation. A week later, a text with the survey link was also sent to all GCSE resit students, allowing those who were absent an opportunity to complete the survey.<br>A total of 112 out of 412 students completed the survey. |
| June – August 2023 (College A) | **1. Analysis of the online student survey from College A**<br><br>**2. Development of findings from College A** | |
| March 2024 (College B) | **1. Online Teacher Survey (n=5)**<br><br>**2. Online Student Survey (n=37)** | The researchers' relocation to a new college in January 2024 enabled additional findings to be generated through the involvement of a second student cohort. Both teachers and GCSE resit students participated, although student participation was lower than at College A, with 37 out of 279 students completing the survey. |
| May – June 2024 | **Analysis of the teacher and student online surveys from College B** | |

My original intention had been to collect initial data through focus groups with participants from my own teaching groups in College A. During the focus groups, resit learners would have had the opportunity to share experiences with mathematics and approaches to WPs through semi-structured interviews. However, when asked to voluntarily participate, my learners expressed a reluctance to taking part in the focus group. Curious about why my learners were reluctant to participate in the focus group I asked for feedback to help me find an alternative way of collecting data. Out of the 15 learners, ten claimed that they felt shy or even anxious discussing their previous experiences in front of others, though they also volunteered that they would be content to discuss them in a one-to-one setting. I sought this feedback in mid-October 2022, at a time when learners were still getting to know each other as they came from different vocational areas within the college. I respected their decision. Although individual interviews were an option (my 'plan B'), I still believed that an element of sharing experiences with their peers would benefit them, perhaps helping them realise that they were not alone and that many others had similar experiences, feelings and attitudes towards mathematics and WPs (Guest et al., 2017).

The revision workshop was used because the structure was a normal part of their college life as students were attending revision workshops for mathematics or other subjects. The idea was to plan it with dual benefit to learners, sharing experiences with each other and improving their knowledge on how they might approach and solve WPs; in parallel, it would serve to provide data for my research. The workshop appeared to be the solution to balancing students' learning needs with the needs of my research. However, this is not a common research method, which led me to search for similar approaches beyond education research. Even then, I found only one example in the field of nursing by Treloar and colleagues (2017), which I used to inform my design. While the field of nursing differs from education, the methodological principles underpinning the study such as the focus on exploring participants' attitudes and experiences are transferable. Both fields deal with human behaviours, experiences, and attitudes, making the adaptation of insights from nursing research to an educational context both reasonable and valuable. The workshop approach had unanticipated affordances, and it provided an ecologically valid and low-pressure environment in which to discern participants' attitudes, approaches to, and journeys with WPs. Further details on the planning of the workshop are presented in section 3.4.3. Related ethical issues are also addressed later in this chapter, in section 3.6.

A teacher survey was also conducted in College A to gather teachers' perspectives on the challenges their resit students face with WPs and the teaching strategies teachers use to help students overcome those challenges (the origin of the questions used are signposted in Appendix D). At a later stage, the related short narratives from the student revision workshop and the teachers' responses subsequently informed the design of a learner survey featuring open-ended and multiple-choice questions, enabling a broader group of resit learners to share their stories, as is typical in an exploratory approach.

Finally, I administered the student survey, including both open-ended and quantitative questions. The survey was the wide-reaching part of the research as it was distributed to all the GCSE Mathematics resit learners at both FE colleges I worked for – in two different academic years. The quantitative part of the survey comprised a combination of multiple choice questions that were developed based on insights gained from the workshop and the teacher survey, and Likert-scale questions to measure a wide range of constructs, from attitudes and opinions to confidence levels. A full version of the survey can be found in Appendix B. The quantitative data gathered from this survey were analysed using descriptive statistical methods. Such an approach is not inconsistent with an interpretivist paradigm. Quantitative methods are often associated with a scientific approach, but responses to the Likert scale questions in my survey will have been responded to subjectively, so the findings are quasi-quantitative.

Likert scales are widely used in social science research due to their convenience and ability to collect data on attitudes, preferences, and perceptions (Bertram, 2007). They are straightforward for respondents to understand and easy for researchers to implement, providing a structured approach to gathering subjective data while ensuring consistency across responses (Joshi et al., 2015). When combined with qualitative methods, such as open-ended questions, Likert scale data can enrich understanding by offering both numerical patterns and deeper narrative context (Bryman, 2016). However, they are not without limitations. One critical limitation is the assumption that the numerical coding of responses represents equal intervals between scale points, which may not always be valid (Sullivan & Artino, 2013). Responses on Likert scales are inherently subjective and may vary depending on external factors, such as the respondent's mood or circumstances on the day of the survey. The odd number of scale points, such as the five-point scale used in this study, provides a neutral mid-point, which research suggests improves reliability (Croasmun & Ostrom, 2011).

Another concern is the ability of Likert scales to capture the complexity of human emotions and opinions. As Bertram (2007) argues, while Likert scales provide structured data, they may oversimplify nuanced responses, reducing the richness of the information collected. Despite these limitations, their adaptability and ease of use make Likert scales a valuable tool for quickly gathering a quantity of subjective data, particularly when combined with qualitative methods to provide additional depth and context (Bryman, 2016).

The open-ended questions enabled participants to share their perspectives and offer more detailed explanations of their experiences, emotions, and approaches to WPs. These responses had the potential to yield rich, 'thick' descriptions of their experiences (Geertz, 2008). The qualitative data from these were analysed through reflexive thematic analysis (Braun & Clarke, 2022), as further detailed in 3.5.

I used convenience sampling for the workshop and the surveys primarily because it allowed me to explore my research topic within my college effectively. This sampling method enabled me to quickly gather data from readily accessible participants, the GCSE Mathematics resit students and their teachers (Stratton, 2021); it was also ethical to do so, since no student was put under any pressure to participate in a given way. This approach enabled me to gather data from participants who were readily accessible within the college environment, ensuring that I could include all opted-in voices in the research while managing practical constraints such as time and resources. However, it also brought obvious issues of non-representativeness that I discuss in 5.6.2.

In the following sections, I present the profiles of the two participating FE colleges and discuss in detail the design and development of each data collection method. This discussion will provide context for understanding the study's findings and further rationale for the chosen methods.

## 3.4.1 Participant College Profiles

### *3.4.1.1 College A*

College A is one of the largest further education colleges in central London, with a diverse student body of around 14,000 learners. The college operates across five campuses throughout central London, attracting students from a wide range of backgrounds. This diversity reflects the multicultural nature of the city and includes various ethnicities and nationalities, different age groups, ranging from school leavers to adult learners, and students with varying educational needs, including those with learning difficulties and disabilities.

The research study took place at one of the college's main campuses, which hosts the majority of 16-18 GCSE Mathematics resit learners, totalling around 500 students annually. At the time of the study in March 2023, the number of 16-18 GCSE Mathematics resit students had decreased to 412. This decline is attributed to retention issues, as not all students who enrol in September continue through to the end of the academic year. Since 2018, the rate of high grades achieved in the college (percentage of learners achieving a grade 4 or higher) has dropped from approximately 15% to about 9%, with the exception of 2019 and 2020, when grades were based on teacher assessments due to the Covid-19 pandemic.

Attendance in GCSE Mathematics lessons is a significant challenge for College A, with rates dropping to as low as 50% at certain times of the year and averaging around 70-75% annually. There are insignificant differences in attendance between male and female students. On average, about two-thirds of the students attending their resit lessons are those resitting the qualification for the first time.

In 2021/22, the mathematics department at College A experienced a period of instability in terms of management and teaching staff, which led to disruptions in continuity, appearing to negatively impact student performance and overall departmental effectiveness. Improvements began in 2022/23 when a new team of teachers was established, and management stability was restored. Mathematics teachers at College A have diverse teaching experience, both abroad and in England, across secondary and FE settings. In the most recent Ofsted inspection, in December 2022, the college received a grade of Good.

My involvement with College A included working as a mathematics lecturer for the first five years and then as a curriculum manager for the following two years.

#### *3.4.1.2 College B*

College B is a small further education college in West London, with a diverse student body of 6,500 learners. The college caters to a wide range of ages, from 14–16- and 16–18-year-olds in specific programmes to adult learners seeking further education or career changes. The student body includes individuals from various ethnic backgrounds and cultures. The college has one of the largest ESOL provisions (English for Speakers of Other Languages) in West London, with approximately 1,000 learners annually. It operates two campuses in the area, offering a variety of courses from Entry Level to Higher Education. The college is recognised as one of the top three further education colleges in London.

The research was conducted at the main campus, which hosts the majority of 16–18-year-olds resitting their GCSE Mathematics examination. This campus also offers GCSE Mathematics courses for adults (19+) and alternative provision (14-15-year-olds). Annually, on average, around 400 students (16-18 and 19+) sit the GCSE Mathematics qualification. During the research period (March 2024), there were 262 16–18-year-olds resitting their GCSE Mathematics exam. The high grades rate (grades of 4 or over) at College B typically ranges from 35-40% annually. Although this rate is influenced by their adult provision, the rate for 16–18-year-olds exceeds the national average of 16%, with College B achieving approximately 21-26% over recent non-Covid years.

Attendance at GCSE Mathematics lessons is at about 80%, generally below the college's target of 85%, but it compares favourably with other further education colleges in the country, where the average stands at about 76% overall for an academic year (AoC, 2024). The college has a robust team of highly trained mathematics teachers who work closely together to maintain high standards of delivery for their learners. Although they experienced some inconsistency in management and teaching staff during the first term of 2023/24, they managed to maintain progress and uphold their educational standards. In the most recent Ofsted inspection, in December 2024, the college received a grade of Outstanding (the previous grade in December 2020 was Good).

I joined the college in mid-January 2024 as the Curriculum and Quality Team Manager. At the time the research was conducted at College B, I had been with the college for only two-and-a-half months, so I was not well known to students. I conjecture that this may have negatively affected participation rates.

### 3.4.2 The Teacher Survey

The teacher survey (Appendix D) included both quantitative and open-ended questions. The quantitative questions included multiple-choice and Likert-scale items adapted from TIMSS (2019) to suit the purpose of this study. My aim was to explore teachers' beliefs about key aspects of teaching GCSE Mathematics, the nature of the subject, and the pedagogical approaches they used. The aim of these questions was to gain insight into each teacher's priorities and the specific areas they focus on in their teaching.

On the other hand, the open-ended questions allowed teachers to offer qualitative insights and elaborate on their experiences and approaches to teaching WPs. These questions aimed to capture teachers' perspectives on WPs, including their teaching methods, the extent of WP exploration in their lessons, and their awareness of the challenges faced by resit learners when working on WPs.

The survey was divided into two parts. The first part sought to understand teachers' general approaches and beliefs regarding the teaching of GCSE Mathematics. The second part aimed to explore their teaching approaches and beliefs specifically concerning the teaching of word problems. A full version of the survey can be found in Appendix D, annotated to show the rationale for each question.

The teacher survey aimed to address two key questions, the findings of which informed the development of the student survey. For instance, the student survey included a multiple-choice question asking students to identify any approaches or strategies they used to solve WPs. The response options for this question were derived from teachers' answers in the teacher survey and insights shared by students during the workshop.

1. What are the approaches towards solving WPs that teachers choose to present to their resit learners?
2. What do teachers think are the challenges their resit learners face when working with WPs?

All six mathematics teachers in College A and all five in College B who taught GCSE Mathematics were invited to opt-in. In each college, I discussed my research and my intention to explore the experiences and approaches that our resit learners have developed towards WPs during one of our weekly team meetings. I explained that their input would be valuable in helping me understand their perspectives on teaching WPs and the challenges they believe their resit learners encounter. The teachers in each college had diverse experiences in teaching resit learners. In total, 10 teachers responded to the survey, five from College A and 5 from College B. **Error! Reference source not found.** shows the characteristics of the GCSE Mathematics teachers who responded to the survey from Colleges A and B.

*Table 4: Teacher/Participant information*

| College A | Gender | Trained as a mathematics teacher | First degree | Number of years teaching mathematics | Number of years teaching mathematics in FE |
|---|---|---|---|---|---|
| **Teacher 1** | F | UK | Relevant to Mathematics | 5 | 3 |
| **Teacher 2** | F | UK | Mathematics | 6 | 6 |
| **Teacher 3** | M | UK | Relevant to Mathematics | 15 | 15 |
| **Teacher 4** | M | Syria | Mathematics | 15 | 10 |
| **Teacher 5** | F | Poland | Mathematics | 27 | 7 |
| **College B** | **Gender** | **Trained as a mathematics teacher** | **First degree** | **Number of years teaching mathematics** | **Number of years teaching mathematics in FE** |
| **Teacher 6** | F | UK | Relevant to Mathematics | 4 | 4 |
| **Teacher 7** | F | India/UK | Mathematics | 10 | 7 |
| **Teacher 8** | F | India/UK | Relevant to Mathematics | 15 | 10 |
| **Teacher 9** | F | Poland/UK | Relevant to Mathematics | 10 | 8 |
| **Teacher 10** | F | Serbia/UK | Mathematics | 20 | 1 |

Data from the teacher survey fed into the development of the online student survey which was distributed to all GCSE Mathematics resit learners at both FE colleges.

### 3.4.3 The Workshop

The revision workshop in February 2023 was conducted with learners from College A, where I was employed at the time, and was a key source of qualitative data. The workshop allowed me to gather short but in-depth narrative accounts of learners' experiences and approaches to solving WPs through their educational journey. This qualitative data are particularly valuable for exploring the nuances and complexities of learners' experiences and it informed the development of the learner survey.

The design of the revision workshop was influenced by Treloar and colleagues (2017) who used the workshop approach to collect narratives from experienced and undergraduate mental health nurses. In their study, they held three workshops which were structured to be interactive and reflective, enabling participants to discuss and examine real-life experiences. I adopted a constructivist learning paradigm in their workshops, focusing on the active role of learners in building their own understanding and knowledge through experiences and interactions. The workshops aimed to assist participants in creating meaningful narratives for educational purposes, incorporating problem/practice-based learning (PBL) activities within the constructivist framework. The participants in my study used their own language and words to articulate their experiences, emotions, and perspectives to WPs. Open-ended questions served as prompts to stimulate their memories, allowing participants to choose what aspects they wanted to share with me.

I focused on understanding the meanings and interpretations that participants bring to their experiences (Treloar et al., 2017; Nickerson, 2022). In this phase of the research, all 412 GCSE Mathematics resit learners in College A received a text message inviting them to participate in the revision workshop, with participation being voluntary. Ultimately, 12 resit learners chose to attend the workshop and participate in the study. As such, they were likely not representative of the whole cohort, but in this exploratory study, their data provided a basis from which to explore how widespread workshop participants' experiences were. I expected them, nevertheless, to be indicative of a range of potential experiences and issues.

In the following paragraphs, I discuss the design of the workshop and its implementation to gather data.

#### *3.4.3.1 Workshop design and implementation*

The key purposes of the workshop were as follows:

1. To provide an opportunity for GCSE Mathematics resit learners to share and reflect on their experiences with mathematics and the approaches they have developed towards solving WPs over the years. This reflection process can be beneficial for students as it fosters self-awareness and metacognition, enabling them to recognise and articulate the strategies they employ in solving WPs (Daradoumis & Arguedas, 2020). This reflection can enhance their problem-solving skills and boost their confidence by validating their efforts and approaches (Zimmerman, 2002). Additionally, creating a space for students to voice their challenges and successes promotes a sense of community and support among peers, which can improve their overall learning experience and motivation (Vygotsky, 1978). For my research, these reflections offered valuable insights into learners' thought processes, attitudes, and strategies, contributing to a deeper understanding of the challenges they face with WPs. This mutual benefit aligns with ethical research practices, ensuring that participants gain something meaningful from their involvement (BERA, 2018).
2. To discuss and develop potential strategies towards WPs and built experience with past examination questions while working collaboratively following a constructivist framework for learning.
3. To analyse their narratives to inform my research and the development of an online student survey which would be distributed to all GCSE Mathematics resit learners in the college.

The workshop consisted of three parts, each addressing the above key purposes: a) learners' reflections on their experiences with WPs; b) strategies for approaching and solving WPs with examples; and c) building experience on past examination questions.

In the first part of the workshop learners were prompted to answer five questions related to general experiences with mathematics, three questions regarding WPs, and work on a small task. The purpose of the first five questions was to stimulate memories about their relationship with mathematics, helping participants connect emotionally and cognitively to their past learning experiences. This process is grounded in the idea that recalling and reflecting on personal experiences can activate prior knowledge and provide a foundation for deeper engagement in subsequent activities (Schunk, 2012). The next three questions aimed to initiate a focused conversation about WPs, encouraging participants to articulate their attitudes and perceptions towards them.

Before becoming involved in a conversation, participants were given time to think and write down their thoughts. This step was crucial to allow shy learners the opportunity to organise their ideas and feel more confident about sharing in a group setting. It also aligns with best practices in learner-centred teaching, which emphasises creating a supportive environment where all participants feel they have a voice (Brookfield, 2015). Participants were then asked to share their thoughts if they wished to. Providing this option ensured that participation remained voluntary, fostering an inclusive and non-threatening environment. This approach respects participants' autonomy and recognizes that some individuals may need more time or may prefer to contribute in other ways, thereby promoting ethical research practices (BERA, 2018).

The task consisted of four carefully selected WPs covering different areas of the mathematics curriculum that Examiner Reports over the years have identified as challenging for students. Specifically, the four WPs focused on the topic areas of Number, Ratio & Proportion, and Geometry. The questions can be found in **Error! Reference source not found.** below. More specifically, according to examiners' reports (2022-2023), the following are common areas of mistakes: ratio and proportion problems are particularly difficult, as students struggle to set them up and solve them correctly, often misunderstanding the relationship between quantities and making arithmetic mistakes; multi-step problems, especially those involving ratios and proportions, also pose significant difficulties, with students frequently failing to break down the problem and apply the correct methods; basic arithmetic errors, such as mistakes in addition, subtraction, multiplication, and division, are common, especially in non-calculator papers. Furthermore, students find it challenging to convert between fractions, decimals, and percentages, and to solve related problems. Lastly, understanding and applying the properties of shapes, including area and perimeter formulae, is another area where students often encounter difficulties (Pearson, 2017-2023).

During the task, the participants were shown a WP situation without any question and were asked questions such as: *do you understand the context of this problem? what kind of feelings* *arose when you saw this problem? is there anything missing?* Learners tend to struggle to fully understand the context of a WP, find it difficult to identify the mathematics 'hidden' behind the context, or feel anxious when they are asked to solve one (Huang et al., 2018; Verschaffel et al., 2020). This approach therefore supported the identification of such challenges, uncluttered by specific question details. Then they were shown the same problem including the question and reported any different feelings or thoughts that were developed. This is an approach I follow in my lessons to minimise the emergence of negative feelings and to keep students focused on understanding the context of the WP rather than focusing on the actual question. While formal evidence of its effectiveness in my own teaching practice is anecdotal, studies in educational psychology support the idea that reducing cognitive load and focusing on problem comprehension can mitigate anxiety and enhance problem-solving performance (Sweller et al., 2011; Artino, 2008). This aligns with broader research that suggests creating a structured and low-pressure environment can improve learners' engagement with complex tasks (Verschaffel et al., 2020).

In this first part of the workshop, participants were not required to solve any of the WPs shown. It was clearly communicated to them that they did not have to attempt to solve them, just read them through and express their thoughts. The aim of the task was to maximise opportunities for individual contributions and elicit their thinking processes when faced with a WP. All the WPs presented were addressed and solved in the second part of the workshop. The four WPs selected represent a range of mathematical content areas that GCSE Mathematics resit students often encounter, and these topics were chosen based on their inclusion in past GCSE examination papers and identified challenges highlighted in Examiner Reports (Pearson, 2017-2023). For example, the selected problems cover typical scenarios that students are likely to face in their examinations, including contextual setups that require understanding ratios, proportionality, and problem-solving in real-world contexts. They were also chosen to reflect common features of word problems that research suggests students struggle with, such as decoding the context, identifying the mathematical operations required, and navigating multi-step solutions (Huang et al., 2018; Verschaffel et al., 2020).

### Problem A

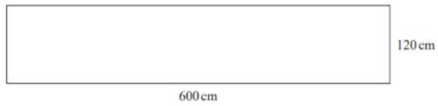
There are 40 students in a class.
Each student walks to school or cycles to school or gets the bus to school.

There are 22 girls in the class.
9 of the girls walk to school.
7 of the boys cycle to school.
6 of the 10 students who get the bus to school are boys.

Find the number of these students who walk to school.

### Problem B

The diagram shows a rectangular garden path.




Wasim is going to cover the path with paving stones.
Each paving stone is a square of side 30 cm.
Each paving stone costs £2.50

Wasim has £220 to spend on paving stones.

Show that he has enough money to buy all the paving stones he needs.

### Problem C

Costcorp sells packets of mints to shop owners.

On Monday three shop owners buy mints from Costcorp.
Each shop owner buys small packets, medium packets and large packets of mints.

Alan buys 400 packets of mints.
32% are small packets.
40% are large packets.

Beryl buys 500 packets of mints.

$\frac{3}{10}$ are small packets.

$\frac{1}{10}$ are large packets.

Charlie buys 150 small packets of mints so that

number of small packets : number of medium packets = 3 : 4

Work out the total number of medium packets of mints these shop owners buy.
You must show all your working.

### Problem D

A shop sells packs of black pens, packs of red pens and packs of green pens.

There are
2 pens in each pack of black pens
5 pens in each pack of red pens
6 pens in each pack of green pens

On Monday,

number of packs of black pens sold : number of packs of red pens sold : number of packs of green pens sold = 7 : 3 : 4

A total of 212 pens were sold.

Work out the number of green pens sold.

*Figure 3: The four WPs used at the workshop during the task*

The four problems (Figure 3) **were selected purposively** because they each come from a different area of mathematics: numbers, geometry and measurement, and proportional/ratio reasoning. **As a group, they also have variation in that so**me stay within one topic while others bring together ideas from different topics, for example moving from continuous area to discrete tiles, or linking percentages, fractions, and ratios. This makes the problems more complex and requires learners to think about the structure of the situation, not just apply a single method. In this way, they reflect what the literature describes as non-routine word problems, where success depends on recognising the underlying structure, using clear representations such as tables or bar models, and keeping track of part–whole relationships.

At the same time, the problems all have important features in common. Each one asks learners to make sense of a written context, to plan several steps, and to decide how best to show their working before carrying out calculations. This links closely to the Department for Education's assessment objectives: **AO1** is about accurate calculation, **AO2** is about interpreting the situation and reasoning clearly, and **AO3** is about modelling, choosing a strategy, and solving problems set in context (see section 2.3.4.: table 1, page 27). **As a group, the four problems provide a balanced 'menu' designed to expose how participant** resit learners handle problem solving, reasoning, and representation, which are central themes in both the assessment framework and the research literature. Taken together, they offer a clear lens on the challenges that GCSE resit learners face when working with word problems that demand more than routine procedures.

The second and third parts of the workshop were designed as a ‘more usual’ revision session, providing learners with the opportunity to discuss the approaches they had already developed towards solving WPs, to be introduced to different strategies through specific examples, and to implement some of those – or other – approaches to past examination problems. The learners worked in groups of three or four, consistent with the principles of social constructivism, which emphasise the value of collaboration and interaction in deepening understanding. Engaging with peers allowed participants to articulate their thought processes, challenge their ideas, and learn from the perspectives of others, which can be particularly beneficial for developing problem-solving skills (Vygotsky, 1978). For each of the WPs presented on the board, participants were given time to look at the problem, solve it following their chosen approach, and then share their methods with others if they wished – initially as individuals and later as groups. The collaborative environment was intended to scaffold learners’ understanding and foster a sense of shared learning. While the workshop was scheduled for three hours, some learners chose to stay longer to follow up on their work with me. The PowerPoint presentation used during the workshop can be found in Appendix A.

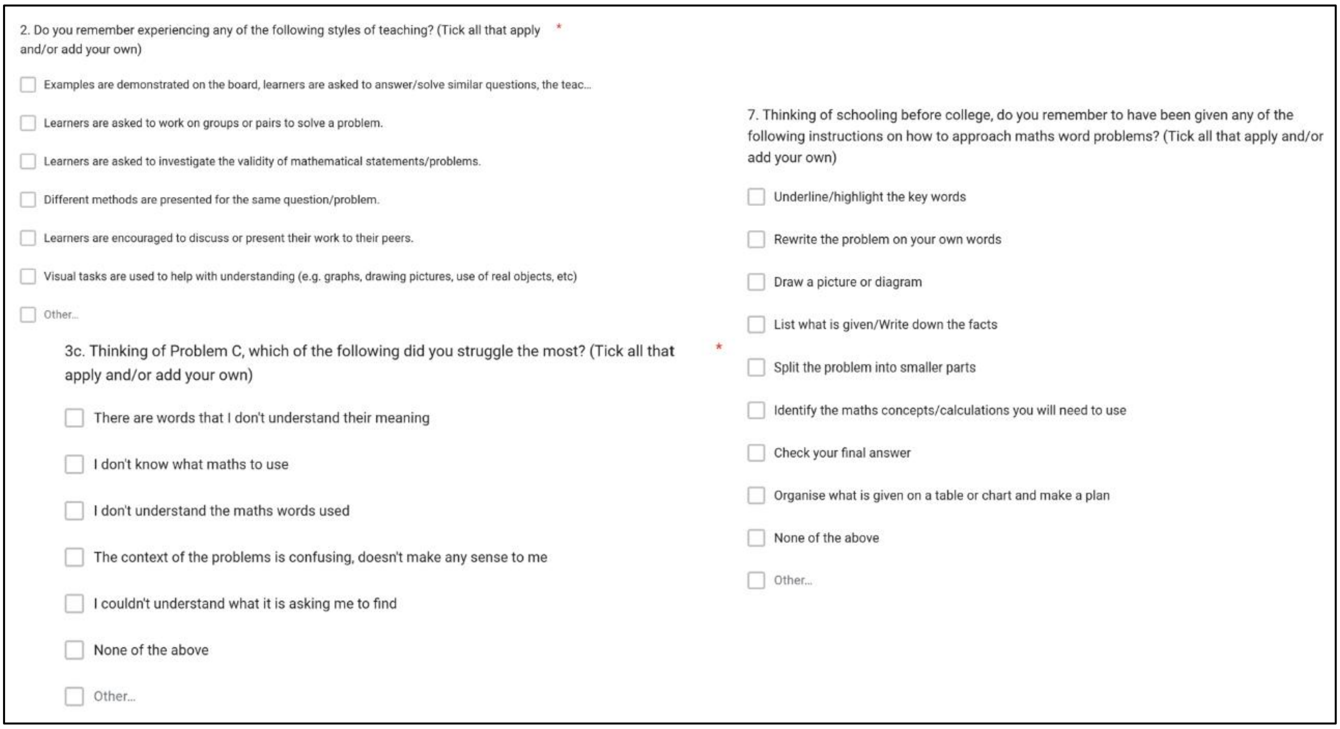
It is worth noting that most of the participants reportedly found the workshop beneficial. During the workshop there were comments such as ‘this makes more sense now’, ‘I have never thought to look at the problems this way’, and ‘I always get confused and don’t know where to start – I feel I can organise my work better now’. In the later days, eight of the participants either visited me in my office or messaged me to request additional sessions.

### 3.4.4 The Learner Survey

The final phase of data collection involved the development and distribution of an anonymous online learner survey. I chose the survey to be online as it makes it easier for data to be collected and analysed and can be accessed at any time and from any location if learners were not in class the week the survey took place. The primary objective of the learner survey was to provide all resit learners at both colleges with the opportunity to share their experiences in mathematics and articulate their strategies for tackling GCSE Mathematics WPs. The survey encompassed questions of both quantitative and qualitative nature, with a significant portion encouraging participants to narrate various aspects of their mathematical journey with WPs.

The survey was designed with a dual focus to serve both research and pedagogical purposes. Firstly, learners were asked to respond to questions related to their experiences and approaches to WPs, which aimed to inform the research study and provide valuable insights for curriculum development. This focus aligns with the ethical responsibility of researchers to ensure that participants' contributions have practical value and potential benefits for improving teaching and learning practices. Secondly, learners were invited to provide feedback on the quality of their learning experience during the current academic year. This element of the survey ensured that participants had a voice in reflecting on their educational journey, fostering a sense of agency and inclusion. The questions for the second part were taken from TIMSS (2019) and adjusted accordingly. The first part of the survey was specifically designed for the research study's purposes, with the intention of enhancing curriculum development. The second part was created to enable learners to provide feedback on their ongoing learning experience. The survey, with notes on its development, can be found in Appendix B.

The formulation and design of the survey questions were guided by insights gained from the preceding workshop and the teacher survey conducted in College A and the emergent themes derived from them. For example, **Error! Reference source not found.** shows three of the questions whose multiple-choice options resulted from the workshop and the teacher survey. Furthermore, regarding the second part of the survey, to ensure the validity of the questions in informing departmental practices, they underwent a thorough review and moderation process by members of my department in College A. As a result, the wording of some questions changed slightly to make better sense to the participants.



2. Do you remember experiencing any of the following styles of teaching? (Tick all that apply and/or add your own) *

- [ ] Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teac...
- [ ] Learners are asked to work on groups or pairs to solve a problem.
- [ ] Learners are asked to investigate the validity of mathematical statements/problems.
- [ ] Different methods are presented for the same question/problem.
- [ ] Learners are encouraged to discuss or present their work to their peers.
- [ ] Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc)
- [ ] Other...

3c. Thinking of Problem C, which of the following did you struggle the most? (Tick all that apply and/or add your own) *

- [ ] There are words that I don't understand their meaning
- [ ] I don't know what maths to use
- [ ] I don't understand the maths words used
- [ ] The context of the problems is confusing, doesn't make any sense to me
- [ ] I couldn't understand what it is asking me to find
- [ ] None of the above
- [ ] Other...

7. Thinking of schooling before college, do you remember to have been given any of the following instructions on how to approach maths word problems? (Tick all that apply and/or add your own)

- [ ] Underline/highlight the key words
- [ ] Rewrite the problem on your own words
- [ ] Draw a picture or diagram
- [ ] List what is given/Write down the facts
- [ ] Split the problem into smaller parts
- [ ] Identify the maths concepts/calculations you will need to use
- [ ] Check your final answer
- [ ] Organise what is given on a table or chart and make a plan
- [ ] None of the above
- [ ] Other...

*Figure 4: Student survey multiple-choice questions, influenced by the workshop and teacher survey data*

Resit students in College A were invited to complete this survey as part of the college's learner feedback mechanism, and it took place during their regular lessons. This strategic timing aimed to optimise participation rates, as past experiences have shown that when students are provided with online survey links to complete at their convenience, participation tends to be quite low. In contrast, offering learners the opportunity to complete the survey during their lessons resulted in higher participation rates. All resit learners who were present on the days of the survey were invited to participate. Learners who were absent on the day of the survey were sent a text message inviting them to complete it. A total of 112 out of 412 learners responded to the survey from College A, with 14 participating in the pilot run and 98 completing its final version.

In College B, due to me being new to the role of curriculum manager and having not yet developed an established relationship with the resit learners, teachers posted the link of the survey on their Microsoft Teams groups asking learners to complete it. A total of 37 out of 260 learners responded to the survey from College B – unsurprisingly, a much lower response rate. Participants' profile characteristics from both colleges can be seen in Tables 5 and 6.

*Table 5: College A: Participants' profiles*

| College A (n=112) | Number of times resitting GCSE Maths |
|---|---|
| 1st time | 75 (67%) |
| 2 or more times | 37 (33%) |
| | English as first language |
| Yes | 74 (66%) |
| No | 38 (34%) |
| | Years of studying in the UK |
| Whole life | 83 (74%) |
| Less than 5 years | 17 (15%) |
| More than 5 Years | 12 (11%) |
| | Gender |
| Female | 60 (53%) |
| Male | 50 (45%) |
| Prefer not to say | 2 (2%) |

*Table 6: College B: Participants' profiles*

| College B (n=37) | Number of times resitting GCSE Maths |
|---|---|
| 1st time | 22 (59%) |
| 2 or more times | 13 (35%) |
| 1st sitting GCSE Maths | 2 (6%) |
| | Have you achieved 4+ in GCSE English |
| Yes | 13 (35%) |
| No | 22 (59%) |
| | English as first language |
| Yes | 14 (38%) |
| No | 23 (62%) |
| | Years of studying in the UK |

| | |
|---|---|
| **Whole life** | 14 (38%) |
| **Less than 5 years** | 13 (35%) |
| **More than 5 Years** | 10 (27%) |
| | **Gender** |
| **Female** | 16 (43%) |
| **Male** | 20 (54%) |
| **Prefer not to say** | 1 (3%) |

The aim of the online survey was to give the opportunity to all learners to share insights regarding their experiences with mathematics and their approaches to GCSE WPs and to find out how typical the views and experiences exposed during the workshop were. Resit learners often face unique challenges and may have distinct learning needs compared to their peers (Dalby, 2020). By actively seeking their input, the mathematics departments of Colleges A and B can tailor their support mechanisms to better meet the specific requirements of resit learners. Moreover, the needs uncovered in these colleges, while not unproblematically generalisable, might be indicative of what is needed in education more widely (Blair & Zinkhan, 2006).

## 3.5 Data Analysis

### 3.5.1 Analysis of the data collected from the Workshop and the Teacher Survey

The purpose of the workshop and the teacher survey was to gather data that would inform the design and development of the learner survey, which served as the primary data collection tool for addressing this study's research questions (Chapter 1). The teacher survey was conducted in December 2022, followed by the workshop in February 2023. The purpose of the analysis was to explore, based on input from students and teachers, the challenges resit students face when working on WPs, the actions they take, the emotions they experience, and the strategies teachers employ to help these students improve their work with WPs. This approach allowed me to reduce the number of open-ended questions in the learner survey and incorporate multiple-choice questions to gather data on attitudes and behaviours toward WPs. I was mindful of the time required for participants to complete the survey and aimed to balance the number of open-ended and multiple-choice questions accordingly.

#### *3.5.1.1 Teacher Survey Analysis*

The focus of the teacher survey analysis was on the following three questions:

1. Describe the difficulties your resit students face when working on mathematical WPs.
2. What do you think causes their difficulty in solving WPs?
3. What specific strategies do you teach students to use when solving WPs?

The analysis involved compiling all the difficulties, causes, and strategies mentioned by the teacher participants into separate lists for each category. These lists were subsequently used to develop the options for the corresponding multiple-choice questions in the learner survey. For example, participants identified several difficulties their learners face when working on WPs. These include challenges in analysing and interpreting the given information mathematically, an inability to recall basic mathematical facts, procedures, rules, or formulae, being intimidated by the length of a WP, language comprehension issues, weak numeracy skills, and difficulty recognising mathematical concepts embedded in the text of a WP. Potential reasons for these challenges were attributed to significant knowledge gaps, inadequate literacy skills, and a lack of understanding of mathematical terminology. Finally, regarding strategies taught to resit students, participants mentioned techniques such as highlighting key words, reading the problem multiple times, drawing pictures or diagrams, and looking for patterns.

The remaining questions in the teacher survey were analysed using descriptive statistics to explore and gain a better understanding of the beliefs and ideas held by the teacher participants. However, these questions were not utilised in the development of the learner survey. Instead, they primarily served to provide context about the teachers and their approaches to supporting resit students. The findings from the teacher survey are presented in chapter 4.

#### *3.5.1.2 Workshop Analysis*

To analyse the data collected from the workshop, I used reflexive thematic analysis (Braun & Clarke, 2022). The primary goal of this analysis was to identify patterns in attitudes and behaviours towards WPs and use these findings to balance the number of open-ended, multiple-choice, and Likert-scale questions in the learner survey. Participants wrote their responses to the workshop questions (both mathematical and non-mathematical), which I then collected and transferred to a PowerPoint document. I began by reviewing their responses to each question, identifying codes, and grouping them into themes. This process not only helped me generate potential questions for the learner survey but also guided me in deciding which questions should remain open-ended and which ones should be formatted as multiple-choice or Likert-scale questions.

For instance, the Task section of the workshop had to be adapted for an online survey environment. To avoid creating a lengthy survey and save time for participants, the task was modified to include four questions (one Likert-scale and three multiple-choice), as shown below. These questions had originally been of an open-ended format during the workshop.

1. On a scale of 1-5, where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem?
2. Thinking of the previous maths problem, do you feel you understand the context of the problem? (Yes – Maybe – No)
3. Thinking of the previous maths problem, do you feel that you know the maths that you need to use to be able to solve it? (Yes – Maybe – No)
4. Thinking of the previous maths problem, which of the following did you struggle the most? (multiple options based on responses gathered from the teacher survey, the workshop and available academic research).

Both the teacher survey and the workshop were integral parts of the design of the learner survey.

## 3.5.2 Analysis of Learner Survey

### *3.5.2.1 Qualitative Analysis*

I employed reflexive thematic analysis (RTA) as my main analytical approach to the qualitative data (Braun & Clarke, 2022). RTA allows me to acknowledge and critically engage with my own perspectives, experiences, and potential biases, recognizing them as integral components that shape the research process and outcomes (Bryne, 2022). By embracing reflexivity, I can ensure that my interpretations are transparent and self-aware, leading to a more nuanced understanding of the data. The iterative nature of RTA offers the flexibility to revisit and refine the analysis phases continuously. This non-linear approach would enable me to engage more deeply with the data, ensuring a thorough exploration of themes as they emerged and evolved throughout the research process.

Consistent with my interpretative epistemology, reflexivity played a pivotal role in my thematic analysis, prompting continuous reflection on my personal viewpoints, predispositions, and presumptions throughout the analytical journey. This practice enabled me to contemplate how my background and standpoint might potentially shape my data interpretation. It is important to note that reflexivity is an ongoing and non-conclusive process, as mentioned by Braun and Clarke (2012, 2022), who advocate for this approach as it grants researchers cognitive insights into diverse thought processes and experiences.

Throughout the process of analysis, I maintained an awareness that my personal beliefs and positioning would inevitably influence both my research and my interaction with the data. For example, as I analysed participants' responses regarding the type of action taken when faced with a WP, my own background in teaching and my experience as a curriculum manager led me to prioritise themes related to the challenges of teaching problem-solving strategies such as students being passive or active towards those strategies. This focus on pedagogy may have shaped the way I interpreted learners' difficulties, particularly in how they approached WPs. Another researcher, without these particular experiences, might have constructed different themes or identified different relationships between the data. The themes found can be seen in Appendix C, where a more detailed overview of the analysis of the findings is provided.

The analytical journey required my active and imaginative engagement, enabling the development of a dialogical relationship with the data. This approach primarily assisted in the construction and organisation of themes rather than their mere discovery (Tsiolis, 2016). In contrast to other data analysis methodologies, thematic analysis is not tethered to specific theoretical frameworks; it serves as a versatile method for examining data that can be applied in various ways by researchers from diverse theoretical backgrounds (Braun & Clark, 2012). While I was deeply engaged in the analysis process, I remained mindful of my research questions (Chapter 1). However, I also maintained an open attitude, allowing for the exploration of the responses and narratives provided by the resit learners. I recognised that what they say might indicate valuable insights or perspectives that I had not previously considered. For example, I was particularly surprised to discover that female participants reported significantly more negative feelings towards mathematics and WPs than their male counterparts, a characteristic I had not found evidenced in the GCSE resit literature.

As previously mentioned, data were collected from two FE London colleges across two different academic years (see **Error! Reference source not found.Error! Reference source not found.**). This resulted in two distinct datasets that were analysed using the same process: reflexive thematic analysis. For the data collected from College A, spreadsheets were printed, and colour coding was done manually using highlighters. In contrast, for the data collected from College B, the analysis was conducted directly on the electronic spreadsheet using Excel's highlighting and note features. This variation did not influence the analysis process or the findings.

I chose to adhere to Braun and Clarke's (2022) six-phase process for RTA. This involved starting with familiarising myself with the set of data, progressing to a meticulous and methodical coding process and then delving into the exploration, development, review and refinement of themes. Eventually, this process led to the generation of the findings discussed below. I revisited some of these phases several times, allowing the developing analysis some distance and returning with a fresh perspective. Below is a detailed explanation of the six-phase analysis process I followed, as outlined by Braun and Clarke (2022).

##### 3.5.2.1.1 Phase 1: Familiarisation with the set of data

During this phase, I aimed to gain a deep and thorough understanding of the data content through immersion. The data included responses to various questions, some quantitative and others qualitative in nature. I dedicated significant time, spread across multiple days, to meticulously reading and re-reading the responses to each question. Throughout this process, I documented any analytical ideas or insights that arose, pertaining to individual questions as well as the dataset as a whole.

For College A, I had a hard copy printed for each data item to make notes and highlight parts that I found important while reading the responses. For College B, the same steps were followed but using an electronic copy of each data item. These initial notes and highlights were for my own use, ensuring that I would not forget ideas and thoughts that I had begun to engage with. Subsequently, on a separate sheet of paper, I compiled a list of common keywords and phrases that I was consistently encountering in participants' responses, which prepared me for the coding phase. This strategy proved invaluable in identifying potential patterns and intriguing features within the data (pictures of this phase can be found in Appendix C).

#### 3.5.2.1.2 Phase 2: Coding

Coding plays a vital role in organising data by breaking down large amounts of qualitative information into manageable chunks, allowing researchers to systematically categorise and make sense of the data (Strauss, 1987). Through coding, researchers can identify recurring themes, patterns, and concepts, which is essential for uncovering underlying trends and insights that might not be immediately apparent (Braun & Clarke, 2019). Additionally, coding facilitates a more detailed and nuanced analysis by enabling comparisons between different data segments, helping to understand relationships between themes, and deepening the overall understanding of the research topic (Williams & Moser, 2019).

In an exploratory approach, coding also enhances reflexivity by prompting researchers to continuously reflect on their interpretations and the meanings they assign to the data, refining and deepening the analysis over time (Probst, 2015). Finally, systematic coding ensures rigor and credibility in qualitative research, providing a clear audit trail of how data was analysed and how conclusions were drawn, which is essential for the transparency and validity of the study (Braun & Clarke, 2019).

The coding process for College A was conducted manually and it involved the handwritten annotation of codes directly onto printed data. I utilised various colours of highlighters, underlined, or circled pertinent segments to visually distinguish and organise the coded information. The coding process for College B was conducted electronically, with codes annotated directly in a comment column on the spreadsheet. The same colour highlighting was used in both datasets. Since codes had already been generated from College A's dataset, I looked for these existing codes in College B's data as well. However, I remained open to identifying new codes that might not have appeared in the first set. Surprisingly, most responses from College B participants aligned with the themes generated from College A's data. However, probably, due to the lower participation rate, not all themes from College A were present in College B's responses. For instance, in the question asking for a definition or example of a word problem, all of College B's responses were mathematically correct (Theme 1), whereas College A's responses spanned three themes: mathematically correct word problem (Theme 1), missing information (Theme 2), and not a word problem (Theme 3).

In this phase, I meticulously examined each data item individually, carefully identifying segments that appeared to be potentially interesting, relevant, or significant with respect to my research questions. I also remained open to identifying elements that could provide fresh perspectives on resit learners that I had not thought about. I would then encapsulate these segments with analytically meaningful descriptions, essentially creating what are commonly referred to as 'codes' (see Appendix C for a visual aspect of the analysis process). Coding deconstructs the data to allow the researcher to make sense of it and synthesise it to make other links (Strauss, 1987).

It is important to note that these codes were generated by me as the sole researcher of this study, though with high level validation by my supervisors. I was thus aware that these codes were dominated by my own analytical interpretation of the data. If another researcher were to examine them, they might perceive the data differently. Consequently, I revisited and refined the codes multiple times throughout and after the analysis process, ensuring that they reflected (my interpretation of) the nuances and insights contained within the data as accurately as possible.

I approached coding with the mindset of a consciously curious researcher, fully attentive to the participants' responses. I remained open to reading and writing about experiences that differ from my own, actively seeking to connect the data with existing knowledge while also striving to generate new insights and potential knowledge. However, I found that this process was surprisingly time- and effort-consuming, as it required careful attention to detail.

###### 3.5.2.1.3 Phases 3 – 5: From generating initial themes to refining, defining and naming them

After establishing the codes, my objective in this phase was to begin identifying shared patterns of meaning across the whole dataset. I systematically organised clusters of codes that appeared to revolve around a common idea or concept. These clusters held the potential to offer meaningful responses to my research questions or even spark new insights. These initial efforts led me to the development of early themes, some of which I retained, while others that did not seem to form a theme I placed under a ‘theme’ called *other*. As Braun and Clarke (2022) emphasise, during this phase, my mindset was centred on the process itself, valuing the journey rather than fixating solely on the destination. The themes explored at this stage were provisional and tentative in nature. They represented candidate themes competing for consideration, but they had not yet been firmly established or finalised. These early themes were shown to and discussed with my two supervisors who either confirmed or challenged my emerging thinking, helping me to organise my thoughts and review the data. For instance, when revisiting the different examples of WPs provided by participants, I initially focused on identifying key words that might indicate levels of thinking (elementary, average, advanced). However, after discussions with my supervisors, we concluded that categorising responses in this way was not feasible. Instead, I shifted the focus to examining the ‘mathematical correctness’ of their examples, leading to the development of three themes: mathematically correct word problem (Theme 1), missing information (Theme 2), and not a word problem (Theme 3).

The next stage involved the refinement and review of the emerging themes. The primary objective of this stage was to evaluate the initial alignment of the provisional data themes and to assess the overall viability of my analysis. This involved revisiting the entire dataset to determine whether the themes held relevance and coherence in connection with the coded responses of the participants. Additionally, I began to contemplate the relationship between these themes and the existing body of knowledge concerning resit learners, the prevailing practices at FE, and the broader context of my research study. These went through supervisors’ scrutiny again to maximise efficacy. Some examples of the emergent themes can be seen in **Error! Reference source not found.**.

*Table 7: Example of Themes generated from College A and B data*

| ***How would you describe your relationship with mathematics since the beginning of schooling (this*** | **College A:**<br><br>• Positive relationship<br>• Negative relationship | **College B:**<br><br>• Positive relationship<br>• Negative relationship |
|---|---|---|

| | | |
|---|---|---|
| ***can include memories from primary, secondary, and/or college)?*** | • Mixed feelings<br>• Average relationship<br>• No relevant answer | • Mixed feelings<br>• Average relationship<br>• Not relevant |
| ***What do you think a maths word problem is? If you want, you can give an example.*** | **College A:**<br><br>• Example given<br>    ○ Mathematically correct<br>    ○ Missing information<br>    ○ Not a WP<br>• Definition given<br>    ○ Real-life definition<br>    ○ Maths in words/sentences<br>• Not sure<br>• Frustration/Confusion<br>• Other (key words: solving, problem solving, equation)<br>• Not relevant | **College B:**<br><br>• Example given<br>    ○ Mathematically correct<br>• Definition given<br>    ○ Real-life definition<br>    ○ Maths in words/sentences /scenario/story<br>• Frustration/Confusion<br>• Other (key words: solving, problem solving, equation, puzzles, riddles)<br>• Not relevant |
| ***In an exam, what is the first thing you do when you face a maths word problem that you don't understand?*** | **College A:**<br><br>• Take action<br>    ○ Come back to the problem later<br>    ○ Look for key words<br>    ○ Read the problem again<br>    ○ Ask for help (teacher)<br>    ○ Other<br>• No action<br>    ○ Skip<br>    ○ Panic/worry<br>    ○ Stare at the problem<br>• Do my best<br>• Not relevant | **College B:**<br><br>• Take action<br>    ○ Come back to the problem later<br>    ○ Look for key words<br>    ○ Read the problem again<br>    ○ Other<br>• No action (skip)<br>• Do my best<br>• Not relevant |

To finalise the themes, I ensured that each theme selected was clearly demarcated and built around a strong core concept or essence (Braun & Clarke, 2022). Each theme was structured to convey a narrative that was intended to seamlessly integrate into the overarching story represented by the data.

#### 3.5.2.1.4 Phase 6: Writing up

The process of documenting the findings commenced during the early stages of the analysis. Initially, this documentation took on an informal nature, but as the analysis progressed, more substantial and robust comments began to take shape. My familiarisation notes and reflexive journaling contributed to this evolving formal writing process. The initial documentation of findings from College A and B can be found in Appendix C.

### *3.5.2.2 Quantitative Analysis*

While the primary focus of this research was on qualitative data analysed using RTA, I also utilised basic statistical methods to enhance comprehension of the primary attributes, trends, and characteristics within the quantitative dataset. The survey responses were automatically compiled into a spreadsheet, which provided an initial summary of the data. The quantitative analysis primarily involved descriptive statistical methods, including the calculation of frequencies, percentages, and basic comparisons across participant groups.

For example, in the survey's final section, participants were asked to reflect on their confidence, contextual comprehension, mathematical knowledge, and potential struggles related to solving four different WPs. Responses were captured using Likert-scale ratings and multiple choices, allowing for the comparison of trends across different participant demographics, such as gender and prior attainment levels (number of times they had resat GCSE Mathematics). The analysis was exploratory in nature, aiming to identify patterns and differences that could inform the qualitative findings. A summary of key quantitative results highlighted variations in participants' confidence levels, comprehension, and struggles with each WP. For instance, confidence ratings revealed that although Problem D was considered challenging by me as a teacher, participants expressed higher levels of confidence compared to other problems. Similarly, gender-based analysis indicated that female participants were more likely to report lower confidence and greater struggles with contextual comprehension and mathematical knowledge (see detailed analysis in Chapter 4).

While this quantitative analysis did not follow a specific analytical framework, it provided valuable context and additional layers of understanding. By triangulating these findings with the qualitative data, I was able to generate richer insights into participants' experiences with

WPs. The simplicity of the statistical methods used reflects the exploratory purpose of this analysis, focusing on descriptive trends rather than inferential statistics.

## 3.6 Ethical Considerations

### 3.6.1 Teacher Survey

As a researcher and curriculum manager, it was imperative to acknowledge and navigate the ethical considerations surrounding power dynamics and insider researcher issues when designing and administering the teacher survey to my team. Power dynamics can influence the interactions between researchers and participants, potentially impacting the voluntary nature of participation and the authenticity of responses (Czerniawski, 2023). The potential power dynamics in this case stemmed from my dual role as both a researcher and a manager, which could have influenced how my colleagues perceived the survey. Given my position, there was a risk that participants might have felt obliged to take part or provide responses they believed aligned with my expectations rather than their true opinions. To mitigate this possibility, I implemented strategies such as providing clear information about the purpose and voluntary nature of the survey, ensuring confidentiality of responses, and making clear that responses would not in any way affect their role and responsibilities (Wulf-Andersen et al., 2021). Additionally, as an insider researcher, there exists a delicate balance between leveraging insider knowledge to inform research design and maintaining objectivity to ensure the integrity of findings. To address this, I maintained transparency about my dual roles, emphasised the importance of unbiased data collection and analysis, and sought feedback from external peers to ensure rigor and credibility (Ross, 2017; Bell, 2022).

### 3.6.2 Workshop

Initial ethical considerations included issues around the use of a workshop as a means of collecting data. Firstly, the workshop aimed to benefit participants' learning and improve their approaches to solving WPs. It was advertised to every GCSE Mathematics resit learner in the college, so it was inclusive. It was offering them a chance to understand their current state with WPs, discuss the challenges they faced, receive strategies to overcome those challenges, and to practise them to see which ones would work for them. To ensure voluntary participation, every resit learner received a text message informing them of the workshop and its purpose, and attendance was entirely optional.

Prior to the start of the workshop, I provided participants with a detailed explanation of both the learning and the research purpose of the workshop. Its structure was presented, both verbally and in written form. Consent forms for use of their data for research purposes were completed at the outset and I made it clear that if any participant did not wish for their narratives to be used in my research, they could still attend the workshop without any obligation. All participants appeared to be comfortable with this arrangement. Additionally, I informed them that no real names would be used and that they could withdraw their data at a later stage if they changed their mind.

I understand that it is not always easy to express and share one's thoughts in front of others and that sometimes this can cause feelings of pressure and anxiety. To address this, in the first part of the workshop, where the questions were more personal, I asked participants to write down their responses and only share with the rest of the group if they felt comfortable to do so. I told them that I would collect their written responses at the end of the workshop, but they did not have to write their name on the paper. This meant that their responses would not be identifiable. I made a conscious decision not to audio record their responses, as my main intention was to provide learners with a secure space to share their experiences, and then I only used those experiences to support the design of the learner survey.

In comparison to the initial design of focus groups, the workshop offered a more familiar and less formal setting for the learners. It gave learners the opportunity not only to share and listen to each other's experiences but also to enhance their learning and actively engage with WPs.

Lastly, I led the workshop. For participants, my role was threefold: researcher, mathematics teacher, and curriculum manager. I was aware that this arrangement could potentially lead to power tensions and create confusion. However, the participants were well aware of my identity as teacher as they had seen me before in their classrooms, in my office and around college. From the beginning, it was made clear that it would be me conducting the workshop and that attendance was optional and open to every GCSE resit learner. Participants were assured that their responses would have no negative impact on any college records or grades. If any safeguarding concerns arose, the college's safeguarding policy – of which students were fully aware – would be followed. They understood that my role was to listen to their stories, facilitate the conversations and provide strategies that could help them improve their understanding and approach to WPs. Their narratives were treated with respect and confidentiality.

Navigating the dual roles of manager/teacher and researcher created some tensions for me during the workshop. As a manager and teacher, my primary focus was on supporting and guiding the resit students, while also overseeing their academic progress and fostering a positive learning environment. However, as a researcher, I had to step back and maintain an objective stance, which sometimes conflicted with my instinct to intervene or provide immediate feedback during discussions. This dual identity also raised concerns about how the student-participants might perceive me – whether they saw me as someone evaluating their performance or as a neutral researcher interested in their experiences. The possibility that they might withhold their true feelings or tailor their responses to please me was a constant concern. I had to consciously navigate these tensions, ensuring that I remained as neutral as possible in my research role, while also being mindful of my responsibilities and relationship with my students as both their manager and teacher.

Similar to the teacher survey, power dynamics were also present in the workshop setting. As both a researcher and a curriculum manager, my position could have influenced how student participants engaged with discussions, potentially leading them to moderate their responses or participate in ways they believed would be viewed favourably. To mitigate this, I reassured participants that their contributions would remain confidential, that there were no right or wrong answers, and that their responses would not impact their academic progress or college records.

### 3.6.3 Trustworthiness

While interpretive research is acknowledged for its capacity to provide rich contextual insights, it frequently faces criticism concerning the validity, reliability, and generalisability of its findings (Perry, 1998). Consequently, ‘trustworthiness’ is instead often the focus as evidence of robustness of the research process.

Cuba and Lincoln (1985), for example, argue that trustworthiness as manifested in credibility, transferability, dependability, and confirmability should be established, rather than attempting to demonstrate validity and reliability as understood in quantitative terms.

According to Stahl and King (2020), credibility in qualitative research is akin to the concept of validity in quantitative research, with a focus on internal validity. Ensuring the credibility of qualitative data involves incorporating various viewpoints during data collection to verify the appropriateness of the data. This can be achieved through techniques such as triangulation (data, investigator, or theoretical), participant validation or member checks, or employing rigorous data gathering methods. However, triangulation occupies a less determinist role in qualitative research than in quantitative.

Transferability is comparable to the concept of generalisability in quantitative research; however, it is distinct from generalisability (Stahl & King, 2020). While generalisability pertains to the broader applicability of findings, transferability focuses on the relevance and application of the findings to similar contexts or individuals rather than broader ones. To enhance transferability, it is essential to provide a ‘thick description’ of the findings obtained from multiple data collection methods. Those then might indicate a range of similar, though likely not identical, findings elsewhere.

Dependability in qualitative research shares similarities with reliability in quantitative studies. Ensuring dependability involves employing meticulous data collection methods and procedures, along with well-documented analysis processes (Stahl & King, 2020). Typically, an inquiry audit conducted by an external reviewer or a university committee helps confirm the dependability of the research.

Confirmability in qualitative research shares similarities with objectivity in quantitative studies. However, objectivity is not attainable in interpretivist research, provided that personal biases are transparently addressed in the research write-up. The process of addressing personal bias can be accomplished through a bracketing interview or in practicing reflexivity (Stahl & King, 2020). Confirmability in qualitative data are enhanced by subjecting the data to thorough scrutiny and validation during both the data collection and the analysis phases, ensuring that the findings could likely be understood and recognised as authentic by other researchers. This confirmability can be documented by implementing a well-defined coding schema that clearly identifies the codes and patterns identified in the analysis, often referred to as an audit trail (Korstjens & Moser, 2018). Additionally, confirmability can be upheld through practices such as triangulation and member checking of the data, as well as conducting a bracketing interview or engaging in reflexivity to acknowledge and confront potential personal biases.

However, acknowledging the high level of subjectivity in interpretivist research is crucial. If another researcher was carrying out my workshop according to my instructions, not only would the workshop be different, but also the participants' responses would be different and the researcher's interpretations and responses to them would be different too. Similarly, if the surveys were to be analysed by another researcher, themes and codes would have been assigned and interpreted differently.

Having the roles of manager/teacher and researcher brought specific challenges, particularly regarding the Hawthorne effect. As a researcher, I was aware that my presence could influence participants' behaviours and responses, leading them to alter their responses or actions simply because they knew they were being observed (Perera, 2023). This was a significant concern, as it could impact the authenticity of the data collected. Participants might have been more inclined to provide responses they believed I wanted to hear or behave in ways that aligned with their perceptions of my expectations as their manager or teacher. This awareness of being observed could inadvertently shape their contributions, making it difficult to distinguish between their genuine experiences and those influenced by the research context (Perera, 2023). Managing this tension required a careful balance between maintaining my role as a researcher and addressing the potential impact of my dual identity on the participants' responses.

In the following paragraphs, I elaborate on the techniques I employed to establish trustworthiness, maintain research quality, and uphold rigor in my study.

#### *3.6.3.1 Credibility*

To enhance the credibility of my research, I implemented several strategies, including prolonged engagement in the field, member checks, and cross-checking of data (Amin et al., 2020). Having been actively involved in the field of FE both as a mathematics teacher and a curriculum manager for seven years, I have accumulated substantial experience and knowledge regarding GCSE Mathematics resit learners, who are the subject of my research. This extended engagement has allowed me ample time to immerse myself in the FE mathematics culture, fostering trust and rapport with its members, including learners, teachers and senior leaders. So far, my experience working with post-16 GCSE Mathematics resit learners has provided me with the opportunity to identify specific characteristics and factors that seem to have an impact on their engagement, learning, and academic achievement. Naturally, this has allowed me to delve more deeply into these aspects.

While my extended involvement in FE provided the rationale for my research, it was the ongoing and persistent observations made over the years that truly enriched the depth of my study. Prior to and during my EdD journey, I actively participated in action research projects and collaborated with internal working groups dedicated to better comprehending the needs and enhancing the learning experiences of our resit learners. This wealth of knowledge and practical experience served as the foundation for my present research study.

Furthermore, I employed three distinct data gathering methods to address my research questions – the student revision workshop, the teacher survey, and the student survey – and each method informed the planning and development of the others. Additionally, insights from existing literature on post-16 GCSE Mathematics played a role in shaping my research methods. For example, given that current research often portrays resit students as disengaged with GCSE Mathematics, having low confidence, and generally showing negative predispositions (Bellamy, 2017; Higton et al., 2017; Noyes & Dalby, 2020b), I chose to employ primarily qualitative data collection methods. This approach was intended to capture their narratives regarding their experiences with mathematics and their approaches to word problems (WPs).

Each data source was carefully associated with a specific research question, thereby offering supportive evidence for that particular inquiry. This corroborative approach was further strengthened by triangulating the information from different data sources. As a result, my research methods and tools were thoughtfully aligned with the research objectives and the coding framework employed for data analysis.

Throughout the data analysis phase and the writing of my thesis, my supervisors 'member-checked' my interpretations, provided valuable input, offering comments and posing questions to ensure the highest possible quality and rigor in my study. They guided me in examining the findings from various angles and consistently emphasised the importance of keeping my research questions at the forefront of my analysis. I revisited the data myself multiple times, approaching it with a fresh perspective, to ensure that my inferences remained coherent and aligned with the data.

#### *3.6.3.2 Transferability*

Transferability in qualitative research does not hold the same significance as external validity in quantitative research. External validity, in its strict sense as used in quantitative methods, is unattainable in qualitative naturalistic research (Stahl & King, 2020). What I can do as qualitative researcher is to provide a detailed description of the process, the environment, and the outcomes of the research. Through the detailed description of both the entire research process and the study's context, as well as the information and outcomes that arise, any interested reader can arrive at a specific conclusion regarding whether these elements are appropriate to their research or could be useful to them themselves.

Although the findings presented in Chapter 4 are specific to my FE college, they are likely to be indicative for the broader context of post-16 GCSE Mathematics resit learners. I note, however, that they might well change with time as the participant students and teachers were, for example, significantly impacted by in- and peri-pandemic constraints on teaching and learning that will have impacted their experiences and perceptions. But they do shed light on and provide a deeper understanding of the mathematical context for a group of learners about whom we currently have limited knowledge.

#### *3.6.3.3 Dependability*

This research study utilised three complementary sources of data collection: a teacher survey, a learner workshop, and a learner survey. Before implementing each method, a pilot process was conducted to enhance the rigor of the questions asked. Additionally, a thorough and transparent audit trail documenting the research process, including data collection, coding, and analysis, was maintained. I was consistent in data collection and analysis procedures throughout the study, and I made sure to clearly document any changes or deviations from the initial research plan.

#### *3.6.3.4 Confirmability*

Confirmability in qualitative research, as previously noted, is similar to objectivity in quantitative studies but is approached differently within the interpretivist paradigm. Recognising that complete objectivity is not achievable, I focused on ensuring that my personal biases were transparently acknowledged and systematically managed.

Firstly, I practiced reflexivity throughout the research process, regularly reflecting on how my own experiences, beliefs, and expectations might influence my interpretations. This reflexive practice involved keeping a research journal where I documented my thoughts and decisions at various stages of the study, allowing me to continuously check and challenge my assumptions.

Additionally, I ensured confirmability by implementing a detailed coding process, which served as a clear audit trail of how themes and patterns were identified and interpreted in the data. This process was meticulously documented, outlining the steps taken during data analysis and providing a transparent account of how the codes were applied to the data. This audit trail can enable other researchers to follow the analytical process and understand how conclusions were drawn, thereby enhancing the study's credibility.

(Qualitative) triangulation was another key strategy employed to bolster confirmability. By using available data sources and perspectives, I was able to cross-check and validate the findings, reducing the influence of any single source of bias. This triangulation process, while sometimes thought inappropriate for interpretivist research, helped to a small extent to ensure that the themes and conclusions were supported by the data.

Finally, confirmability was strengthened through the involvement of external evaluators – my supervisors – who rigorously examined both the process and the product of the research.

They provided critical feedback at various stages, ensuring that the methods used were appropriate and that the conclusions were not overly influenced by personal biases. This external review process served as an additional safeguard against excessive potential bias, ensuring that the research findings were credible and trustworthy.

In the next chapter I turn to the findings from the methodology described in this chapter.

# Chapter 4: Findings

This chapter presents the key findings from this study, bringing together data collected from teachers and learners across two FE colleges. The chapter begins with insights from the online teacher survey and the student workshop, both of which informed the design of the larger student survey. The next sections focus on the responses from the student survey, exploring learners' experiences and attitudes towards mathematics and WPs. Particular attention is given to differences based on gender and the distinction between persistent low attainers and first-time resit students. The findings are structured around three main areas: learners' relationship with mathematics and their self-image, disruptions to learning in Year 11, and learners' understanding, emotional responses, and strategies when working on word problems. Together, these findings form the basis for the discussion in Chapter 5.

## 4.1 Findings from the Online Teacher Survey and the Workshop

This section presents the findings from two key components of the data collection process: the online teacher survey (n=5) and the student workshop (n=12), both in College A. These both fed into the design of the student survey. The teacher survey was designed to explore College A's GCSE mathematics resit teachers' beliefs, perceptions, and teaching practices in relation to WPs. Part A included closed-ended questions that examined attitudes towards the learning of mathematics, teaching strategies, and classroom interactions, while Part B prompted for open-ended responses about teachers' views on the importance of WPs, the challenges learners face, and the strategies teachers advise their students to use. The questions were taken and adjusted to the GCSE context, from TIMSS 1999 since those questions were well trialled and validated and offered the potential to compare study responses with those from teachers of year 5 and 9 (see Appendix D). Complementing the teacher perspective, the student workshop offered insights into how resit learners themselves experience mathematics and WPs. Divided into three parts, the workshop enabled learners to reflect on their past experiences with mathematics, discuss potential approaches to solving WPs, and engage with actual exam-style problems. These dual perspectives, teacher and student, provide a rich foundation for understanding the interplay between teaching practices and learner experiences.

## 4.1.1 Findings from the Online Teacher Survey

### *4.1.1.1 Part A*

In the initial section of this part, participants were asked to categorise six statements regarding what is important for a resit learner to be able to do in order to make progress with GCSE mathematics. The purpose of these statements was to gain an understanding of the teacher beliefs, and the classroom priorities related to supporting GCSE mathematics resit students with each item reflecting a different aspect of mathematical competence or cognitive skill.

*Table 8: Teacher-participants' responses on Question 1, Part A*

| To be able to progress with GCSE mathematics, how important do you think for resit students to ... | Not Important | Somewhat Important | Very Important |
|---|---|---|---|
| a) remember formulas and procedures | - | - | 100% |
| b) think in a sequential and procedural manner | - | - | 100% |
| c) understand GCSE mathematics concepts, principles and strategies | - | - | 100% |
| d) be able to think creatively | 20% | 60% | 20% |
| e) understand how mathematics is used in the real world | 20% | 40% | 40% |
| f) be able to provide reasons to support their written solutions | | 20% | 80% |

In the second section, teacher-participants asked to rate statements related to the nature of GCSE mathematics, teaching approaches when learners struggle with mathematics, and their beliefs around the innate aptitude of some students for mathematics. The purpose here was to see how teachers conceptualise mathematics and view student learning, especially when working with students who have previously not succeeded in GCSE mathematics. These beliefs could significantly influence the choice of teaching approaches and student expectations and set the foundation for teacher-student relationships.

*Table 9: Participants' responses to Question 2, Part A*

| *1 = Strongly disagree – 5 = Strongly agree* | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **a) GCSE mathematics is primarily an abstract subject** | 20% | 20% | 40% | 20% | - |
| **b) GCSE mathematics is primarily a formal way of representing the world** | - | 20% | - | 40% | 40% |
| **c) GCSE mathematics is primarily a practical and structured guide for addressing real situations** | - | 20% | - | 40% | 40% |
| **d) If resit students are having difficulty, an effective approach is to give them more practice by themselves during the class** | 20% | 20% | 20% | 20% | 20% |
| **e) Some students have a natural talent for mathematics and others do not** | - | - | 60% | - | 20% |
| **f) More than one representation (picture, concrete material, symbol set, method, etc.) should be used in teaching GCSE mathematics topics** | | | | | 100% |
| **g) GCSE mathematics should be learned as sets of algorithms or rules that cover all possibilities** | 20% | 20% | 20% | 20% | 20% |
| **h) An understanding of resit students' characteristics is essential for teaching GCSE mathematics** | 20% | - | 20% | 20% | 40% |

In the third section, participants were prompted to indicate the frequency with which they employ each of six teaching approaches in their lessons. These questions aimed to understand the ways teachers engage students in different types of mathematical activity during GCSE mathematics lessons. These approaches are similar to what was presented in section 2.3.5 regarding approaches to word problems.

*Table 10: Participants' responses on Question 3, Part A*

| **In your GCSE mathematics lessons, how often do you ask your students to do the following:** | **Never/Almost never** | **Some lessons** | **Most lessons** | **Every lesson** |
|---|---|---|---|---|
| **a) Explain the reasoning behind an idea (written or verbally)** | - | - | 40% | 60% |
| **b) Represent and analyse relationships using tables, charts, or graphs** | - | 80% | 20% | - |

| | | | | |
|---|---|---|---|---|
| **c) Work on problems for which there is no immediately obvious method of solution** | - | 60% | 40% | - |
| **d) Use computers to solve questions or problems** | 20% | 80% | - | - |
| **e) Write equations to represent relationships** | - | 80% | 20% | - |
| **f) Practice numeracy skills** | - | - | 60% | 40% |

In the fourth and final section of Part A, participants were asked about the frequency with which their resit learners engage in individual work, work in pairs/small groups, or engage in whole class discussions with or without teachers' assistance. These statements aimed to provide an understanding of the predominant mode of reported classroom interactions and to what extend resit students experience collaborative learning. This is important because resit students are often presented as having low confidence and low engagement, and the structure of classroom activities and interactions can significantly impact their re-engagement and learning outcomes.

*Table 11: Participants' responses on Question 4, Part A*

| In your GCSE mathematics resit lessons, how often do students ... | Never/Almost never | Some lessons | Most lessons | Every lesson |
|---|---|---|---|---|
| **a) work individually without assistance from the teacher** | 40% | 40% | 20% | - |
| **b) work individually with assistance from the teacher** | - | 20% | 40% | 40% |
| **c) work together as a whole class with the teacher teaching the whole class** | - | - | 60% | 40% |
| **d) work together as a class with students responding to one another** | - | - | 80% | 20% |
| **e) work in pairs of small groups without assistance from the teacher** | - | 80% | 20% | - |
| **f) work in pairs or small groups with assistance from the teacher** | - | 60% | 40% | - |

#### *4.1.1.2 Part B*

The second part of the survey was dedicated to word problems. The objective was to gain insights into teachers' perspectives on WPs, the approaches/methods they advise their resit learners to follow when working with WPs, and their perceptions of the challenges encountered by resit learners in solving WPs. The questions in this part were open-ended to prompt the teacher participants to think about the methods (if any) they use in the classroom to support their learners understanding and work with WPs. Because the sample is small (n=5), participants' responses are unlikely to be fully representative of wider GCSE resit teachers' perspectives. However, participants gave valuable information which gave a clear picture on their perspectives towards WPs and the struggles their learners face and might well be indicative of broader patterns.

**Importance of solving WPs for GCSE mathematics**

All participants agreed that the ability of knowing how to approach and solve a WP in GCSE mathematics is *extremely important.* According to their responses, they recognise that a substantial proportion of the GCSE mathematics curriculum requires learners to be able to correctly solve WPs, so learners need to develop the skills needed during their resit year. Two of the participants pointed out that solving WPs is the essence of mathematics education and maybe one of the most interesting parts in teaching mathematics.

**Difficulties faced by resit students in solving WPs**

The participants identified the following difficulties their learners seem to face in their work with WPs: analyse the information given and interpret them mathematically, unable to recall basic maths facts, procedures, rules or formulae, the length of a WP putt learners off, problems with language comprehension, weak numeracy skills, unrelatable content, and unable to recognise mathematical concepts hidden in the text of a WP. Examples of participants' responses can be seen below:

> *"[students find difficult] to turn words into calculations".*
>
> *"[students find difficult] analysing the information and presenting their solutions systematically".*
>
> *"Some students find word problems long and are put off before they even try. For many students, multi-step procedures seem to be too abstract. Language comprehension is a barrier for many students. Not being able to recognise*

*mathematical concepts hidden in a text. The content of many problems is not relevant for the age of students and their interests. Weak basic numeracy skills."*

**Causes of resit learners' difficulties with WPs**

According to the various participants' responses, the potential reasons for their learners' challenges with WPs can be attributed to significant knowledge gaps, inadequate literacy skills, and a lack of comprehension of mathematical terminology. One participant highlighted the influence of previous schooling experiences in the learners' relationships with mathematics, leading to a lack of mathematical resilience and diminished confidence. The same participant also pointed out the potential impact of a learner's family on their engagement with mathematics, mentioning numeracy neglect or a lack of intellectual (mathematical) stimulation at home. Examples of participants' responses can be seen below:

*"[students don't know] how to break it down into steps and where to begin".*

*"[the difficulty comes from] not knowing all their topics well".*

*"I think the learners who struggle with these types of questions require further assistance with their comprehension skills. […] [M]any learners do not have the numerical capabilities required to solve the questions".*

*"[…] Students may also have difficulty with reading, writing and speaking […] these students may have difficulty understanding written or verbal directions or explanations and find word problems especially difficult to understand".*

*"Previous experience in maths education. […] Lack of professional and passionate teachers in primary school not being able to teach problem solving or develop interest in problem solving among young learners. Family background – numeracy neglect, lack of intellectual stimulation at home. […] Lack of mathematical resilience".*

**Strategies teachers advise their resit learners to follow when solving WPs**

*Table 12: Participants responses on Questions 5 and 6, Part B*

| | How the teacher approaches a WP | How the teacher advises a learner to approach a WP | Where did the teacher learn the approach(es) |
|---|---|---|---|
| **Teacher 1** | Breaks the WP into steps | Look for key words | School |
| **Teacher 2** | Highlights key words and uses logical thinking | Highlight the key words then decide what method to use | School |
| **Teacher 3** | Looks for patterns, relates worded and non-worded questions to draw comparisons | Highlight key words, look for patterns, find totals, groups & variables, apply a reusable method | Trial and error |
| **Teacher 4** | Writes the meanings of the words, draws pictures | Write the meaning of the words, draw pictures, give examples | CPD sessions |
| **Teacher 5** | Separates known from unknown, underlines key words, uses/draws pictures when possible, identifies mathematical concepts needed | Read the WP carefully (several times if needed), replace the names/words on the problem with yours to make it personal, underline what is known and write what is unknown, draw a picture if you can, check if your answer makes sense | University<br>*How to solve it* by George Polya<br>Teaching practice |

## 4.1.2 Findings from the Workshop

To recap, the student workshop was divided in three parts, reflecting its threefold purpose: firstly, to provide participants the opportunity to reflect on previous schooling experiences with mathematics and WPs; secondly, to discuss and demonstrate approaches they could employ when working with WPs; and finally, to build up the experience of these approaches on past examination questions. The complete PowerPoint presentation used during the workshop is available in Appendix A. The main objective of the first part was to gather data for the research, informing the development of the online student survey but also to contextualise later discussion. The second and third parts aimed to contribute to and refine participants' existing learning, improving their proficiency with WPs. Below, I present the data collected and analysed from the first part of the workshop which was used to develop the online student survey.

#### *4.1.2.1 Past experiences with mathematics*

*Table 13: Student-participants' summary responses on their past experiences with mathematics*

| **Question theme** | **Participants' response (n=12)** |
|---|---|
| **Relationship with mathematics** | Nine out of 12 used strong negative words such as *hate, horrible, emotional wreck*, and *painful process* to describe their relationship with mathematics.<br><br>One said that they have a "*good relationship*" and another one that sometimes they *"hate maths*" and other times they *"enjoy it".* |
| **Year 11 incidents** | Seven out of the 12 participants suggested that *covid ruined* their learning and that they struggled with online lessons.<br><br>One participant said the following to express the impact that the pandemic had on them: "*When lockdown came the student in me died*". |
| **Maths teachers** | Mixed responses in this, a third of the learners had mostly something negative to say about their past maths teachers, another third had experienced good teachers, and a final third could not remember any of their maths teachers. |
| **Styles of teaching** | Mixed responses mentioning teacher on the board, group work, use of online apps, independent work and teacher going around the class to check, and one-to-one teaching. |
| **Self-image as a maths student** | A quarter of the participants used some positive words such as "*hardworking*", "*confident*", "*try hard*".<br><br>Half of the participants used negative words to describe themselves as a maths student such as "*never understand*", "*tend to quit*", "*not the best*", "*impatient*", "*bad memory*", "*don't do well in exams*". |

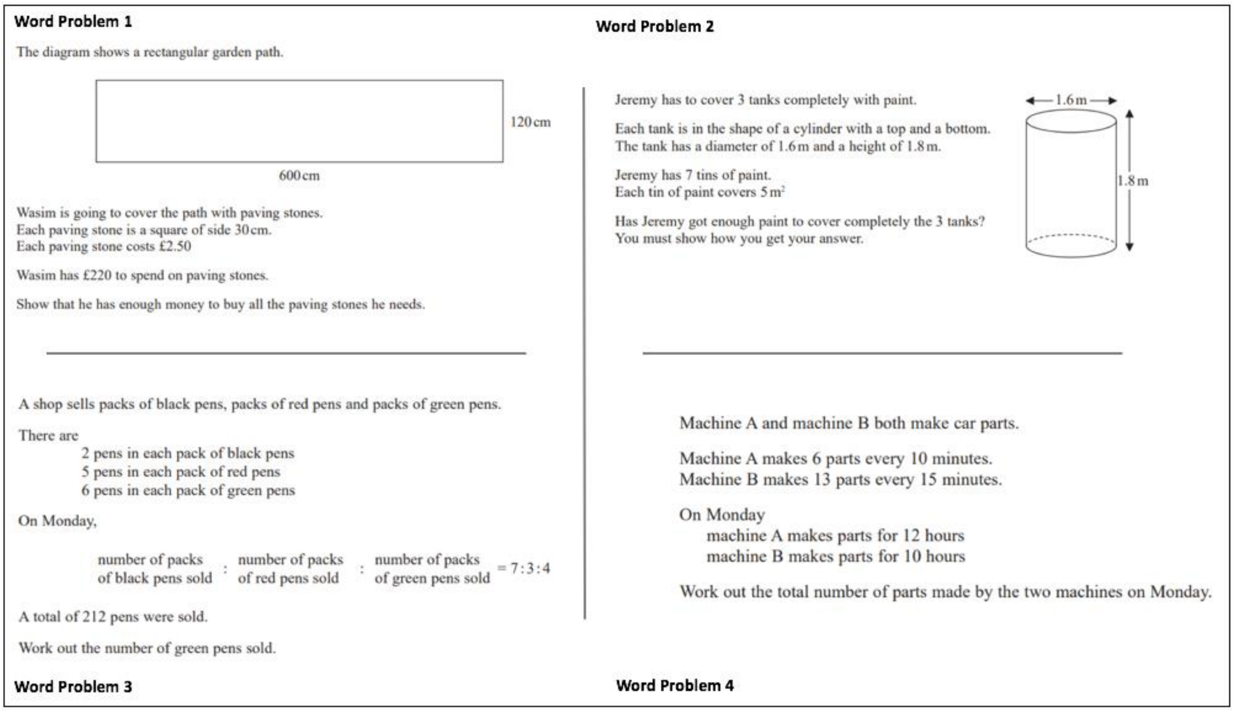
#### *4.1.2.2. Participants' Perceptions about WPs*

*Table 14: Student-participants' summary responses on their perceptions about WPs*

| Question theme | Participants' response |
|---|---|
| **First thing in mind when hear the phrase 'word problem'** | Almost half of the participants gave a 'definition' of a WP, referring to it as *a maths question written in words.*<br><br>A quarter expressed that negative feelings arise when faced with a WP.<br><br>One participant referred to the steps that need to be taken to solve a WP. |
| **Approaches to solve a WP** | The majority said that they remember to have been given instructions on how to solve/approach a WP but could not remember those instructions.<br><br>A quarter of the participants mentioned the approach of *"underlining" or "highlighting key words".*<br><br>Two participants mentioned the approach of *breaking down the problem*. |
| **Feelings related to solving a WP** | *"Confused", "annoyed", "pressured", "makes me want to give up", "do not understand what to do", "anxious", "frustrated".* |

#### *4.1.2.3 Word Problem Task*

The participants were shown two versions of each of the WPs, one including only the context and one complete version including the actual question. Participants' feedback indicate that the context-only version of the WP was less stressful as they were not asked to do or solve anything. Once shown the complete version of the WP they felt confused and were not sure how to approach the WPs (Figure 5).



**Word Problem 1**

The diagram shows a rectangular garden path.

120 cm

600 cm

Wasim is going to cover the path with paving stones.
Each paving stone is a square of side 30 cm.
Each paving stone costs £2.50

Wasim has £220 to spend on paving stones.

Show that he has enough money to buy all the paving stones he needs.

**Word Problem 2**

Jeremy has to cover 3 tanks completely with paint.

Each tank is in the shape of a cylinder with a top and a bottom.
The tank has a diameter of 1.6 m and a height of 1.8 m.

Jeremy has 7 tins of paint.
Each tin of paint covers 5 m²

Has Jeremy got enough paint to cover completely the 3 tanks?
You must show how you get your answer.

1.6 m

1.8 m

**Word Problem 3**

A shop sells packs of black pens, packs of red pens and packs of green pens.

There are
2 pens in each pack of black pens
5 pens in each pack of red pens
6 pens in each pack of green pens

On Monday,

number of packs of black pens sold : number of packs of red pens sold : number of packs of green pens sold = 7 : 3 : 4

A total of 212 pens were sold.

Work out the number of green pens sold.

**Word Problem 4**

Machine A and machine B both make car parts.

Machine A makes 6 parts every 10 minutes.
Machine B makes 13 parts every 15 minutes.

On Monday
machine A makes parts for 12 hours
machine B makes parts for 10 hours

Work out the total number of parts made by the two machines on Monday.

*Figure 5: Word Problems used in the workshop task*

According to participants' responses, WP1 was perceived as simpler than the other three word problems in terms of both comprehension and identifying what was being asked. Except for two participants who were unsure whether it was an area or perimeter problem, the majority correctly identified the steps needed to solve it. Additionally, participants did not express any difficulty in understanding the language used.

In WP2, all participants except one, failed to identify the mathematical concept of surface area and were unsure where to begin. When asked what made the problem confusing, many pointed to mathematical vocabulary such as cylinder, diameter, and m², which initially distanced them from the context of the problem. However, most participants eventually managed to understand the situation described.

In WP3, participants correctly recognised that the problem involved ratio, but struggled to identify the steps needed to solve it. They found it challenging to connect the two parts of the problem, specifically, the number of pens in each pack and the ratio of packs sold. Most participants, however, did not appear to have difficulty with contextual understanding or language comprehension.

Finally, in WP4, participants demonstrated good contextual understanding and did not report issues with the language. More than half correctly identified multiples as the key mathematical concept, and most of them found it difficult to connect the 12- and 10-hour cycles with the relevant multiples needed to solve the problem.

### 4.1.3 In summary

Overall, the findings from both the teacher survey and the student workshop point to the multifaceted nature of the challenges resit learners face when engaging with GCSE mathematics and WPs. Teachers broadly agreed on the value of conceptual understanding and multiple representations, yet their reported practices suggest a limited use of more exploratory or creative approaches in the classroom. Open-ended responses further revealed a clear awareness among teachers of the specific barriers students encounter ranging from weak numeracy skills and difficulties in language comprehension to a lack of confidence and mathematical resilience.

From the student perspective, the workshop revealed a strong emotional response to mathematics and WPs, often rooted in previous negative schooling experiences and disrupted learning due to the COVID-19 pandemic. While some participants could recall strategies taught in school, many struggled to articulate or apply them, indicating a potential disconnect between instructional intent and learner uptake. Their responses to specific WP tasks highlighted issues with mathematical vocabulary, interpretation, and the integration of multiple steps.

Taken together, the findings highlight the importance of addressing both the cognitive and affective dimensions of learning for resit students. They suggest a need for targeted interventions that build not only mathematical skills but also learner confidence and resilience. These insights were used to develop the online student survey and will be revisited in the discussion chapter, where they will be considered in relation to the broader aims of this study.

## 4.2 Findings from the Online Student Survey

A total of 112 resit learners responded to the online student survey from College A and 37 from College B. The general characteristics of all participants by college and combined can be seen in Tables 15-17.

*Table 15: General characteristics of College A participants in the online learner survey*

| College A (n=112) | Number of times students will have resat GCSE Mathematics | |
|---|---|---|
| | Preparing for 1st sitting of GCSE Maths | 0 (0%) |
| | 1st time resit (preparing for 2nd attempt at GCSE) | 75 (67%) |
| | 2 or more times resitting (preparing for 3rd or later attempt at GCSE) | 37 (37%) |
| | **English as first language** | |
| | Yes | 74 (6%) |
| | No | 38 (34%) |
| | **Years of studying in the UK** | |
| | Whole life | 83 (74%) |
| | Less than 5 years | 17 (15%) |
| | More than 5 years (but less that whole life) | 12 (11%) |
| | **Gender** | |
| | Female | 60 (53%) |
| | Male | 50 (45%) |
| | Prefer not to say | 2 (2%) |

*Table 16: General characteristics of College B participants in the online learner survey*

| College A + B (n=37) | Number of times students will have resat GCSE Mathematics | |
|---|---|---|
| | Preparing for 1st sitting of GCSE Maths | 2 (6%) |
| | 1st time resit (preparing for 2nd attempt at GCSE) | 22 (13%) |
| | 2 or more times resitting (preparing for 3rd or later attempt at GCSE) | 13 (35%) |
| | **English as first language** | |
| | Yes | 14 (38%) |
| | No | 23 (62%) |
| | **Years of studying in the UK** | |

| | | |
|---|---|---|
| | Whole life | 14 (38%) |
| | Less than 5 years | 13 (35%) |
| | More than 5 years (but less that whole life) | 10 (27%) |
| | **Gender** | |
| | Female | 16 (38%) |
| | Male | 20 (54%) |
| | Prefer not to say | 1 (3%) |

*Table 17: General characteristics of College A + B participants in the online learner survey*

| **College A + B (n=149)** | **Number of times students will have resat GCSE Mathematics** | |
|---|---|---|
| | Preparing for 1st sitting of GCSE Maths | 2 (1%) |
| | 1st time resit (preparing for 2nd attempt at GCSE) | 97 (65%) |
| | 2 or more times resitting (preparing for 3rd or later attempt at GCSE) | 50 (33%) |
| | **English as first language** | |
| | Yes | 88 (59%) |
| | No | 61 (41%) |
| | **Years of studying in the UK** | |
| | Whole life | 97 (65%) |
| | Less than 5 years | 30 (20%) |
| | More than 5 years (but less that whole life) | 22 (15%) |
| | **Gender** | |
| | Female | 76 (51%) |
| | Male | 70 (47%) |
| | Prefer not to say | 3 (2%) |

The findings from both colleges, separately and combined, are presented below. The choice of presenting in charts or tables was determined by the nature of the data and the aim of providing readers with a clear and comprehensible presentation. Also, the findings are presented both by separate college and combined to mark any significant or insignificant trends in responses. Furthermore, while analysing the online learner survey data, I noticed variations in the responses between first-time resit learners and those who have resat GCSE Mathematics multiple times (2 or more times), referred to herein as ‘persistent low attainers’.

These distinctions primarily revolved around their attitudes towards learning and engagement with mathematics and WPs. Table 18 represents the proportion of PLA participants by college and as a total. There were also variations in responses between female and male participants in terms of their self-image as mathematics students and their attitudes towards mathematics. The findings presented below predominantly reflect insights from these two perspectives: PLAs/non-PLAs and female/male responses.

*Table 18: Number of participants from each college who fall under the PLA definition*

| **Persistent Low Attainers** | **College A (n=112)** | **College B (n=37)** | **Total (College A+B, n=149)** |
|---|---|---|---|
| **Female** | 23 (21%) | 5 (14%) | 28 (19%) |
| **Male** | 13 (12%) | 7 (19%) | 20 (13%) |
| **Total** | 36 (32%) | 12 (32%) | **48 (32%)** |

Findings fall into three categories:

1. Participants' relationship with mathematics and their self-image.
2. Disruptions during Year 11.
3. Experiences and approaches to word problems.

I present findings in the above order, drawing on data from the online learner survey.

### 4.2.1 Participants' Relationship with Mathematics and their Self-image

The relationship with mathematics was described by most participants in College A as being negative over their schooling years (Figure 6). Nonetheless, about a third appear to have had what I categorise as 'a positive relationship', with a small proportion reporting mixed feelings towards their relationship with mathematics over the years. In contrast to their relationship with mathematics, approximately half of all participants in College A used positive language to describe their current self-image as mathematics students, with less than a quarter using negative terms (Figure 6).

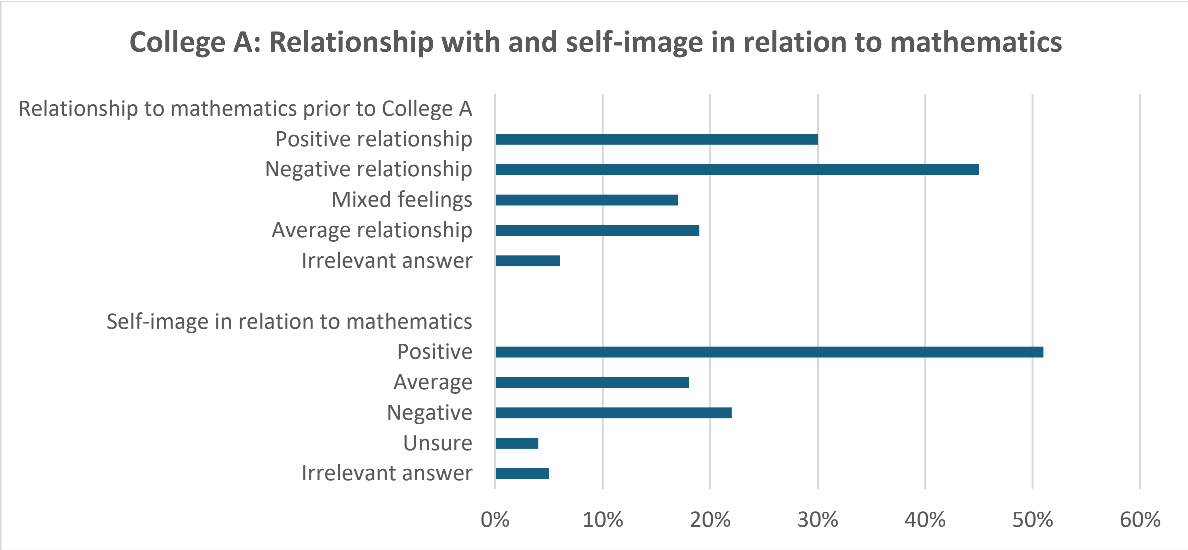



*Figure 6: College A participants' responses regarding their relationship with mathematics and their self-image as mathematics students.*

In contrast to College A, students' relationships with mathematics were described by most College B participants as being positive over their schooling years (Figure 7). Slightly more than a quarter reported having a negative relationship, with a small proportion reporting mixed feelings or average relationship with mathematics over the years. Almost half of the College B participants used positive language to describe how they view themselves as a mathematics student (Figure 7).

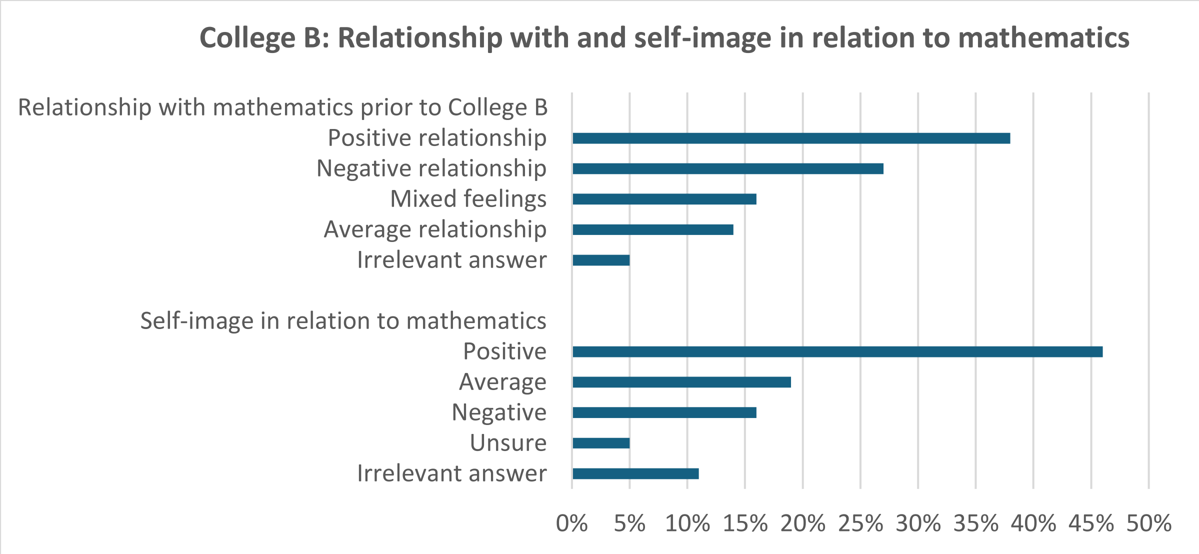



*Figure 7: College B participants' responses regarding their relationship with and self-image in relation to mathematics.*

When considering the combined data, the relationship with mathematics was described by most participants as having been 'negative' throughout their school years, likely influenced by the large difference in sample sizes between the two colleges (Figure 8). Nonetheless, about a third appear to have had a 'positive relationship', with a small proportion reporting mixed feelings towards their relationship with mathematics over the years. In contrast to their relationship with mathematics, half of all participants used positive language to describe their current self-image as mathematics students, with less than a quarter using negative expressions (Figure 8).

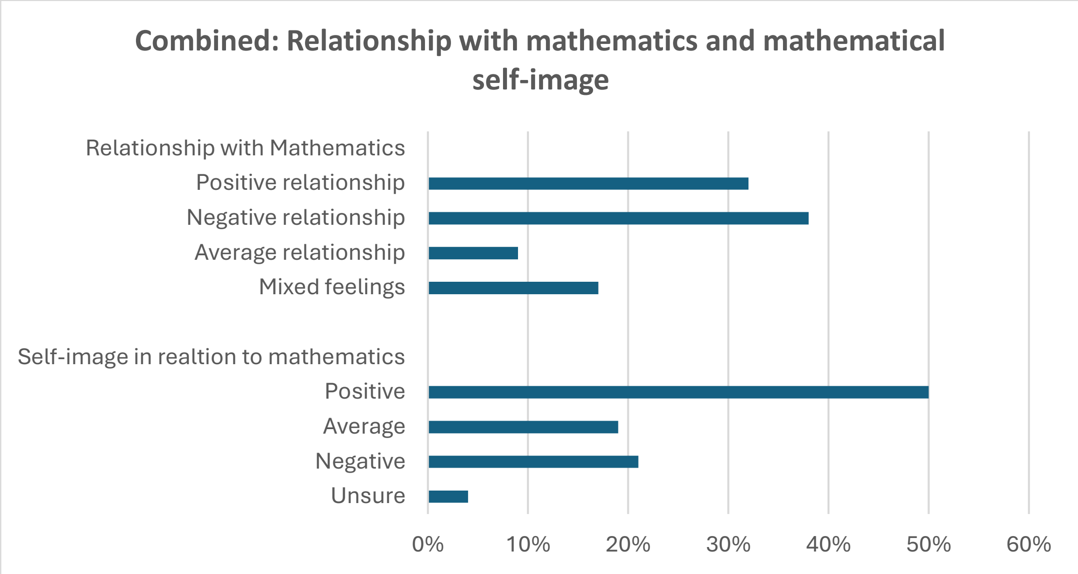



*Figure 8: Participants' responses regarding their relationship with mathematics and their self-image as mathematics students.*

As example of the categorisation, in Tables 19- and 20, I present selected quotations form participants' responses referring to negative/positive/mixed feelings towards their relationship with mathematics (Table 19) and the expressions I considered positive/negative/average regarding their self-image (Table 20).

*Table 19: Examples of participants' responses on their relationship with mathematics*

| **Negative relationship - 38% (n = 57/149)** |
|---|
| *"Not very good because I just don't understand very well and I always need help with nearly every question also I struggle to remember for exams".*<br>*"Maths has never been my strong subject".*<br>*"Terrible, I feel like I'm really bad at maths and no matter how hard I try it's still confusing to me".*<br>*"Always struggled with maths, never enjoyed it".*<br>*"Most of education has been negative and math is difficult to memorise because of its abstract nature. I find I'm good at maths but can't remember stuff".*<br>*"my teacher did not explain the explanation and when i asked for help he didn't help me".*<br>*"Scary since i was bullied for using my fingers in maths".*<br>*"Dreadful".*<br>*"Never really been good at it".*<br>*"Stressful".*<br>*"Hate it".* |
| **Positive relationship - 32% (n = 48/149)** |

| |
|---|
| *"Really good, I like maths".*<br>*"I have always been able to easily understand mathematics".*<br>*"I loved maths all the time".*<br>*"Yeah it is pretty good and I have good relationship with the teachers".*<br>*"It was so good, my favourite subject is maths as well".*<br>*"Good".*<br>"It was good and I am enjoying solving problems".<br>"I like maths as it is my first favourite subject requiring good topics."<br>"I find numbers very fascinating. I try to find easy solutions to the problems rather than doing it the complex way." |
| **Mixed feelings - 17% (n = 25/149)** |
| *"It's been good but hard because I will do good but when it comes to the test I do bad and I don't know why".*<br>*"I used to really dislike maths, I feel the more I understand it the more I like it".*<br>*"I don't favour maths that much but I understand that it's important to pass".*<br>*"At first, I find this subject very hard. I was struggling to get good grades so I hated this subject. But as I progress, I am starting to enjoy it. Now, I think I love maths more than Reading and Writing".*<br>*"Hate maths but I'm good at it".*<br>*"It has been easy to understand the problems where some of the questions are very hard for me."*<br>*"I always feel as if I was good at maths, however I always get poor grades."* |

These quotations provide rich insight into the emotional and cognitive aspects of participants' relationships with mathematics. Those who described negative relationships often refer to confusion, anxiety, vulnerability and a lack of support, with comments such as *"I feel like I'm really bad at maths*" and "*my teacher did not explain the explanation, and when I asked for help, he didn't help me".* These experiences might reflect what Boaler (2015) refers to as detrimental mathematical identity formation, meaning that learners internalise repeated failure or lack of (positive) feedback and begin to see themselves as inherently 'bad at maths'. The language used, *"dreadful", "stressful", "scary",* reflects the role of affect in shaping mathematical self-image (Hannula, 2006), showing how emotional responses to mathematics, whether rooted in teaching, assessment, or peer interactions, could shape long-term attitudes. In contrast, those reporting positive relationships used concise yet confident affirmations such as *"I like maths"* or *"It was so good, my favourite subject is maths."* These responses suggest a sense of competence and enjoyment. Responses reflecting mixed feelings towards mathematics are particularly interesting, highlighting the non-linear and evolving nature of learners' relationships with mathematics. For example, comments such as *"I used to* *really dislike maths, [but] the more I understand it the more I like it"* suggest the potential for transformation over time, especially when understanding improves. This supports the idea that mathematical identity is fluid and context-dependent (Bibby, 2013), influenced not only by performance but by the learner's perceived trajectory and experiences of agency and support. Overall, these participants' voices show that a student's relationship with mathematics is rarely just about ability; it is shaped by experience, context, and emotion.

*Table 20: Examples of participants' responses on their self-image as a mathematics student*

| **Negative self-image - 21% (n = 32/149)** |
|---|
| *"Demotivated, because I find it hard to understand and failed already".*<br>*"Lazy".*<br>*"Not motivated".*<br>*"Stressed".*<br>*"Below average".*<br>*"Weak in maths".*<br>*"I am not that great of a mathematician, I'm sometimes lazy when it comes to maths and unfocused".*<br>*"Most of education has been negative and math is difficult to memorise because of its abstract nature. I find I'm good at maths but can't remember stuff".*<br>*"my teacher did not explain the explanation and when i asked for help he didn't help me".*<br>*"Scary since i was bullied for using my fingers in maths".* |
| **Positive self-image - 50% (n = 74)** |
| "It was good and I am enjoying solving problems"<br>"I like maths as it is my first favourite subject requiring good topics."<br>"I find numbers very fascinating. I try to find easy solutions to the problems rather than doing it the complex way."<br>*"I think I am pretty ok at maths".*<br>*"Responsible".*<br>*"Hardworking".*<br>*"I am very interactive, I try to ask questions to [my teacher] to help me understand where I am at with my learning".*<br>*"Focused".*<br>*"Good maths student with potential".*<br>*"I would describe myself hard driven and persistent".* |
| **Average self-image - 19% (n = 28)** |
| *"Hate maths but I'm good at it".*<br>*"It has been easy to understand the problems where some of the questions are very hard for me".*<br>*"I always feel as if I was good at maths, however I always get poor grades".*<br>*"Decent but struggles a lot".* |

*"Average learner trying to pass".*
*"I could be better".*
*"Not the best but pretty average".*

The responses regarding participants' mathematical self-image align with mindset theory (Dweck, 2006), particularly the way in which fixed, or growth mindsets may influence a learner's perseverance, self-efficacy, and response to challenge. Importantly, they reveal the extent to which many GCSE resit students carry into Further Education not just a knowledge gap, but a deeply embedded emotional narrative around mathematics.

In the following two sections, I examine the data on learners' relationship with mathematics and their mathematical self-image in more depth. I present findings according to: (a) gender differences, and (b) this 'new' group of learners I refer to as persistent low attainers.

#### *4.2.1.1 Findings on relationship with mathematics and mathematical self-mage by gender*

Of the College A participants reporting a 'negative relationship' with mathematics and/or 'negative self-image' female participants were significantly more than the males (about 70% versus 26%). Contrary, of the College B participants who reported a 'negative relationship' and/or a 'negative self-image' there was an even split between females and males.

Table 21 shows a more detailed breakdown by individual colleges and specific gender. The focus here is to look deeper at the 'positive' and 'negative' so the 'mixed feelings' and 'average self-image' responses have been omitted. In College A, a higher proportion of male participants reported having a positive relationship with mathematics (36%) compared to their female peers (27%), while females are more likely to describe their relationship as negative (55% vs. 24% for males). This is also evident in participants' self-image: 60% of males describe themselves positively compared to 45% of females, while 30% of females report a negative self-image compared to 16% of males. In contrast, College B shows a more balanced picture, with similar proportions of males and females reporting both positive relationships (35% and 38% respectively) and negative relationships (25% and 31% respectively) with mathematics. Interestingly, in College B, females report a higher positive self-image than males (63% vs. 35%), which contrasts with what is observed in College A. It is important to remind the reader that the sample size in College B (n=37) was much smaller than that of College A (n=112), and the student demographics of College B differ from those of College A. Despite these differences, across both colleges, females consistently report higher levels of negative self-image than males, suggesting that issues of confidence and identity remain a key concern, particularly among female learners.

*Table 21: Relationship with mathematics and mathematical self-image by individual college and by gender.*

| College A (N=112) | Male (n=50) | Female (n=60) | College B (N=37) | Male (n=20) | Female (n=16) |
|---|---|---|---|---|---|
| **Positive Relationship (n=34: 16F, 18M)** | 36% of males | 27% of females | **Positive Relationship (n=14: 6F, 7M, 1PNS)** | 35% of males | 38% of females |
| **Negative Relationship (n=47: 33F, 12M, 2PNS*)** | 24% of males | 55% of females | **Negative Relationship (n=10: 5F, 5M)** | 25% of males | 31% of females |
| **Positive Self-Image (n=57: 27F, 30M)** | 60% of males | 45% of females | **Positive Self-Image (n=17: 10F, 7M)** | 35% of males | 63% of females |
| **Negative Self-Image (n=26: 18F, 8M)** | 16% of males | 30% of females | **Negative Self-Image (n=6: 3F, 3M)** | 15% of males | 19% of females |

When combining the data from both colleges, College A's influence is significant due to its sample size. Of all the participants reporting a positive relationship with mathematics, 46% were female and 52% were male. Overall, female participants were more likely to report a negative relationship with mathematics (67%) compared to male participants (29%), while males reported slightly more positive relationships towards mathematics. While the difference is modest, it suggests a slightly more favourable attitude towards mathematics among male participants.

Table 22 shows a more detailed breakdown combining the responses from both colleges and focusing on gender differences. Overall, male participants appear to have a slightly more positive relationship with mathematics than females, with 36% of males reporting a positive relationship compared to 29% of females. However, 'negative relationships' are more common among females (50%) than males (24%). When considering self-image as a mathematics learner, the findings is more balanced. Just over half of the males (53%) and nearly half of the females (49%) report a positive self-image, indicating that many learners see themselves as capable or confident in their mathematics learning, despite their broader relationship with the subject. Nonetheless, negative self-image is more frequently reported by females (28%) than by males (16%).

*Table 22: Combined - Relationship with mathematics and mathematical self-image - responses by gender*

| **Combined (N=149)** | **Male (n=70)** | **Female (n=76)** |
|---|---|---|
| **Positive Relationship (n=48: 22F, 25M)** | 36% of all males | 29% of all females |
| **Negative Relationship (n=57: 38F, 17M)** | 24% of all males | 50% of all males |
| **Positive Self-Image (n=74: 37F, 37M)** | 53% of all males | 49% of all females |
| **Negative Self-Image (n=32: 21F, 11M)** | 16% of all males | 28% of all females |

In summary, this comparison highlights some gender differences, especially in the perception of relationships and mathematical self-image, with females showing a tendency to develop a more negative relationship with mathematics and having a more negative mathematical self-image in comparison to the male participants. However, the findings show that negative (and lack of positive) both in relationships with mathematics and self-image around mathematics are much more a problem for the females in College A than for those in College B (especially when noticing the positive self-image for females at College B) which is a good reminder that it is important not to over-generalise and that individual colleges will always have differences.

#### *4.2.1.2 Findings on relationship with mathematics and mathematical self-mage with a focus on persistent low attainers*

In College A, of the participants who reported a 'negative relationship' with mathematics more than a third (38%) were PLAs and of the participants who reported a 'negative self-image', 42% were PLAs. Similarly, in College B, half of the participants who reported a 'negative relationship' and two thirds of the ones reported a 'negative self-image' were PLAs. In the case of persistent low attainers, responses follow similar patterns.

Table 23 presents a more detailed breakdown of the 'negative' and 'positive' responses focusing on those of PLAs. In College A, Non-PLAs (34%) are more likely than PLAs (22%) to report a positive relationship with mathematics, but PLAs are much more likely (50%) than Non-PLAs (38%) to report a negative relationship.

*Table 23: Relationship with mathematics and mathematical self-image by individual college - responses of PLAs*

| **College A (n=112)** *PNS: prefer not to say | **Positive Relationship (n=34: 16F, 18M, 8PLAs)** | **Negative Relationship (n=47: 33F, 12M, 2PNS*, 18PLAs)** | **Positive Self-Image (n=57: 27F, 30M, 14PLAs)** | **Negative Self-Image (n=26: 18F, 8M, 11PLAs)** |
|---|---|---|---|---|
| **Non-PLAs (n=76)** | 34% of the Non-PLAs | 38% of the Non-PLAs | 57% of the Non-PLAs | 20% of the Non-PLAs |
| **PLAs (n=36)** | 22% of the PLAs | 50% of the PLAs | 39% of the PLAs | 31% of the PLAs |
| **Female PLAs (n=23)** | 31% (n=5) of the 16 females | 39% (n=13) of the 33 females | 59% (n=10) of the 27 females | 44% (n=8) of the 18 females |

| | | | | |
|---|---|---|---|---|
| **Male PLAs (n=13)** | 17% (n=3) of the 18 males | 42% (n=5) of the 12 males | 13% (n=4) of the 30 males | 38% (n=3) of the 8 males |
| **College B (n=37)** | **Positive Relationship (n=14: 6F, 7M, 1PNS, 3PLAs)** | **Negative Relationship (n=10: 5F, 5M, 5PLAs)** | **Positive Self-Image (n=17: 10F, 7M, 4PLAs)** | **Negative Self-Image (n=6: 3F, 3M, 4PLAs)** |
| **Non-PLAs (n=25)** | 44% of the Non=PLAs | 20% of the Non-PLAs | 52% of the Non-PLAs | 8% of the Non-PLAs |
| **PLAs (n=12)** | 25% of the PLAs (2F, 1PNS*) | 42% of the PLAs | 33% of the PLAs | 33% of the PLAs (2F, 2M) |
| **Female PLAs (n=5)** | 33% (n=2) of the 6 females | 40% (n=2) of the 5 females | 20% (n=2) of the 10 females | 67% (n=2) of the 3 females |
| **Male PLAs (n=7)** | 0% of the 7 males | 60% (n=3) of the 5 males | 29% (n=2) of the 7 males | 67% (n=2) of the 3 males |

When combining the data from both colleges, we can see clearly that PLAs, as a group, are more likely to report negative experiences with mathematics and negative mathematical self-image than the wider cohort. Table 24 shows, for example, that of all the participants who reported a 'negative relationship', two fifths were PLAs and of the participants who reported a 'negative self-image', almost a half were PLAs. In Table 24, it is also worth noticing the following:

1. Of the female participants who reported a 'negative relationship' with mathematics, almost two thirds (61%) were PLAs.
2. Of the female participants who reported a 'negative self-image', nearly half (48%) were PLAs.
3. Of the male participants who reported a 'negative relationship', more than half (53%) were PLAs.
4. Of the male participants who reported a 'negative self-image', almost half (45%) were PLAs.

5. Of the ones who either reported a 'positive relationship' or a 'positive self-image', just under a quarter are PLAs with both male and female PLAs being underrepresented in both 'positive' categories.

*Table 24: Combined - Relationship with mathematics and mathematical self-image - responses of PLAs*

| College A + B (n=149)<br><br>*PNS: prefer not to say | Positive Relationship (n=48: 22F, 25M, 1PNS, 11PLAs) | Negative Relationship (n=57: 38F, 17M, 2PNS, 23PLAs) | Positive Self-Image (n=74: 37F, 37M, 18PLAs) | Negative Self-Image (n=32: 21F, 11M, 15PLAs) |
|---|---|---|---|---|
| **Non-PLAs (n=101)** | 37% of all Non-PLAs | 56% of all Non-PLAs | 55% of all Non-PLAs | 17% of all Non-PLAs |
| **PLAs (n=48)** | 23% of all the PLAs | 48% of all PLAs | 38% of all PLAs | 31% of all PLAs |
| **Female PLAs (n=28)** | 32% (n=7) of the 22 females | 61% (n=15) of the 38 females | 32% (n=12) of the 37 females | 48% (n=10) of the 21 females |
| **Male PLAs (n=20)** | 12% (n=3) of the 25 males | 53% (n=8) of the 17 males | 16% (n=6) of the 37 males | 45% (n=5) of the 11 males |

The findings highlight that PLAs are overrepresented among learners with negative relationships and self-image in mathematics and might suggest that low attainment often aligns with negative self-perception. However, it is noteworthy that within the broader group of learners who reported positive relationships and self-image, a sizable proportion were still PLAs, particularly among females. This may point to a disconnect between learners' effort, enjoyment, or engagement with mathematics and their actual attainment, especially for some female students. Such findings raise important questions about the role of self-image, support systems, and educational experiences in shaping both mathematical identity and outcomes among low-attaining learners.

### 4.2.2 Disruptions During Year 11

Another question explored through the online survey focused on factors or incidents that influenced participants' learning of mathematics during Year 11. This question was included in the survey because the study was conducted about a year and a half after the easing of Covid-19 pandemic-related restrictions, when teaching and learning had returned to normal. I wished to see in what degree those circumstances had affected students' preparation for the GCSE Mathematics examination. The data reveal that participants from College A frequently mentioned the COVID-19 pandemic as a major incident that impacted their learning. In contrast, only three participants from College B mentioned the pandemic, likely because it occurred prior to their Year 11 studies. Factors and incidents that seemed to have impacted on participants learning can be seen in Figure 9.

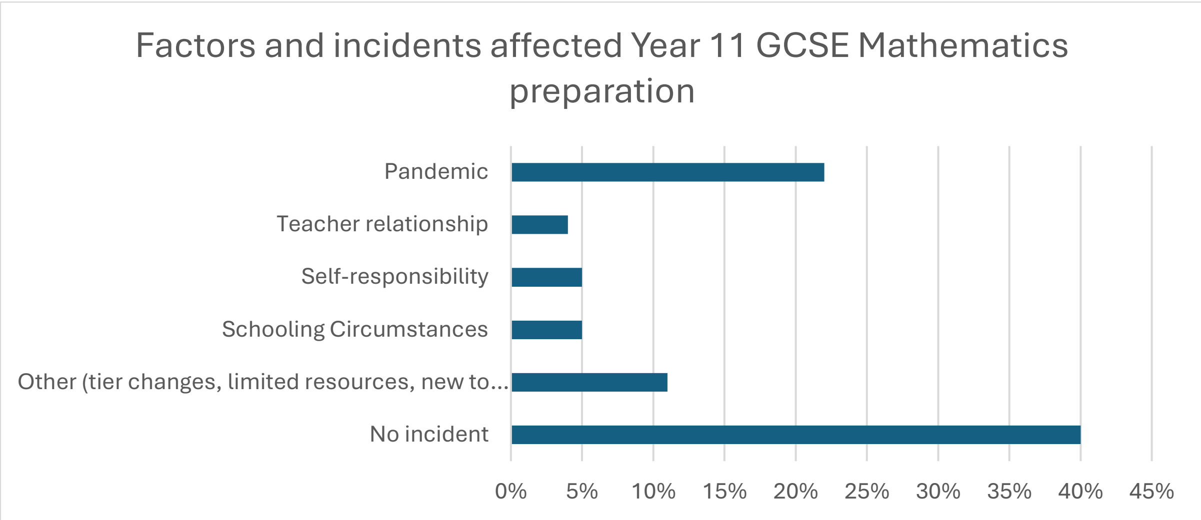



*Figure 9: Combined data - Factors and incidents that impacted on participants' mathematics learning in Year 11.*

Although 40% of all the participants reported no notable incidents during Year 11, another 22% mentioned that the lockdowns resulting from the Covid-19 pandemic had an impact on their learning and engagement with mathematics. The relationship with their mathematics teacher, their personal responsibility, medical reasons, tier changes, being new to the English education system, having limited access to resources, or facing personal or schooling challenges were among the various other factors that had an impact on some participants' engagement with mathematics. The following are quotations from students in relation to what impacted on their mathematical learning during Year 11:

> *"Covid-19 ruined everything, put stress on students as everything was online learning. Didn't as authentic as real life".*

*"It was Covid so it wasn't really great so I never really understood".*

*"Never listened or done any work just slept during lessons".*

*"I don't know why I was doing the higher paper and none of the teachers switched me to foundation so by the beginning of April I asked to be moved to foundation…".*

*"Due to Covid maths was rushed and it got overwhelming".*

*"I was in the hospital a lot which caused me to miss a lot of content…".*

*"When I took my maths GCSE I had just moved to England so it was very difficult for me".*

*"My teacher couldn't teach maths which affected my learning".*

*"Covid affected my learning, we got our results depending on our behaviour and work in class which is unfair".*

*"Yes, there was Covid so I spent most of my time at home as schools were closed, that affected my learning a lot".*

In summary, while a significant number of participants did not identify any particular incidents affecting their learning during Year 11, a notable proportion from College A highlighted the impact of the Covid-19 pandemic, along with a range of personal, institutional, and contextual factors. These insights offer important background to understanding students' mathematical journeys and the development of their attitudes towards learning.

The next section shifts to the main focus of the student survey which was around the experiences, attitudes and approaches participants have developed towards WPs. The following section presents the findings related to this area.

### 4.2.3 Experiences and Approaches to WPs

This section is about participants' experiences and approaches to WPs and is divided into four themes. Findings are presented by individual college and/or combined, depending on whether attention is needed to highlight possible differences or similarities. The focus is also on examining the findings by gender and by PLA responses. The four themes are the following:

1. Participants' understanding of WPs.
2. Participants' affective responses and actions when working on a WP.
3. Participants' approaches to WPs.
4. Participants' attitudes towards WPs - The survey task: confidence, understanding, knowledge and areas of vulnerability.

#### *4.2.3.1 Participants' understanding of WPs*

Initially, participants were asked to share their understanding of what a word problem is. They were prompted to provide an example if they wished to. Table 25 presents participants' responses by individual colleges and combined. There are some significant differences between the ways participants form the two colleges responded to this question. For instance, over half of College B participants provided either a 'definition' of what they understood a WP is or gave an example. On the other hand, just above a third of College A participants provided their version of a WP definition or gave an example, with just above a quarter being unsure of what a WP is.

*Table 25: Responses to the question 'What is a word problem?' by individual colleges and combined.*

| What is a word problem? | College A (n=112) | College B (n=37) | Combined (n=49) |
|---|---|---|---|
| A 'definition' was given. | 22% | 41% | 28% |
| An example was given. | 13% | 16% | 14% |
| Not sure. | 26% | 0% | 19% |
| Frustration/Confusion | 8% | 3% | 7% |
| Other (solving, problem solving, equation, puzzles, riddles). | 18% | 19% | 18% |
| Not a relevant response. | 5% | 27% | 11% |

Looking at these data as combined from both colleges, less than 20% of all the participants were not sure or did not know what a WP is. However, 42% provided either an example or a 'definition' to show their understanding of what a WP is. It is important to notice that a small proportion used language that demonstrated frustration or confusion when having to work on a WP (e.g. 'it makes me anxious/confused').

It was important to look further on the definitions or examples provided by the participants to gain a better understanding of their perceptions and way of thinking. Of the ones who provided their version of a definition, two themes occurred, a) the view of being a real-life problem and b) the view of putting maths in words. Table 26 shows that in both colleges, of the participants provide a definition, most view WPs as maths written in words (85% and 63% respectively). Consequently, the latter is also shown when data are combined (Table 26). Examples of quotations that fall under some of the themes identified are presented in Table 27.

*Table 26: Themes of participants' given definitions and examples on the questions 'what is a word problem?' by individual colleges and combined.*

| **Themes of given definitions** | **College A (n=26)** | **College B (n=15)** | **Combined (n=41)** |
|---|---|---|---|
| **Real-life problem** | 15% | 27% | 20% |
| **Maths in words** | 85% | 63% | 80% |
| **Themes of given examples** | **College A (n=15)** | **College B (n=6)** | **Combined (n=21)** |
| **Mathematically correct** | 50% | 100% | 62% |
| **Missing information** | 29% | 0% | 19% |
| **Not a word problem** | 36% | 0% | 24% |

Similarly, a deeper exploration on the responses of the participants who provided an example was necessary to examine their point of view. This time, what was paid attention to, was the mathematical correctness of the examples: a) mathematically correct, b) missing information and c) the example is not a word problem. An example was considered mathematically correct when the context and numerical information provided were enough to answer the question posed. Examples of participants' responses that fall under each theme can be seen in Table 27. There were a few significant differences between College A and College B when it comes to their 'example' responses. Table 26 shows that all six examples provide by College B participants were mathematically correct. On the other hand, half of the examples provided by College A participants were mathematically correct, less that a third were missing information to solve the problem and over a third would not be considered a WP based on the definition used in this study.

*Table 27: Examples of participants' responses on their understanding of what a WP is*

| **College A + B (n=149)** | |
|---|---|
| **A 'definition' given - 28% (n=41)** | |
| **Maths in words (n=8)** | *"Written maths."*<br>*"A problem with words."*<br>*"Is the maths equation in words instead of in equations."*<br>*"Problems not only including integers but words for students to solve."*<br>*"A maths problem in worded sentence."* |
| **Real-life problem (n=33)** | *"Real-life maths problem."*<br>*"A maths question with a real-life scenario."*<br>*"Maths questions but in a real-world scenario."* |
| **An example given - 14% (n=21)** | |
| **Not a word problem (n=5)** | *"What is 1/3 of 18?"*<br>*"Forty-two thousand six hundred."*<br>*"6x+y"* |
| **Missing or confusing information (n=4)** | *"12 men dig a hole, how long does it take them to dig a hole in 24h?"*<br>*"Has Sinita got enough nails to make all 35 frames?"*<br>*"Find out how much more males there was than females."* |
| **Mathematically correct (n=13)** | *"Mathew has eight apples. He gives half of his apples to his friend. How many apples does he have left?"*<br>*"Alex has 2 apples, his brother has 3. How many they have in total?"*<br>*"Joe has 5 apples, Diana eats 2 apples. How much apples are left?"*<br>*"There are 19 apples. Suzi and Ben share the apples in the ratio 2:3. Who has more apples and how many apples did they get?"* |
| **Frustration/Confusion - 7% (n=10)** | |
| *"I'm not really sure, the first think that comes in mind is complicated."*<br>*"Too many things that are not going to help us in the future."*<br>*"The sentence in maths words can be confusing"*<br>*"I think that's annoying that's what I think."* | |
| **Other - 18% (n=27)** | |
| *"Problem solving."*<br>*"Algebra."*<br>*"A problem that is solved."*<br>*"Breaking down maths."*<br>*"An equation."*<br>*"Addition multiplication solving questions."*<br>*"A question that requires intensive thinking."* | |

It is important to note that when looking at the combined data, of the participants who were not sure or did not know what a WP is (n=29), more than half were PLAs, that is 41% of all (n=48) the PLA participants, while nearly half of all PLA participants gave either an example, a definition or a response under the 'Other' theme.

#### *4.2.3.2 Participants' affective responses and actions when working on WPs*

In one of the survey questions, participants were asked to elaborate on the feelings arise when they are asked to work on a WP. Initial analysis showed no markedly different trends in responses between College A and College B participants regarding their affective responses when working on a WP. For that reason, findings for this are presented as combined. Figure 8 shows that more than a third of all the participants employed positive language while an equivalent proportion used negative words to describe those feelings. Less than 10% of the participants expressed neutral or mixed feelings when confronted with a WP (Figure 10). Relevant quotations from participants' responses can be found in Table 28.

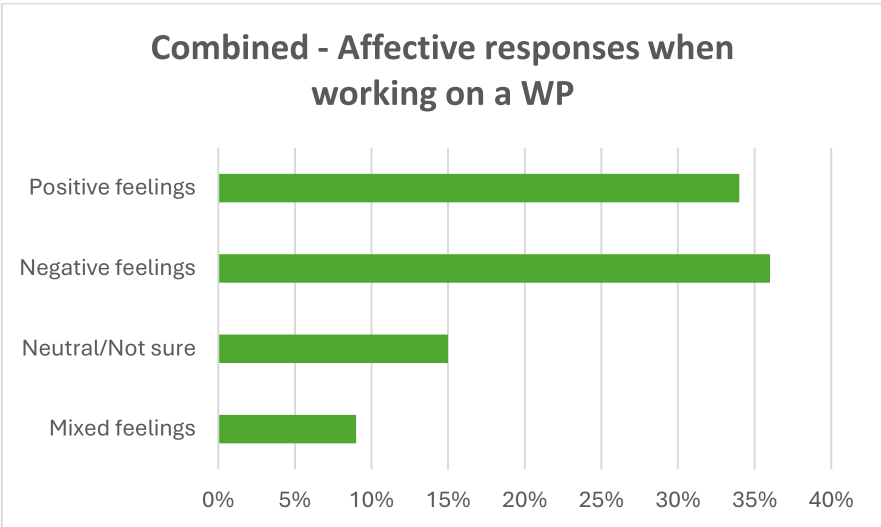



*Figure 10: Combined participants' responses on the question 'What words would you use to describe your feelings when you are asked to work on a maths word problem'*

*Table 28: Examples of participants' responses on their feelings when working on WPs*

| | |
|---|---|
| **Positive feelings - 34% (n=50)** | *"Confident."*<br>*"Getting better."*<br>*"Good because I enjoy it."*<br>*"Motivated."*<br>*"I use positive language, I have good feeling."*<br>*"Determined."*<br>*"Concentrated."*<br>*"Calm"*<br>*"Gained confidence in knowledge of understanding on this specific mathematical topic"*<br>*"When asked to work on math word problems, I feel engaged, determination and eager to unravel the puzzle and find the solution"* |
| **Negative feelings - 36% (n=53)** | *"Anxious because it is hard to understand and to remember."*<br>*"Annoyed, stressed."*<br>*"Unhappy."*<br>*"It feels long and tiring."*<br>*"I hate maths."*<br>*"I feel a bit pressured."*<br>*"Confused, complicated"*<br>*"Scared"*<br>*"Tired"*<br>*"Competitive and problematic"* |
| **Neutral feelings/Uncertainty - 15% (n=23)** | *"Normal."*<br>*"Neutral."*<br>*"I don't know."* |
| **Mixed feelings – 9% (n=13)** | *"I like to work on maths problems but sometimes I find it difficult."*<br>*"Not happy but not sad."*<br>*"Some are easy so easy ones are good I don't like hard ones."*<br>*"Challenged, committed, anxious, resilient"* |

Participants were also asked about the actions they would employ when faced with a WP that they did not understand in two different scenarios: at home or in class and during an examination. Again, no significant differences were noticed between the responses of the two colleges, so findings on this are presented as combined. Figure 9 shows that nearly half of all participants stated that when at home they would seek external help, such as asking their teacher, a friend, a family member or refer to a textbook or their notes. When at home, less than a third would rely on themselves by highlighting key words, reading the problem several times to enhance their understanding, or attempting it based on what they felt they understood about the problem. Finally, it is worth noticing that 14% would choose to skip the problem when at home with two thirds of those being female participants and nearly half being PLAs.

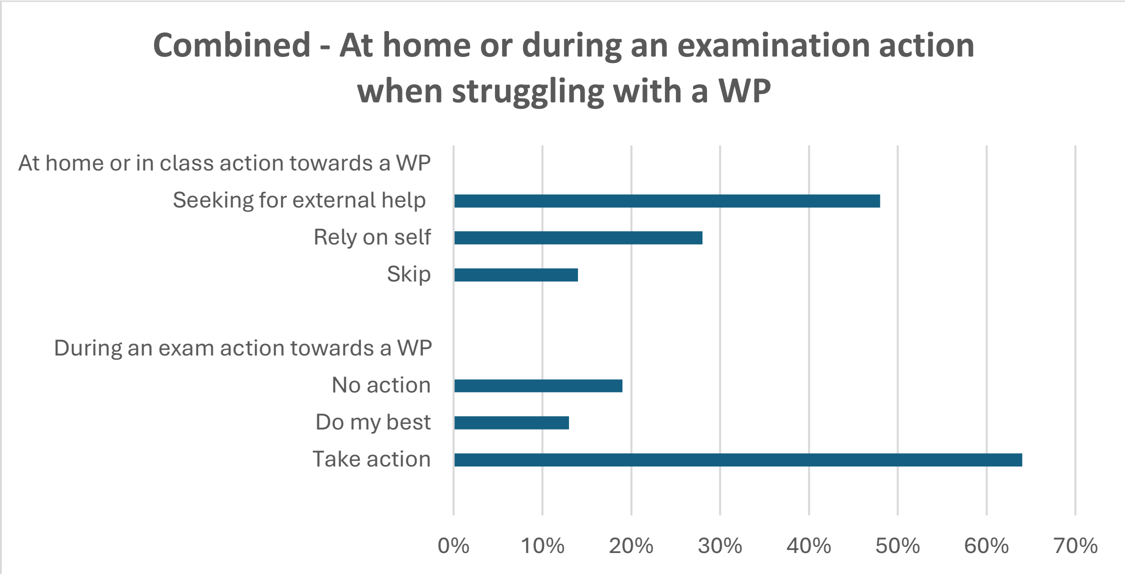



*Figure 11: Participants' responses to the questions, 1) 'At home, what is the first thing you do when you face a maths word problem that you don't understand' and 2) ' In an exam, what is the first thing you do when you face a maths word problem that you*

Figure 11 also shows, that in the examination scenario, almost two thirds of the participants would take some kind of action to approach the problem, such as looking for key words, reading the problem several times, coming back to it later or asking for the teacher's help (even though they should be aware that they could not do that during an examination, informally or formally). Of those, there was almost an even proportion between females and males willing to take some form of action, and just over a quarter were PLA participants. Nearly a fifth would take no action to understand or solve the problem, with most of them skipping it completely and a few panicking or just staring at the problem. Of those, more than half were females and over a third were PLAs. A small proportion (13%) expressed that they would 'try their best'. In summary, a significant number of participants said they would adopt proactive measures to approach a WP they did not fully understand, whether working at home or during an examination.

#### 4.2.3.2.1 Findings on affective responses towards WPs by gender

In Figure 8 we saw that just over a third of all participants used positive language to describe their affective response when working on WPs. Of those participants almost two thirds were males, which means that only just over a third were females. On the other hand, 45% of all participants expressed negative or mixed feelings. Of those participants over two thirds were females. It appears that female participants face more negative feelings when it comes to solving WPS. To better explore this difference in affective responses by female and male participants, Table 29 shows a more detailed overview by individual colleges and combined.

*Table 29: Positive and negative or mixed feelings when working on WPs by individual colleges and combined, split by gender.*

| Affective responses when working on WPs | College A (n=112) | | College B (n=37) | | Combined (n=149) | |
|---|---|---|---|---|---|---|
| | Male (n=50) | Female (n=60) | Male (n=20) | Female (n=16) | Male (n=70) | Female (n=76) |
| Positive response | 50% | 20% | 30% | 38% | 44% | 24% |
| Negative/Mixed feelings | 24% | 62% | 35% | 56% | 27% | 61% |

Male participants appear generally more positively inclined towards WPs than female participants. The majority of female participants seem to experience feelings of discomfort, frustration, or ambivalence when working on WPs. Female learners appear significantly more challenged or disengaged by word problems, particularly in College A. In College B, females report slightly more positive feelings than males (38% vs 30%), however when seen as combined data, females still report significantly high levels of negative or mixed feelings.

#### 4.2.3.2.2 Findings on affective responses towards WPs with a focus on persistent low attainers

Looking at Figure 8, of those participants who used positive language form both colleges (34%), less than a quarter were PLAs. On the other hand, of those who reported negative or mixed feelings when working on a WP from both colleges (45%), almost half were PLAs. Table 30 shows a more detailed break down of the feelings reported specifically by PLAs and Non-PLAs by individual colleges and combined.

*Table 30: Positive and negative or mixed feelings when working on WPs by individual colleges and combined, split by PLA/Non-PLA participants.*

| Affective responses when working on WPs | College A (n=112) | | College B (n=37) | | Combined (n=149) | |
|---|---|---|---|---|---|---|
| | PLAs (n=36) | Non-PLAs (n=76) | PLAs (n=12) | Non-PLAs (n=25) | PLAs (n=48) | Non-PLAs (n=101) |
| Positive response | 19% | 41% | 25% | 32% | 23% | 39% |
| Negative/Mixed feelings | 61% | 37% | 42% | 44% | 54% | 40% |

PLAs report significantly fewer positive responses than non-PLAs with only just below a quarter of PLAs across both colleges reporting positive feelings, compared to more than two thirds of non-PLAs. Negative or mixed feelings are far more common among PLAs. As shown in table 30 (combined data), more than half of all PLAs report negative/mixed affective responses compared to 40% of non-PLAs. In College A, the gap is most stark: 61% of PLAs report negative/mixed feelings, compared to 37% of non-PLAs. College B's results are more balanced but still show a similar pattern as College A.

#### *4.2.3.3 Participants' approaches to WPs*

When it comes to approaches used when solving WPs, no significant differences in responses were observed between the two colleges so findings in this case are presented as combined data. Nearly three-quarters of all participants remembered having worked on WPs in the past and almost all had been given instructions on how to approach them, despite some participants being unable to say what a WP was when asked in a previous question. Figure 12 demonstrates that participants have been provided with various instructions on how to approach WPs with underlining or highlighting the key words being predominant, followed by identifying the maths concepts or calculations they needed to solve the WP, and splitting the problems into smaller parts. When participants were asked to articulate their actions when facing a challenging WP (either at home or during an examination), the approaches evident in their responses were 'to highlight key words/facts', 'to read the problem again', or to 'write the problem in simpler words' despite the variety of strategies they seem to have been instructed.

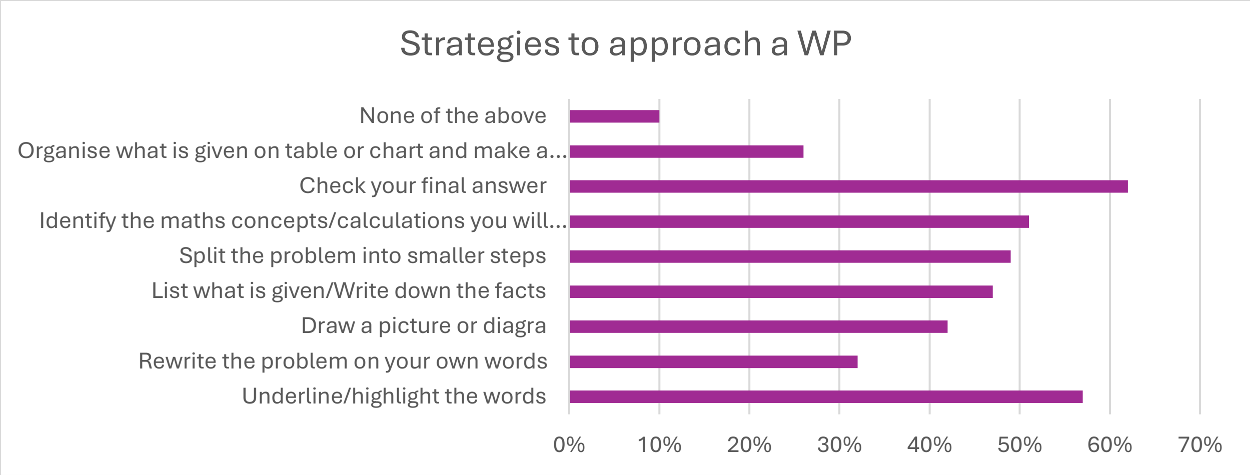



*Figure 12: Participants' responses on the strategies used to approach WPs*

A small percentage of all participants mentioned receiving other instructions, such as the importance of reading and fully understanding the problem before attempting to solve it. Less than 5% reported that they had not received any of the listed instructions, indicating that the vast majority of all participants had some form of guidance in approaching WPs. Overall, the data from both colleges reveal a strong focus on strategies that help students comprehend and verify word problems, with a lesser emphasis on rewriting or listing the facts.

Finally, participants were invited to reflect on their experiences with WPs and suggest any adjustments their teachers could have made to assist their learning. No common themes emerged in responses to this question. Suggestions participants provided for what a teacher can do to support students in improving their skills with WPs included:

- Teachers to be more approachable
- More practice in class
- Create a better learning environment
- More homework for practice at home
- Teachers to believe in their learners' ability to understand maths
- More exam tips
- More out of class workshops
- More depth in teaching
- Focus on maths vocabulary

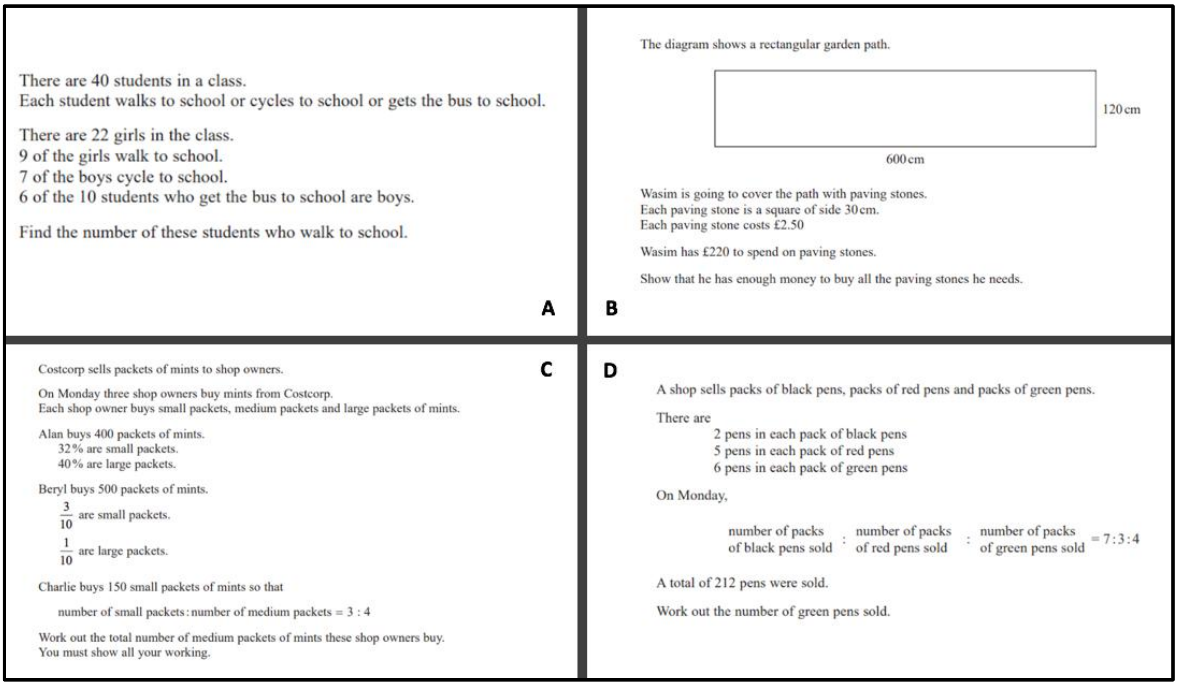
- Learners to be engaged on the whiteboard
- More frequent repetition of methods and strategies.
- More time to be given to explain mathematical concepts.
- More fun tasks to make the lessons enjoyable.
- Break down the problems into smaller steps for better understanding.
- Teach at a slower pace.

More than a third of all the participants commented on the quality of teaching, expressing a desire for more in-depth explanations and a breakdown of problems into simpler steps to enhance understanding. Two participants also expressed that there was nothing the teacher should do differently; they believed that the responsibility for any shortcomings lies with the students themselves. Some examples of participants' responses can be found below:

> *"Explain things in a nicer and calmer manner, not disrespect a student if they get something wrong, they should show us what we need to focus on and what maths problems to use".*
>
> *"Create better environments for students to learn".*
>
> *"Give us more questions, explain more carefully".*
>
> *"More revisions needed and to be patient with me because I could be a slow learner".*
>
> *"Slow it down when trying to explain and explain clearly".*
>
> *"Instead of going through the easy question then giving us hard one, go through both then give a mixture of both to do when feeling ready".*
>
> *"Nothing, it's just me"* and *"It's not the teacher it's me"*
>
> *"Make teaching more fun and engaging".*
>
> *"Have a word problem question in every class".*
>
> *"Ask individually students if they understand and examples to do together on the board".*

*4.2.3.4 Participants' attitudes towards WPs - The survey task: confidence, understanding, knowledge and areas of vulnerability.*

In the final part of the survey, participants were shown four WPs and were asked to comment on their confidence in being able to solve the WP, their contextual comprehension, the maths they needed to solve the WP and any potential areas of struggle. The participants were not asked to solve any of the word problems (Figure 13). It was expected that as the WPs get more 'wordy' and of greater complexity, confidence levels would drop, and more potential areas of struggle would be evident. However, as a teacher, I was surprised to see that although I would consider Problem D to be a challenging WP, participants had different opinions.



There are 40 students in a class.
Each student walks to school or cycles to school or gets the bus to school.

There are 22 girls in the class.
9 of the girls walk to school.
7 of the boys cycle to school.
6 of the 10 students who get the bus to school are boys.

Find the number of these students who walk to school.

**A**

The diagram shows a rectangular garden path.



Wasim is going to cover the path with paving stones.
Each paving stone is a square of side 30 cm.
Each paving stone costs £2.50

Wasim has £220 to spend on paving stones.

Show that he has enough money to buy all the paving stones he needs.

**B**

**C**

Costcorp sells packets of mints to shop owners.

On Monday three shop owners buy mints from Costcorp.
Each shop owner buys small packets, medium packets and large packets of mints.

Alan buys 400 packets of mints.
32% are small packets.
40% are large packets.

Beryl buys 500 packets of mints.
$\frac{3}{10}$ are small packets.
$\frac{1}{10}$ are large packets.

Charlie buys 150 small packets of mints so that

number of small packets : number of medium packets = 3 : 4

Work out the total number of medium packets of mints these shop owners buy.
You must show all your working.

**D**

A shop sells packs of black pens, packs of red pens and packs of green pens.

There are
2 pens in each pack of black pens
5 pens in each pack of red pens
6 pens in each pack of green pens

On Monday,

number of packs of black pens sold : number of packs of red pens sold : number of packs of green pens sold = 7 : 3 : 4

A total of 212 pens were sold.

Work out the number of green pens sold.

*Figure 13: The WPs participants were asked to view and comment on.*

Tables 31 to 34 present a comparison of the confidence levels, contextual comprehension, and maths needed to solve the WP and potential areas of struggle for Problems A-D (**Error! Reference source not found.**). The data from both colleges have been combined for this presentation as no significant differences were found.

*Table 31: Combined data - Comparing confidence levels among Problems A-D*

| *On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem (A-D)?* | | | | |
|---|---|---|---|---|
| **n = 149** | **A** | **B** | **C** | **D** |
| **Not confident at all** | 2% (n=3) | 13% (n=20) | 16% (n=24) | 10% (n=15) |
| **Not confident** | 9% (n=14) | 13% (n=20) | 17% (n=25) | 9% (n=14) |
| **Neutral** | 22% (n=33) | 30% (n=44) | 32% (n=48) | 33% (n=49) |
| **Confident** | 32% (n=47) | 23% (n=34) | 21% (n=31) | 31% (n=46) |
| **Extremely confident** | 35% (n=52) | 14% (n=21) | 14% (n=21) | 17% (n=25) |

Table 31 demonstrates that Problem A had the highest confidence levels, with two thirds of all participants feeling either confident or extremely confident. In contrast, Problems B and C had the lowest confidence levels, with just above a third of the participants feeling confident or extremely confident. Of the participants who selected 'not confident/not confident at all' for Problem A, more than two-thirds were PLAs. For Problems B-D, of the participants selecting 'not confident/not confident at all' just under half were PLAs. More specifically, focusing only on PLAs (n=48), for Problem A, just over a quarter of the PLAs said they were 'not confident/not confident at all', and just above a third felt 'confident/extremely confident' about solving the problem. For Problem B, nearly half of the PLAs reported feeling 'not confident/not confident at all', while nearly a quarter felt 'confident/extremely confident'. In Problem C, approximately half of the PLAs expressed feeling 'not confident/not confident at all' and almost a fifth felt 'confident/extremely confident'. Finally, in Problem D, nearly a quarter of PLAs stated they felt either 'confident/extremely confident' and another quarter 'not confident/not confident at all'.

Table 32 presents participants' responses related to their understanding of the context of each of the four WPs. The highest level of contextual understanding was reported for Problem A, with almost three quarters of all the participants stating they understood the context. In contrast, the lowest understanding was reported for Problems B and C, where just below half of all the participants felt they understood the context, and 21% explicitly stated that they did not. Problem D had slightly higher levels of contextual understanding than B and C. The 'Maybe' responses were highest for Problems B and C (32% respectively) indicating some uncertainty about the context. Overall, Problem A was the most clearly understood, while Problems B and C appeared to have the highest levels of confusion.

*Table 32: Combined data - Comparing contextual comprehension among Problems A-D*

| *Thinking of Problem (A, B, C, D) do you feel you understand the context of the problem?* | | | | |
|---|---|---|---|---|
| **n = 149** | **A** | **B** | **C** | **D** |
| **YES** | 72% (n=108) | 48% (n=71) | 47% (n=70) | 55% (n=82) |
| **NO** | 5% (n=8) | 21% (n=31) | 21% (n=32) | 15% (n=22) |
| **MAYBE** | 22% (n=33) | 32% (n=47) | 32% (n=47) | 26% (n=39) |

Table 33 shows participants' perceptions of whether they knew the mathematical methods required to solve each of the problems (A–D). Problem A had the highest percentage of students (74%) who felt confident that they knew the necessary maths, with only 7% stating that they did not. This might suggest that the mathematical concepts involved in Problem A (addition and subtraction) were more familiar and accessible to students. In contrast, Problems B (area and money) and C (fraction & percentage of amount, and ratio) had the lowest proportion of students who felt they knew the required maths, with only just over two fifths responding 'Yes'. Problem C followed a similar pattern, with 43.8% stating they knew the maths, while 35.2% were unsure. Problem D saw a slightly higher level of confidence than B and C, with half of the participants stating that they knew the maths required to solve it. However, a considerable proportion (33%) still responded with 'Maybe', and 17% explicitly stated that they did not know the necessary mathematics. This might indicate that while some students felt capable, a significant portion remained uncertain or struggled with identifying the correct mathematical approach. Overall, students felt most confident in their mathematical knowledge for Problem A, while Problems B and C caused the most uncertainty.

*Table 33: Comparing knowledge on maths needed to solve each of the Problems A-D*

| *Thinking of Problem (A, B, C, D) do you feel that you know the maths that you need to use to be able to solve it?* | | | | |
|---|---|---|---|---|
| **n = 149** | **A** | **B** | **C** | **D** |
| **YES** | 74% (n=110) | 44% (n=66) | 43% (n=64) | 50% (n=75) |
| **NO** | 7% (n=10) | 18% (n=27) | 21% (n=32) | 17% (n=25) |

| MAYBE | 19% (n=29) | 38% (n=56) | 36% (n=53) | 33% (n=49) |
|---|---|---|---|---|

The data in Table 34 show clear differences in what participants found difficult about the four WPs. Problem B seemed to be the most challenging overall, with a third of all participants saying they didn't know what maths to use, and 26% finding the context of the problem confusing. Problem C also appear to create challenges, with 32% being unsure about what maths to apply and 24% feeling confused by the context. These results might suggest that many students struggle more with understanding what a problem is asking and how to approach it, rather than with the words themselves. Fewer participants said they didn't understand specific words or maths terms, which shows that vocabulary may not be the main issue. Problem A seems to be the most approachable, with 59% of participants saying they didn't have any difficulties, and over half (52%) said the same for Problem D. This might suggest that when problems are clearly worded and the maths is easier to recognise, students feel more confident.

*Table 34: Comparing possible struggles among Problems A-D*

| *Thinking of Problem (A, B, C, D) which of the following did you struggle with the most? (Tick all that apply and/or add your own)* | | | | |
|---|---|---|---|---|
| **Total Participants** | **Word Problem** | | | |
| **n = 149** | **A** | **B** | **C** | **D** |
| **There are words I don't understand their meaning** | 12% (n=18) | 13% (n=19) | 15% (n=23) | 9% (n=14) |
| **I don't know what maths to use** | 10% (n=15) | 33% (n=49) | 32% (n=48) | 16% (n=24) |
| **I don't understand the maths words used** | 9% (n=13) | 14% (n=21) | 18% (n=27) | 14% (n=21) |
| **The context of the problem is confusing/doesn't make any sense for me** | 16% (n=24) | 26% (n=39) | 24% (n=36) | 13% (n=19) |
| **I can't understand what it is asking me to find** | 10% (n=15) | 14% (n=21) | 14% (n=21) | 11% (n=17) |
| **None of the above** | 59% (n=88) | 38% (n=56) | 38% (n=57) | 52% (n=77) |

Overall, the findings highlight the need to help students connect the context of a problem to the maths they need to use, and to support them in understanding how to get started when solving word problems.

## 4.4 Conclusion

These findings highlight the complexity of the challenges faced by resit learners that are not always purely academic, but deeply connected to emotional responses, past experiences, and self-perceptions. The online teacher survey highlighted a clear recognition among teachers of the importance of conceptual understanding and multiple representations in supporting resit learners. However, responses also pointed to a limited use of more creative or exploratory approaches in practice. Teachers described a range of strategies for supporting learners with word problems, yet acknowledged persistent barriers such as poor numeracy, limited mathematical language comprehension, and low learner confidence. These teacher perspectives were echoed and expanded through the student workshop and online survey. Students' accounts consistently pointed to negative past experiences with mathematics often linked to teaching quality, exam pressure, and disruptions caused by the Covid-19 pandemic. While a proportion of learners expressed enjoyment or growing confidence, many described feelings of confusion, anxiety, struggle and disengagement when faced with mathematical word problems. The data also revealed important gendered differences and patterns associated with PLAs, who reported particularly high levels of negative self-image and low confidence, but not uniformly so. Some PLAs expressed positive engagement, suggesting that effort and mindset do not always align with attainment levels.

The final section of the chapter examined students' understanding of word problems, their emotional responses, and the strategies they reported using. These findings point to key areas of vulnerability, especially when problems are multi-step, 'wordy', or embedded in unfamiliar contexts. While many students had been taught strategies, the ability to apply them confidently and independently varied greatly. Together, these findings suggest that any efforts to improve outcomes for resit learners must take into account not only curriculum and pedagogy, but also the affective and psychological dimensions of learning mathematics. Chapter 5 will now explore these themes in greater depth, drawing on the literature reviewed in Chapter 2 to analyse and interpret the significance of the findings in relation to the wider educational landscape.

# Chapter 5: Discussion of Findings

The primary objective of this study is to understand the experiences of GCSE Mathematics resit learners with word problems, and the approaches they had developed through their schooling years prior to entering further education in order to inform teachers/teacher educators, both in pre- and post-16 education. The responses gathered from learners in the online learner survey not only offered valuable insights into addressing the research questions but also unveiled new areas for discussion requiring further exploration. In the sections that follow, I discuss the findings by offering my own interpretations and drawing comparisons with the existing literature. I then explore the pedagogical and theoretical implications. I outline the contributions this research offers to the existing knowledge in the field of mathematics education in the UK, considering the generalisability of the findings to a broader population and their transferability to other contexts or settings. Concluding, I summarise gaps in the literature and discuss potential areas for further exploration.

## 5.1 Resit Learners' Experiences and Approaches to WPs

WPs are a fundamental component of the curriculum across all levels of mathematics education. Therefore, it would have been unusual if resit learners had not encountered the task of working on WPs before resitting GCSE Mathematics in FE. Their responses confirm that during their schooling years, they were exposed to teaching for the solution of WPs without much emphasis given to the context. What intrigued me in their reported perceptions of what a WP is or when they offered an example of a WP, was the simplistic nature of many of their responses. According to my interpretation, the 'definitions' or examples they provided showed a poor grasp of the contexts in which they are typically expected to operate if they are to make progress. The examples provided could have been used in the primary classroom (e.g. John has 8 apples, he gives 3 to Fatima. How many apples does John have now?) – though in fairness, such examples strictly only evidence a 'floor' to their level of understanding.

According to Piaget's theory (Piaget & Inhelter, 2008), primary school students (typically aged 5-11) are typically in the concrete operational stage: they can perform logical operations on concrete objects but struggle with abstract concepts. Problem-solving at this stage involves simple, context-based problems that require direct application of learned procedures (Ling &

Wong, 2024). Secondary school students (typically aged 11-16) transition to the formal operational stage, where they develop the ability to think abstractly and reason logically about hypothetical situations (Piaget & Inhelter, 2008). Secondary school students (typically aged 11-16) transition to the formal operational stage, where they develop the ability to think abstractly and reason logically about hypothetical scenarios (ACME, 2016). The participants in this study belong to the 16-18 age group. The WP examples they provided were either very simple, similar to those that primary stage students might have given or were incomplete and lacked coherence. None of the participants provided a WP example that might be seen in the GCSE Mathematics curriculum. Their responses may suggest that their prior educational experiences emphasised rote memorisation and isolated skill practice rather than fostering a deeper understanding of concepts and flexible thinking. Bridging these gaps could involve instructional approaches that explicitly focus on teaching strategies for developing creative mathematical thinking that can lead to more mathematically confident and fluent resit learners. However, it might simply be that they have not previously had much experience of providing classified examples – or of having their ideas in this area valued.

Another intriguing aspect is the contrast between resit learners' relationship with mathematics and their self-image as mathematics students. Despite many resit learners not having had a positive experience with mathematics, the majority of sample resit learners employed positive language to characterise themselves as mathematics students – at least now they are in FE. Existing literature often portrays resit learners as having low motivation and a high level of disengagement with the subject (Dalby & Noyes, 2015; Hough et al., 2017; Smith, 2017; Noyes & Dalby, 2020b). In contrast, the resit learners involved in this research study exhibited notable levels of willingness to actively engage with mathematics and try to understand the mathematical areas that need improvement, and even though there are instances of a reported temporary decline in motivation, they seem to eventually want to rebound – evident from their responses regarding their relationship with mathematics or their self-image as mathematics students. That is also evident from learners' responses on their actions when faced with a challenging WP either at home or during an examination. A sizeable majority said that they put effort into solving the challenging problems when at home and most said they would attempt the problem during an examination. Whether or not that is the case, they showed awareness of the positive steps they could take.

However, it is essential to remind the reader that the survey occurred during regular lesson time. Although a text message containing the survey link was sent to all resit learners afterward, no new responses were received. This leads me to assume that most respondents to the survey were learners who attend their lessons regularly – overall attendance when the survey took place in College A was around 65-70%. This may, in turn, explain the high number of positive self-image responses; most participants were students who were sufficiently motivated and confident to attend lessons, so responses will have been skewed by that. Additionally, as further explored in a later section, most of the resit learners who expressed willingness to engage with mathematics were first-time resit learners. These learners appear more determined to work in a way that is likely to promote success at the end of year examination in comparison to learners who had resat the qualification several times. It seems unlikely that overall, learners in College A have much more positive relationships with mathematics than average resit learners, given the much lower-than-average resit 'success' rates – though it is possible.

Solving WPs often involves several steps, such as reading and understanding the problem, figuring out which mathematics operations to use, solving the problem, and checking whether the answer makes sense (Verschaffel et al., 2000). A considerable number of learners try to identify keywords in the problem and merely perform calculations without grasping the underlying mathematical concepts (Van Dooren, De Bock & Verschaffel, 2010; Verschaffel et al., 2000). In this study, it is evident from participants' responses that most of the resit learners had been given various instructions on how to approach WPs. Learners could clearly recall what they had been told, but often reframed this information for their own purposes, focusing on strategies such as highlighting key words.

The approaches that resit learners report employing when it comes to solving a WP seem to correspond to the areas of difficulty revealed by their analysis of the WP Task, such as identifying the mathematical concepts 'hidden' in the problem and facing confusion with the context. The approaches they choose to follow demonstrate their efforts to make sense of the problem they are working on. Additionally, their responses illustrate an acknowledgment of a lack of deeper and connected mathematical knowledge that would assist them in solving the WPs. This is evident from their comments on what their teachers could have done differently to help them approach WPs, with several resit learners expressing a desire for more in-depth explanations and a breakdown of problems into simpler steps to enhance understanding: "[the teacher] should explain in more depth", "give us more questions and explain more carefully", "[the teacher should] just explain more, use more resources", and "[we should] work more on this kind of problems to understand them better".

In conclusion, the exploration of resit learners' experiences with WPs reveals not only the challenges they face but also points towards actionable insights for pedagogical improvements. The contrast between their, on average, self-perceived positive image as mathematics students and the challenges they face with WPs highlights the complexity of their mathematical journey. The observed gap between instructed strategies and learners' chosen strategies highlights the necessity for instructional methods that promote a deeper understanding of mathematical concepts. The acknowledgment of limited mathematical knowledge among resit learners emphasises the need for continuous, targeted support to bridge existing gaps. A pedagogical review is necessary to address the cognitive gaps in resit students' development of mathematical literacy and problem-solving skills. By looking more deeply at these insights, educational stakeholders can contribute to a more inclusive and effective learning environment, ultimately enhancing resit learners' success in GCSE Mathematics.

## 5.2 The Case of Persistent Low Attainers

Existing literature discusses continuous failures in GCSE Mathematics to provide appropriately for resit learners but does not tend to separate findings between learners resitting the qualification for the first time and those who have resat it multiple times (PLAs). The fact that this research identified a significant amount of positivity in participants' responses prompted a closer examination of the number of times each participant has resat GCSE Mathematics. First-time resit learners appear to be more positive and willing to invest in progression when it comes to resitting the qualification. In contrast, PLAs overall reported less positivity, including in the unproductive potential of another year spent studying GCSE Mathematics.

Persistent low attainers were primarily those who viewed themselves as having a negative or average self-image as mathematics students. Additionally, many of them did not show they knew what a WP was; even among those who provided an example, the examples were often not mathematically valid. It is worth mentioning that data from both colleges show that the PLAs are generally those who also struggle with regularly attending their mathematics lessons. Taking these findings together, it seems likely that the repeated examination failure these learners have faced contributes to sapping their engagement and motivation levels.

However, failing an examination is probably not the sole reason underlying this type of learning behaviour. Understanding the reasons for failing the (re-)examinations, in the first place, are essential. Consistent with my teaching experience, many sample resit learners self-reported entering Further Education with significant gaps in their mathematical knowledge, not only in relation to word problems but also lacking understanding of fundamental mathematical concepts. If these gaps are not addressed properly, they will persist, and learners will continue to struggle with and find mathematics challenging. Given the poor 'success' data, I argue that a re-examination of the curriculum offered, the quality of teaching, and the time needed for these learners to be re-educated mathematically is overdue.

There are a range of possible solutions. It is crucial to implement targeted interventions that specifically address the needs of both first-time resit learners and PLAs. Personalised support programmes, such as additional workshops and mentoring can help in closing the knowledge gaps identified in these learners (EEF, 2021a, 2021b; Dunne et al., 2007). Moreover, fostering a positive learning environment that emphasises the value of persistence and provides resources for re-building foundational mathematical skills is essential in empowering PLAs to overcome challenges and succeed in their academic pursuits (Dweck, 2006; Shemshack & Spector, 2020).

I argue that collaboration between educational institutions and policymakers is imperative in shaping systemic changes to promote a more inclusive and effective mathematics education. This involves revisiting and refining the curriculum to ensure it aligns with the diverse learning needs of resit learners. By addressing the multifaceted challenges encountered by resit learners, educational stakeholders can contribute to a more equitable and supportive educational system, ultimately enhancing the success rates of resit learners at this level.

## 5.3 Affective Responses Towards WPs and Gender Differences

A study by Niepel, Stadler and Greif (2019), among many others, showed that while the overall mathematical performance of female students matches that of their male counterparts in secondary school, female students commonly express lower levels of self-concept in mathematics compared to their male peers. For example, in TIMSS 2019, it was found that girls on average exhibited significantly lower confidence in and liking for STEM subjects less (by year 9) when compared to their male counterparts, despite achieving similar levels of performance (TIMSS, 2019), and TIMSS 2023 shows those gaps having widened, particularly in mathematics and, worryingly, being significant by year 5 (Richardson, Golding et al., 2025).

Research on gender differences in mathematics education has historically been influenced by stereotypes suggesting that males possess a natural aptitude for mathematics (Rossi et al., 2022). However, contemporary studies indicate that there are generally no significant differences in mathematical potential among male and female students who are provided with equitable opportunities and support (Niepel, Stadler & Greif, 2019). As replicated in this study's findings, girls may internalise the belief that they are less capable in mathematics, leading to diminished confidence levels, high mathematics anxiety, and a reluctance to engage in challenging mathematical tasks (Devine et al., 2012; Copur-Gencturk et al., 2023).

Although as a teacher I had the impression that female resit learners were more confident in the classroom than their male peers (possibly due to their social interface confidence) the findings suggest the opposite. In this study, more than half of the female resit learners reported experiencing negative emotions when faced with a WP, in contrast to just one-fifth of male resit learners. However, thinking of their self-image as mathematics students, only about a quarter of the female resit learners expressed a negative image about themselves. It appears that the female resit learners in this study recognise positive qualities in themselves, such as being *driven, persistent, motivated,* and *eager to learn* when it comes to their self-image. Nevertheless, negative feelings including *nervousness, hate, anxiety, panic, fear* and *sadness* arise disproportionately when they are asked to work with a WP.

## 5.4 Resit learners' experiences of studying GCSE Mathematics in their Further Education college

Existing literature demonstrates varying levels of dissatisfaction among resit learners regarding their overall mathematics experience in further education (Noyes & Dalby, 2020b; Bellamy, 2017). It is important to note that the literature has not distinguished between two very different groups of resit learners: first-time resit learners and PLAs. This study's findings suggest that much of the apparently widespread resit learner dissatisfaction might be a result of the significant number of PLAs in FE and the continuous cycle of examination failures they experience.

In terms of studying GCSE Mathematics, most of the resit learners in this study conveyed positive opinions about the approach their teachers took towards their learning, despite their individual struggles with mathematics (Appendix F). It is important to note that two-thirds of the participants in this study were first-time resit learners, and most exhibited a strong willingness to actively participate in their learning. Additionally, it is likely that a significant proportion of these resit learners had consistently attended their lessons.

It seems likely, from this data, that first-time resit learners often experience a positive first year of relearning mathematics. This positivity potentially emanates from their own perceptions of self, but also from a more mature relationship with teachers and college systems now they are in FE. On the other hand, the needs of PLAs are not being adequately addressed, and their needs may not even be known to the broader FE community. However, recent data suggest that approximately two thirds of first-time resit learners will likely join the groups of PLAs, and the cycle of renewed disaffection will continue.

## 5.5 Implications

This study presents significant implications across theoretical, pedagogical, and methodological domains, as discussed below. The findings not only expand our understanding of GCSE Mathematics resit learners but also provide actionable insights for improving educational practices and policies. Recognising the distinct needs of resit learners, especially the contrast between first-time resit learners and PLAs, offers a foundation for more tailored teaching strategies, curriculum adjustments, and institutional policies. The implications outlined in this section offer pathways for further research, better-informed teaching practices, and meaningful policy reform aimed at enhancing the mathematical journey of resit learners.

### 5.5.1 Theoretical implications

A significant contribution of this study is the evidenced characterisation of GCSE Mathematics resit learners into two groups: first-time resit learners and persistent low attainers. These two distinct groups exhibited markedly different perceptions on the way they view and approach their resit year. First-time resit learners on average reported higher levels of motivation and a greater willingness to enhance their proficiency in mathematics. They were more likely to view the resit year as a valuable opportunity to achieve the GCSE Mathematics qualification and better equip themselves mathematically. On the other hand, PLAs who have undergone multiple resits of GCSE Mathematics, reported diminished motivation, and were more likely to perceive the resit process of mathematics as a waste of their time, linked with irregular attendance in lessons.

It is essential for the academic research community – including teachers, FE senior leadership teams, and policymakers – to recognise these two distinct groups of resit learners, even though their characteristics overlap. First and foremost, acknowledging their existence can significantly impact how FE senior leadership teams plan to improve attendance in lessons, alert and guide teachers in addressing the unique needs of each resit group in the classroom. In addition, academic researchers can leverage this information to conduct more in-depth investigations into these two groups, and policymakers can reassess the mathematics curriculum and the suitability of the GCSE qualification for learners without a GCSE grade 4 in mathematics in post-16 education. Policymakers need to engage seriously with the negative impact that repeated resits can have on learners' mathematical self-image and learning behaviours, as evidenced widely in existing work (Kay, 2022) and reinforced in this study.

### 5.5.2 Pedagogical implications

The findings of this study clearly indicate significant differences in typical learning behaviour between first-time resit learners and PLAs as groups, although with marked variation within each group. This insight has pedagogical implications for the classroom. In addition to a resit classroom comprising different ‘ability’ levels, we now recognise two overlapping subgroups, each with its own profile of characteristics and prior experiences. Therefore, mathematics teachers should be aware of resit learners’ mathematical histories and use differential strategies that enhance positive self-image and motivation, while addressing the knowledge gaps from diverse pedagogical perspectives. For instance, first-time resit learners, with higher levels of engagement, may more readily participate in coursework or additional sessions. Conversely, the PLAs, having experienced multiple failures in mathematics, may present more challenges in engaging with coursework or extra sessions. The teacher should be aware of these attitudinal nuances to differentially convey the importance of resitting mathematics to both groups.

Another area with pedagogical implications for the classroom involves addressing the gaps in the mathematical knowledge that resit learners bring. These gaps may manifest as obstacles when tackling WPs, contributing to dwindling confidence and engagement, ultimately resulting in cycles of examination failure. Some action research projects conducted on behalf of the Centres of Excellence in Maths have proposed a ‘Mastery’ approach as a teaching strategy to make GCSE Mathematics more meaningful for resit learners. While Mastery approaches are commonly followed in primary and secondary education for mathematics courses spanning from Year 1 to Year 6 and Year 7 to Year 11, adjustments are necessary when applying them to resit learners. For example, the five big ideas framework (NCETM, 2017) – coherence, representation & structure, mathematical thinking, fluency, and variation – need to be adjusted in the 36-week resit scheme of learning to prove beneficial for resit learners. Nonetheless, efforts that facilitate a more profound understanding of mathematics should be embraced. Recognising the substantial knowledge gaps among resit learners is an essential element for curriculum development and lesson planning.

Finally, although over the years there has been a positive shift in attitudes and perceptions, challenging gender stereotypes in mathematics education, teachers and FE institutions should remain mindful that female resit learners might still be influenced by received stereotypes and limited female role models in mathematics – potentially female role models related to their vocational area and use some type of mathematics in their everyday jobs. Sharing success stories of females in mathematics, promoting events that encourage or exemplify female participation in STEM areas, and workshops that show the potential of GCSE-level mathematical knowledge in the creative industries for instance are essential initiatives to foster inclusivity and diversity. Smith and Golding's (2015) work around encouraging female participation in mathematics suggests that girls differentially benefit from deliberate recognition of their successes and positive assumptions about 'when they succeed' or 'when they get their grade 4'; they also benefit from opportunities to have less public or outside-lesson support. These approaches are likely to be even more important if the students in question are resit students, particularly if they are PLAs.

### 5.5.3 Methodological implications

A novel data collection method (for mathematics education) was introduced in this study - using a revision workshop instead of individual or focus group interviews. The workshop demonstrated its secure and supportive nature, providing a familiar setting for participants to share their narratives about WPs in an arguably more ecologically valid way. This approach to gathering data offered dual benefits to learners: the opportunity to reflect on their experiences with WPs, with the approaches they had developed, and the opportunity to practise and refine these approaches, along with new ones, collaboratively with their peers and the facilitator (myself). Consequently, the workshop proved to be a place for both reflection and practical application to enhance their work with WPs. This suggests such an approach might be considered more frequently in classroom-close research.

## 5.6 Contributions to Knowledge and Limitations

### 5.6.1 Contributions to knowledge

This research provides several key contributions to the understanding of GCSE Mathematics resit learners, specifically regarding their experiences with WPs and the approaches they have developed to tackle them.

This study adds to the body of research by examining learners' emotional and psychological responses to WPs. It shows that, despite their previous struggles, many resit learners maintained a positive outlook towards mathematics and actively engaged with WPs, albeit with varying levels of success. This contrasts with the existing literature, which often portrays resit learners as largely disengaged and demotivated. Particularly among female learners, this study found a clear disparity between their positive self-image as mathematics students and the negative emotions they experience when tackling WPs, which highlights the affective barriers that need to be addressed in pedagogical strategies.

Another significant contribution is the exploration of the strategies resit learners employ when solving WPs. The study found that many learners have reframed the strategies they were taught in school, such as focusing on keywords rather than understanding the context or underlying mathematical concepts. This finding suggests that there are gaps in both their basic mathematical knowledge and the instructional methods, often catalysed by short timescales to high stakes assessments, typically used to teach them. I would therefore advocate for a pedagogical reform in curriculum for resit students that focuses on building deeper mathematical understanding rather than merely procedural skills.

### 5.6.2 Limitations

Despite the contributions of this study, there are several limitations to this research that need to be acknowledged. The study was conducted across two Further Education colleges, in College A with 112 participants and in College B with 37 participants, spanning two academic years. While the sample size provides a substantial amount of data, the findings may not be fully generalisable to all FE colleges or other educational settings. A broader study involving more institutions across different regions would provide a more comprehensive picture.

The data were collected within a single academic year for each cohort, which limits the ability to track changes in learners' attitudes and strategies over time. A longitudinal study would have provided more insight into how learners' experiences evolve as they continue to engage with mathematics in FE.

Finally, the research concentrated specifically on WPs, which, while critical to mathematical understanding, represent only one aspect of the GCSE Mathematics curriculum. Learners' difficulties and strategies in other mathematical areas were not explored in this study. This focus limits the applicability of the findings to a broader understanding of resit learners' mathematical experiences. However, I argue that solving WPs is a 'threshold' skill for learners, representing a shift to adaptable and contextualised mathematical functionality.

### 5.6.3 Generalisation and transferability

While the findings of this research are specific to the context of GCSE Mathematics resit learners in two FE colleges, they offer several insights that might be generalised or transferred to other contexts.

The characterisation of learners as first-time resit learners or PLAs may be relevant beyond GCSE Mathematics resits. These learner profiles could potentially apply to other academic subjects or even educational systems internationally where students are required to retake examinations or qualifications – although the situation for the study learners is a particularly high stakes one in terms of both gatekeeping and funding. The emotional and motivational differences between these groups suggest that educators in various settings should consider tailoring their approaches based on learners' histories including academic failure and resits.

The insights gained from this study are not limited to mathematics education. For instance, the pedagogical implications regarding how learners approach word problems, the use of strategies such as keyword identification, and the emotional responses to challenging tasks can inform teaching practices in other subjects where problem-solving and abstract reasoning are required.

Furthermore, the revision workshop method used in this study as an ecologically valid (or authentic) tool for data collection could be adapted for use in other educational research settings, providing a dynamic environment for learners to reflect on their learning.

## 5.7 Conclusion and Recommendations

This research highlights several critical areas for improvement in the provision of GCSE Mathematics resit courses, with a particular focus on enhancing the experience and outcomes of resit learners. Based on the findings, the following recommendations are proposed to better support the development of these students:

**Longitudinal studies:** Future research should explore how the attitudes and strategies of resit learners evolve over time, particularly as they progress through multiple resits. A longitudinal study would provide deeper insight into the long-term effects of repeated failures and the impact of sustained interventions on learners' mathematical understanding and motivation.

**Further exploration of the curriculum:** Further research could investigate how resit learners engage with other challenging areas of the GCSE Mathematics curriculum beyond word problems. Understanding their difficulties with particular areas such as algebra, geometry, and data handling could provide a more holistic view of the resit experience and inform comprehensive curriculum adjustments.

**Extension of GCSE Mathematics courses in further education:** One significant recommendation is to consider extending the duration of GCSE Mathematics resit courses from one academic year to two. A longer course duration would allow for a more measured approach to addressing the diverse needs of resit learners and meeting those in more robust depth. These students often have significant gaps in their mathematical understanding and have developed negative affective responses towards the subject, which cannot always be addressed effectively in a single year. Alternatively, a differential system could be introduced to identify – with their own preferences taken into account – learners who may benefit from a one-year course versus those requiring a two-year approach. Such a process would provide flexibility in curriculum delivery while ensuring that all students receive the appropriate level of support. The overarching objective is to integrate pedagogical strategies that not only close knowledge gaps but also build conceptual understanding, demonstrate the practical relevance of mathematics to everyday life and the workplace, and foster positive attitudes towards learning and doing mathematics. This two-year model could potentially allow for the 're-education' of learners, providing sufficient time to develop mathematical competence and confidence.

The findings of this study showed that learners often struggled with the pace and coverage of the resit course. Several participants described how large gaps in their knowledge made it difficult to follow lessons at the required speed, and that new topics were sometimes introduced before earlier content was secure. These experiences suggest that the one-year structure may not allow enough time for some learners to consolidate understanding. A two-year pathway, or greater flexibility in course length, would give teachers space to revisit foundations and adapt the pace to different learner needs. At an organisational level, this would mean timetabling structures and funding models that allow for longer or more flexible courses. At a classroom level, it would involve teachers having the scope to slow down, re-teach key ideas, and give learners more opportunities to practise and build confidence before moving on.

**Curriculum review for resit learners:** The GCSE Mathematics curriculum for resit learners needs to be reassessed and adjusted to better align with the needs of relatively mature and experienced students. Many of these learners bring life experience and knowledge that should be considered when designing the course. The current GCSE framework may not fully meet the needs of resit learners, whose priorities might differ from those of younger, first-time candidates.
As such, it may be necessary to consider an alternative qualification that maintains Level 2 equivalency but is more appropriate for older learners and their future aspirations. The curriculum should still ensure alignment with employer expectations and higher education requirements, but could, for example, adopt the model proposed by MEI, which offers a more contextualised and relevant mathematical education for these students (Davies et al., 2020). By doing so, colleges and educators can offer a qualification that resonates more with the real-world needs and experiences of this learner demographic.

The findings also suggest that many resit learners struggle when the curriculum moves on before earlier gaps have been addressed. Several participants described difficulties in keeping up with new content while still feeling uncertain about prior topics. This points to the need for a more tailored curriculum that recognises learners' varied starting points and allows teachers to revisit foundational concepts before progressing. At an organisational level, this would involve designing resit programmes that build in diagnostic assessment and flexible sequencing. At the classroom level, it would mean teachers adapting schemes of work, re-teaching where necessary, and making deliberate links between topics so that learners can connect new material with what they already know.

**Further targeted training for resit mathematics teachers:** Effective teaching of GCSE Mathematics resit learners requires not only content knowledge but also an understanding of the unique challenges and backgrounds these students bring to the classroom. Therefore, it is essential that initial and continuing teacher training programmes, particularly for those entering the FE sector, incorporate specific strategies for working with resit learners. This includes a focus on empathy in the classroom to understand the emotional and psychological barriers that resit learners face. Teachers need to be educated to recognise and address the affective responses learners have developed towards mathematics, which often include anxiety, frustration, or disengagement. In addition, it is crucial that teachers familiarise themselves with their students' mathematical backgrounds, life experiences, and learning needs in order to tailor their instructional approaches accordingly. Teacher training programmes should equip both new and experienced educators with the tools to create supportive and responsive learning environments that foster persistence and growth in their students.

The theme of fostering a positive learning environment was also strong in the findings. Learners valued teachers who showed patience, encouragement, and belief in their abilities, which in turn motivated them to try harder. However, negative experiences, such as feeling dismissed or judged, reinforced avoidance behaviours. At the organisational level, fostering a positive environment could mean embedding professional development and mentoring that emphasises relational practice and empathy. At the classroom level, it involves building trust, recognising small successes, and creating spaces where learners feel safe to make mistakes and learn from them.

These recommendations aim to address the systemic issues that resit learners face, advocating for more time, tailored curriculum, and better-prepared teachers. Together, they form a comprehensive approach to improving outcomes for GCSE Mathematics resit students, ultimately supporting better their mathematical thriving in the short, medium and longer term.

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# Appendices

## A. The power point presentation used during the workshop

GCSE MATHS REVISION WORKSHOP

**Objectives:**

1. To reflect on what has not worked well in your relationship with mathematics and especially word problems.
2. To develop an approach that will help you solve any GCSE maths problem given to you.
3. To practice on past exam word problems in order to improve your understanding and work.

**PART 1:**
*Reflecting on previous experiences with mathematics*

**Why is it important?**

Reflective learning is a way of allowing learners to step back from their learning experience, helping them to develop critical thinking skills and, improve on future performance by analysing what they have learned, or they have not learned and how far they have come. It provides learners with the space to understand better the why behind the situation they currently find themselves and help them develop strategies to improve their learning.

*How would you describe your relationship with mathematics from when you started school onward?*

Click to add text

*Thinking of Year 11 and GCSE preparation, are there any incidents that you remember?*

Click to add text

*Do you remember any of your maths teachers? What is it that you remember about this/these teacher(s)?*

Click to add text

*Do you remember experiencing different styles of teaching?*

Click to add text

*Thinking of your experiences with mathematics, how would you describe yourself as a maths student?*

Click to add text

*What comes in your mind when you hear the expression word problem?*

Click to add text

*Do you remember to have been given specific instructions on how to solve or approach a word problem?*
*If yes, what were those instructions?*

Click to add text

*How do you feel when you are working on word problems?*

Click to add text

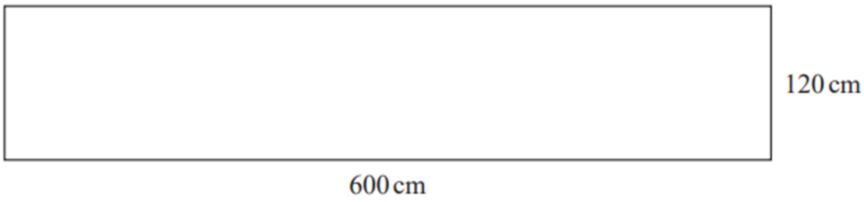
## *Looking at word problems*

We are now going to look at some word problems.
Please do not attempt solving the problems at this stage.

I would like you to read them and have in mind the following questions:

1. *What emotions arise when you read the word problem?*
2. *Is the context clear?*
3. *Is the language used easy to understand?*
4. *What thoughts come in your mind while reading the word problem?*
5. *What would you do if this was in an exam paper?*

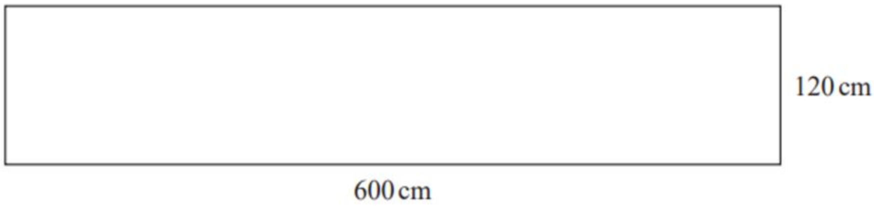
The diagram shows a rectangular garden path.




Wasim is going to cover the path with paving stones.
Each paving stone is a square of side 30 cm.
Each paving stone costs £2.50

Wasim has £220 to spend on paving stones.

The diagram shows a rectangular garden path.




Wasim is going to cover the path with paving stones.
Each paving stone is a square of side 30 cm.
Each paving stone costs £2.50

Wasim has £220 to spend on paving stones.

Show that he has enough money to buy all the paving stones he needs.

A shop sells packs of black pens, packs of red pens and packs of green pens.

There are

2 pens in each pack of black pens
5 pens in each pack of red pens
6 pens in each pack of green pens

On Monday,

$$\text{number of packs of black pens sold} : \text{number of packs of red pens sold} : \text{number of packs of green pens sold} = 7:3:4$$

A total of 212 pens were sold.

A shop sells packs of black pens, packs of red pens and packs of green pens.

There are

- 2 pens in each pack of black pens
- 5 pens in each pack of red pens
- 6 pens in each pack of green pens

On Monday,

number of packs of black pens sold : number of packs of red pens sold : number of packs of green pens sold = 7 : 3 : 4

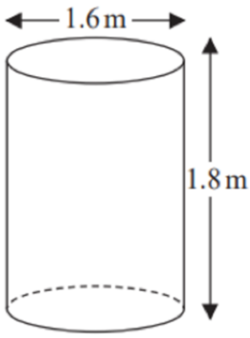
A total of 212 pens were sold.

Work out the number of green pens sold.

Jeremy has to cover 3 tanks completely with paint.

Each tank is in the shape of a cylinder with a top and a bottom.
The tank has a diameter of 1.6 m and a height of 1.8 m.

Jeremy has 7 tins of paint.
Each tin of paint covers 5 $m^2$

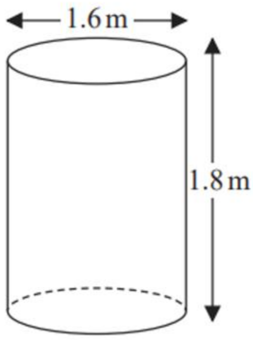



Jeremy has to cover 3 tanks completely with paint.

Each tank is in the shape of a cylinder with a top and a bottom.
The tank has a diameter of 1.6 m and a height of 1.8 m.

Jeremy has 7 tins of paint.
Each tin of paint covers 5 $m^2$

Has Jeremy got enough paint to cover completely the 3 tanks?
You must show how you get your answer.



Machine A and machine B both make car parts.

Machine A makes 6 parts every 10 minutes.
Machine B makes 13 parts every 15 minutes.

On Monday
machine A makes parts for 12 hours
machine B makes parts for 10 hours

Machine A and machine B both make car parts.

Machine A makes 6 parts every 10 minutes.
Machine B makes 13 parts every 15 minutes.

On Monday
machine A makes parts for 12 hours
machine B makes parts for 10 hours

Work out the total number of parts made by the two machines on Monday.

**PART 2:**
*How to approach any word problem in GCSE Maths*

*One of the biggest reasons why some learners struggle with word problems is because* ***they aren't just regular math problems - they involve reading****! And more than that, learners have to be able to fully comprehend what is happening in the problem in order to figure out how to solve it.*

1. Read the problem
2. Identify key words and maths concepts
3. Think "what do I need to find" (**unknown**)
4. List what is given (***known***)
5. Start solving the problem

**In Part 2 I used the word problems shown in Part 1 to model how to follow the steps mentions in the previous slide.**

**PART 3:**

*Practice on past exam word problems*

Now is your turn to apply the steps we just went through to solve word problems taken from previous GCSE Mathematics examinations!

You can work in pairs or small groups and discuss your thoughts.

I am here to support you!

## B. Online student survey questions with notes on its development and the original TIMSS questions

# Word Problems in GCSE Mathematics

The purpose of this survey is to collect information on how you have been engaging with word problems in Maths through your schooling life. This information will help the maths department to design next year's lessons in a way that will help learners who retake GCSE Maths to better approach maths word problems and build a good understanding of maths.

I am asking you to answer all the questions with honesty and as much detail as possible as this will help us understand why some learners struggle to work with word problems. Your responses to the questions that follow are anonymous which means that you don't have to tell us who you are.

The data of this survey will also be used to write my thesis (a very long essay) for the UCL Institute of Education as it is part of my doctoral studies. The findings could also be published in research publications or presented in conferences. When I write my findings, no names will be used as this survey is anonymous.

If you have any further questions you can email me on despoina.boli@westking.ac.uk or come and see me in person in room K200.

This survey will take you no more than 20 minutes.

Thank you in advance for your responses!

Despoina Boli

* Indicates required question

1. I have read and understood the above information leaflet about this survey. *

- Yes
- No

2. I understand that the results will be shared, without any names, in research publications and/or presentations in college or beyond that. *

- Yes
- No

3. I agree for the data I provide to be archived securely, and with no links to me, for further research use or research validation, in line with UCL guidelines. *

- Yes
- No

**PART A: A few questions about you**

In this section I will ask you a few questions about you without asking you to write your name.

1. How many times have you re-sat GCSE Maths so far? *

   - This is my first time
   - 2 times
   - 3 times
   - 4 times
   - 5+ times

2. Is English your first language? *

   - Yes
   - No

3. How long have you been a student in the UK? *

   - Whole life
   - This is my first year in the UK
   - About 2 years
   - About 3 years
   - About 4 years
   - 5+ years

4. What is your gender? *

   - Female
   - Male
   - Prefer not to say
   - Other: ______________________

**PART B: Questions about your experiences with maths**

In this section, I will ask you a few questions about your experiences with maths in general and word problems in particular.

1. How would you describe your relationship with mathematics from when you started school onward? *

After the Pilot, I changed 'from when you started school' to 'since the beginning of your schooling (this can include memories from primary, secondary, and/or college)' as there was a bit of confusion on what 'started school' meant, some thought it was since they started college.

2. Do you remember experiencing any of the following styles of teaching? (Tick all that apply and/or add your own) *

- [ ] Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.
- [ ] Learners are asked to work on groups or pairs to solve a problem.
- [ ] Learners are asked to investigate the validity of mathematical statements/problems.
- [ ] Different methods are presented for the same question/problem.
- [ ] Learners are encouraged to discuss or present their work to their peers.
- [ ] Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc)
- [ ] Other: ______________________

3. How would you describe yourself as a maths student? *

4. What do you remember about Year 11 and CSE Maths preparation? Were there any incidents that affected your learning? *

After the Pilot, I added the following: 'If yes, how did it affect you?' I added this because Pilot participants mentioned the event without elaborating on how it had affected them.

5. What do you think a maths word problem is? If you want, you can give an example. *

6. Do you remember working on maths word problems in any of your maths classes before you join this college? *

- ( ) Yes
- ( ) No
- ( ) Not sure

7. Thinking of schooling before college, do you remember to have been given any of the following instructions in order to approach maths word problems? (Tick all that apply and/or add your own) *

After the pilot, I added the 'none of the above' option.

- [ ] Underline/highlight the key words
- [ ] Rewrite the problem on your own words
- [ ] Draw a picture or diagram
- [ ] List what is given/Write down the facts
- [ ] Split the problem into smaller parts
- [ ] Identify the maths concepts/calculations you will need to use
- [ ] Check your final answer
- [ ] Organise what is given on a table or chart and make a plan
- [ ] Other: ______________________

8. Thinking of this year in college and your maths lessons, have you been given any of the following instructions in order to approach maths word problems? (Tick all that apply and/or add your own) *

After the Pilot, I changed 'Thinking of this year in college' to 'Thinking of your current year in this college' because there were about 4 learner paticipants who thought that this is the same as question 6. I also added the "none of the above" option.

- [ ] Underline/highlight the key words
- [ ] Rewrite the problem on your own words
- [ ] Draw a picture or diagram
- [ ] List what is given/Write down the facts
- [ ] Split the problem into smaller parts
- [ ] Identify the maths concepts/calculations you will need to use
- [ ] Check your final answer
- [ ] Organise what is given on a table or chart and make a plan
- [ ] Other: ______________________

9. What words would you use to describe your feelings when you are asked to work on maths word problems? *

10. At home or in class, what is the first thing you do when you face a maths problems that you don't understand? *

11. In an exam, what is the first thing you do when you face a maths problems that you don't understand?*

**PART C: Maths word problems**

In this section, you will see four maths word problems taken from past exam papers. You will not need to solve these problems. For each maths word problem presented I would like you to read it and tell me how confident you feel about being able to solve it. Then you will be asked to answer 4 questions in relation to your understanding about each of the word problems.

After the Pilot, I labelled each problem A, B, C, D for better understanding in a,b,c parts. I also added the 'none of the above option' on part c.

After completing the final online student surey I thought that maybe I should have added an extra bit on part b) asking participants of the maths they think they need to use and look if it correlates with their chosen confidence level.

1 ---> A. On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem? *

There are 40 students in a class.
Each student walks to school or cycles to school or gets the bus to school.

There are 22 girls in the class.
9 of the girls walk to school.
7 of the boys cycle to school.
6 of the 10 students who get the bus to school are boys.

Find the number of these students who walk to school.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not confident at all | ◯ | ◯ | ◯ | ◯ | ◯ | Extremely Confident |

1a. Thinking of (Problem A) the previous maths problem, do you feel you understand the context of the problem? *

◯ Yes

◯ No

◯ Maybe

1b. Thinking of (Problem A) the previous maths problem, do you feel that you know the maths that you need to use to be able to solve it? *

◯ Yes

◯ No

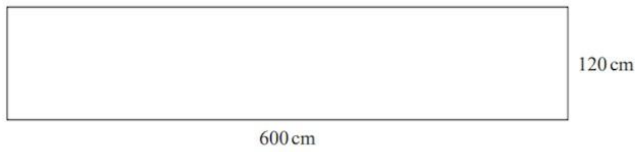
◯ Maybe

1c. Thinking of (Problem A) the previous maths problem, which of the following did you struggle the most? (Tick all that apply and/or add your own) *

- [ ] There are words that I don't understand their meaning I
- [ ] don't know what maths to use
- [ ] I don't understand the maths words used
- [ ] The context of the problems is confusing, doesn't make any sense to me I
- [ ] couldn't understand what it is asking me to find
- [ ] Other: ____________________

2---> B. On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem? *

The diagram shows a rectangular garden path.




Wasim is going to cover the path with paving stones.
Each paving stone is a square of side 30 cm.
Each paving stone costs £2.50

Wasim has £220 to spend on paving stones.

Show that he has enough money to buy all the paving stones he needs.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not confident at all | ○ | ○ | ○ | ○ | ○ | Extremely confident |

2a. Thinking of (Problem B) the previous maths problem, do you feel you understand the context of the problem? *

- Yes
- No
- Maybe

2b. Thinking of (Problem B) the previous maths problem, do you feel that you know the maths that you need to use to be able to solve it? *

- Yes
- No
- Maybe

2c. Thinking of (Problem B) the previous maths problem, which of the following did you struggle the most? (Tick all that apply and/or add your own) *

- [ ] There are words that I don't understand their meaning I
- [ ] don't know what maths to use
- [ ] I don't understand the maths words used
- [ ] The context of the problems is confusing, doesn't make any sense to me I
- [ ] couldn't understand what it is asking me to find
- [ ] Other: ______________________

3---> C. On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem? *

**23** Costcorp sells packets of mints to shop owners.

On Monday three shop owners buy mints from Costcorp.
Each shop owner buys small packets, medium packets and large packets of mints.

Alan buys 400 packets of mints.
32% are small packets.
40% are large packets.

Beryl buys 500 packets of mints.
$\frac{3}{10}$ are small packets.
$\frac{1}{10}$ are large packets.

Charlie buys 150 small packets of mints so that

number of small packets : number of medium packets = 3 : 4

Work out the total number of medium packets of mints these shop owners buy.
You must show all your working.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not confident at all | ◯ | ◯ | ◯ | ◯ | ◯ | Extremely confident |

3a. Thinking of (Problem C) the previous maths problem, do you feel you understand the context of the problem? *

- ◯ Yes
- ◯ No
- ◯ Maybe

3b. Thinking of (Problem C) the previous maths problem, do you feel that you know the maths that you need to use to be able to solve it? *

- ◯ Yes
- ◯ No
- ◯ Maybe

3c. Thinking of(Problem C) the previous maths problem, which of the following did you struggle the most? (Tick all that apply and/or add your own) *

- ☐ There are words that I don't understand their meaning I
- ☐ don't know what maths to use
- ☐ I don't understand the maths words used
- ☐ The context of the problems is confusing, doesn't make any sense to me I
- ☐ couldn't understand what it is asking me to find
- ☐ Other: ______________________

4 ----> D. On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem? *

A shop sells packs of black pens, packs of red pens and packs of green pens.

There are

2 pens in each pack of black pens
5 pens in each pack of red pens
6 pens in each pack of green pens

On Monday,

number of packs of black pens sold : number of packs of red pens sold : number of packs of green pens sold = 7 : 3 : 4

A total of 212 pens were sold.

Work out the number of green pens sold.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not confident at all | ◯ | ◯ | ◯ | ◯ | ◯ | Extremely confident |

4a. Thinking of (Problem D) the previous maths problem, do you feel you understand the context of the problem? *

- ◯ Yes
- ◯ No
- ◯ Maybe

4b. Thinking of (Problem D) the previous maths problem, do you feel that you know the maths that you need to use to be able to solve it? *

- ◯ Yes
- ◯ No
- ◯ Maybe

4c. Thinking of (Problem D) the previous maths problem, which of the following did you struggle the most? (Tick all that apply and/or add your own) *

- [ ] There are words that I don't understand their meaning I
- [ ] don't know what maths to use
- [ ] I don't understand the maths words used
- [ ] The context of the problems is confusing, doesn't make any sense to me I
- [ ] couldn't understand what it is asking me to find
- [ ] Other: ______________________

5. Reflecting on your own experience with maths word problems, what do you thing your teachers should have done differently to help you improve your work with maths problems? *

**PART D: Views about maths**

In this final section, I will present you some statements regarding mathematics in which I would like you to state how much you agree or disagree. Respond to these statements thinking of your current GCSE maths experience in college.

On a scale of 1 to 5, where 1 is 'strongly disagree' and 5 is 'strongly agree', how much to you agree with each of the following statements regarding maths?

After the pilot responses, I changed the title 'Views about maths' to 'Your views about maths this academic year' to make more obvious that they need to focus on their current academic year.

1. The following questions were taken from TIMSS 2019 and some of them were adapted to fit the purpose of this study.
2. In my survey I used the term 'maths' instead of 'mathematics' used in TIMMS because the student-participants use the term 'maths' more often than the term 'mathematics'.
3. The questions aim to determine participants level on a) Liking maths (LM), b) Instructional clarity in maths lessons (ICiML) and c) Confidence in maths (CiM)

1. I enjoy learning maths. * LM

*TIMSS: I enjoy learning mathematics.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

2. I wish I did not have to study maths. * LM

*TIMSS: I wish I did not have to study mathematics.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

3. Maths is often boring. * LM

*TIMSS: Mathematics is boring. – I added the word 'often' to make the statement a bit softer and allow participants the possibility that some aspects of maths can be boring but some others may not be.*

1. I sometimes learn interesting things in maths. * LM

   *TIMSS: I learn many interesting things in mathematics* – I adapted this to give the possibility of more varied responses.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

2. I like any schoolwork that involves numbers. * LM

   *TIMSS: I like any schoolwork that involves numbers*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

3. I enjoy trying to solve maths problems. * LM

   *TIMSS: I like to solve mathematics problems* – I changed 'like' to 'enjoy trying' to mphasise the effort and engagement involved in problem-solving, rather than just the act of solving itself. This could lead to responses that reflect not just whether participants like maths, but also their attitudes towards persistence and challenge.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

4. I usually look forward to maths class. * LM

   *TIMSS: I look forward to mathematics lessons* – My adaptation makes the statement feel a bit more flexible as I wanted to acknowledge that enjoyment may vary from day to day. Also, I used 'class' instead of 'lesson' because I had noticed that participants tend to use the term 'class' more often.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

1. Maths is one of my favourite subjects. * LM

*TIMSS: Mathematics is one of my favourite subjects.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

2. I usually know what my maths teacher expects me to do. * ICiML

*TIMSS: I know what my teachers expects me to do.* - By adding 'maths teacher', I wanted to make sure that participants are thinking about expectations within their maths class rather than general expectations from all teachers. The addition of 'usually' also gives a bit of flexibility to allow participants to acknowledge occasional uncertainty.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

3. My maths teacher is easy to understand. * ICiML

*TIMSS: My teacher is easy to understand.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

4. My maths teacher has clear answers to my questions. * ICiML

*TIMSS: My teacher has clear answers to my questions.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

5. My teacher is good at explaining maths. * ICiML

*TIMSS: My teacher is good at explaining mathematics.*

1 2 3 4 5

1. My maths teacher does a variety of things to help us learn. * ICiML

*TIMSS: My teacher does a variety of things to help us learn.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

2. My maths teacher links new lessons to what I already know. * ICiML

*TIMSS: My teacher links new lessons to what I already know.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

3. My maths teacher explains a topic again when we don't understand. * ICiML

*TIMSS: My teacher explains a topic again when we don't understand.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

16. I usually do well in maths. * CiM

*TIMSS: I usually do well in mathematics.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

17. Maths is more difficult for me than for many of my classmates. * CiM

*TIMSS: Mathematics is more difficult for me than for many of my classmates.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

Maths is not one of my strengths. * CiM

*TIMSS: Mathematics is not one of my strengths.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

19. I learn thinks quickly in maths. * CiM

*TIMSS: I learn things quickly in mathematics.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

20. Maths makes me nervous. * CiM

*TIMSS: Mathematics makes me nervous.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

21. I am good at working out difficult maths problems. * CiM

*TIMSS: I am good at working out difficult mathematics problems.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

22. My maths teacher tells me I am good at maths. * CiM

*TIMSS: My teacher tells me I am good at mathematics. – I added 'maths teacher' instead of just 'teacher' to ensure that participants are thinking about the right person when answering the question.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

23. Maths is harder for me than any other subject. * CiM

*TIMSS: Mathematics is harder for me than any other subject*.

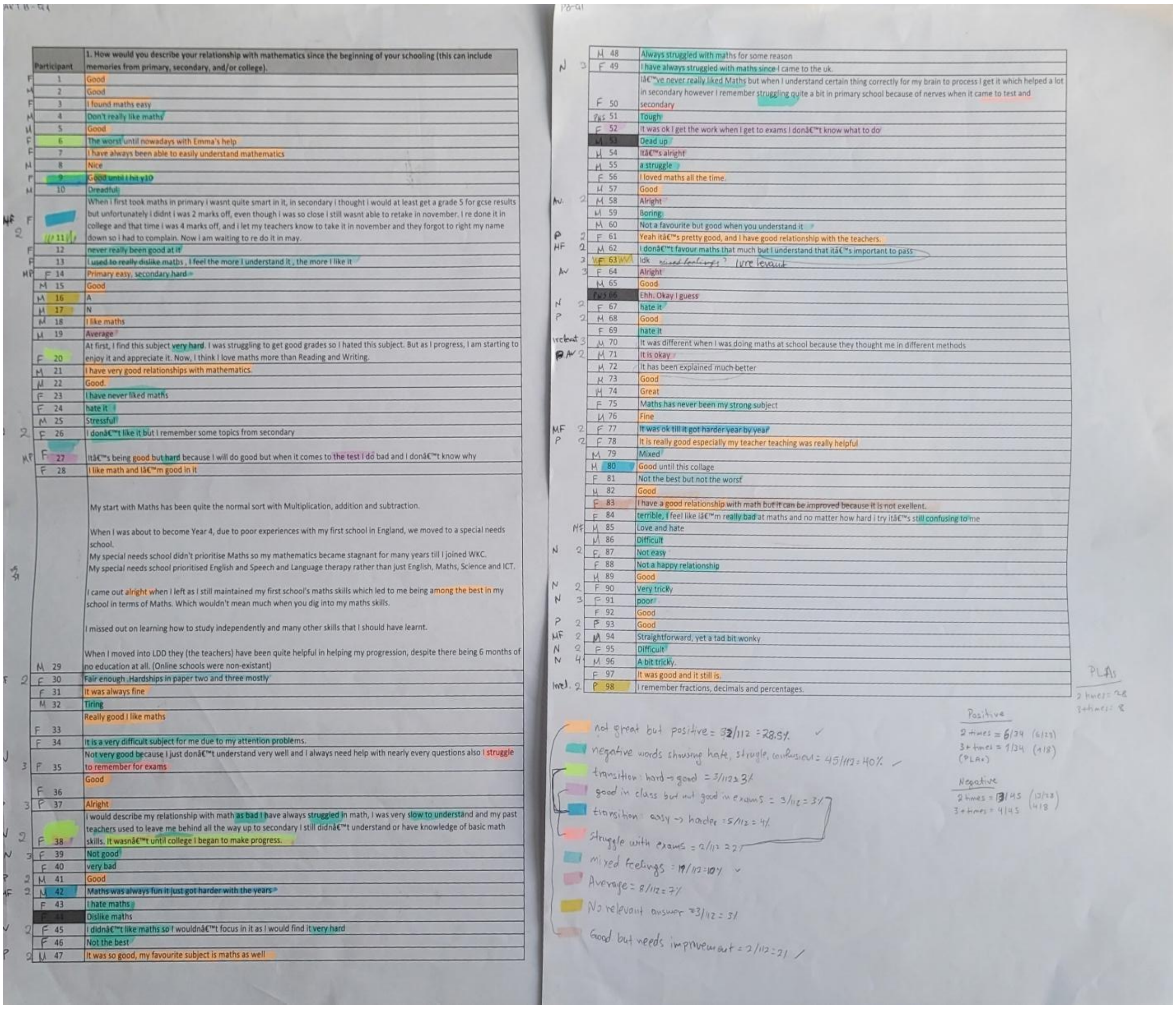
24. Maths makes me confused. * CiM

*TIMSS: Mathematics makes me confused.*

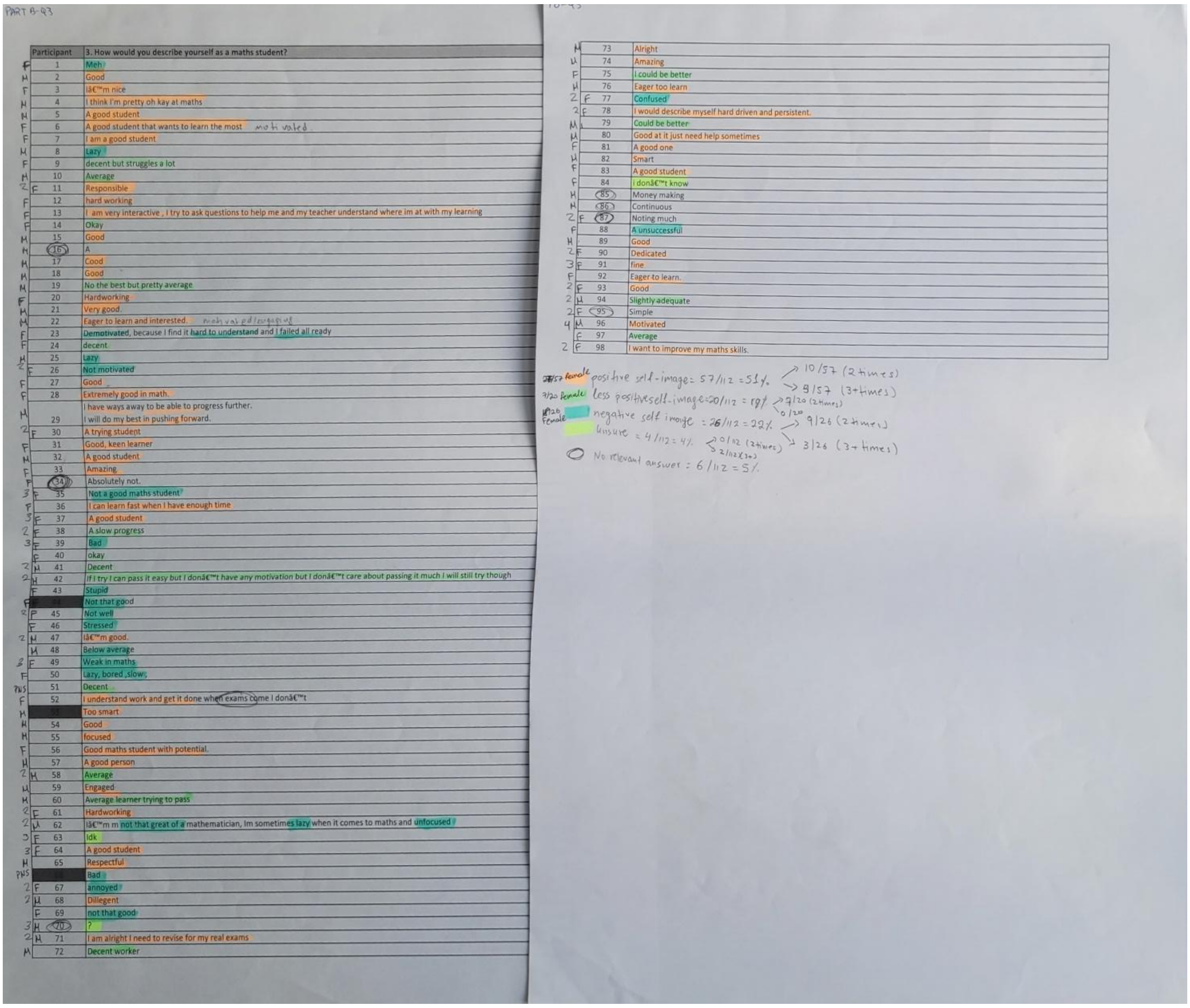
| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ◯ | ◯ | ◯ | ◯ | ◯ | Strongly agree |

## C. Example images depicting the process of analysing qualitative data from the online student survey

**College A Part B Question 1 Thematic Analysis Process** – *How would you describe your relationship with mathematics since the beginning of your schooling (this can include memories from primary, secondary and/or college).*



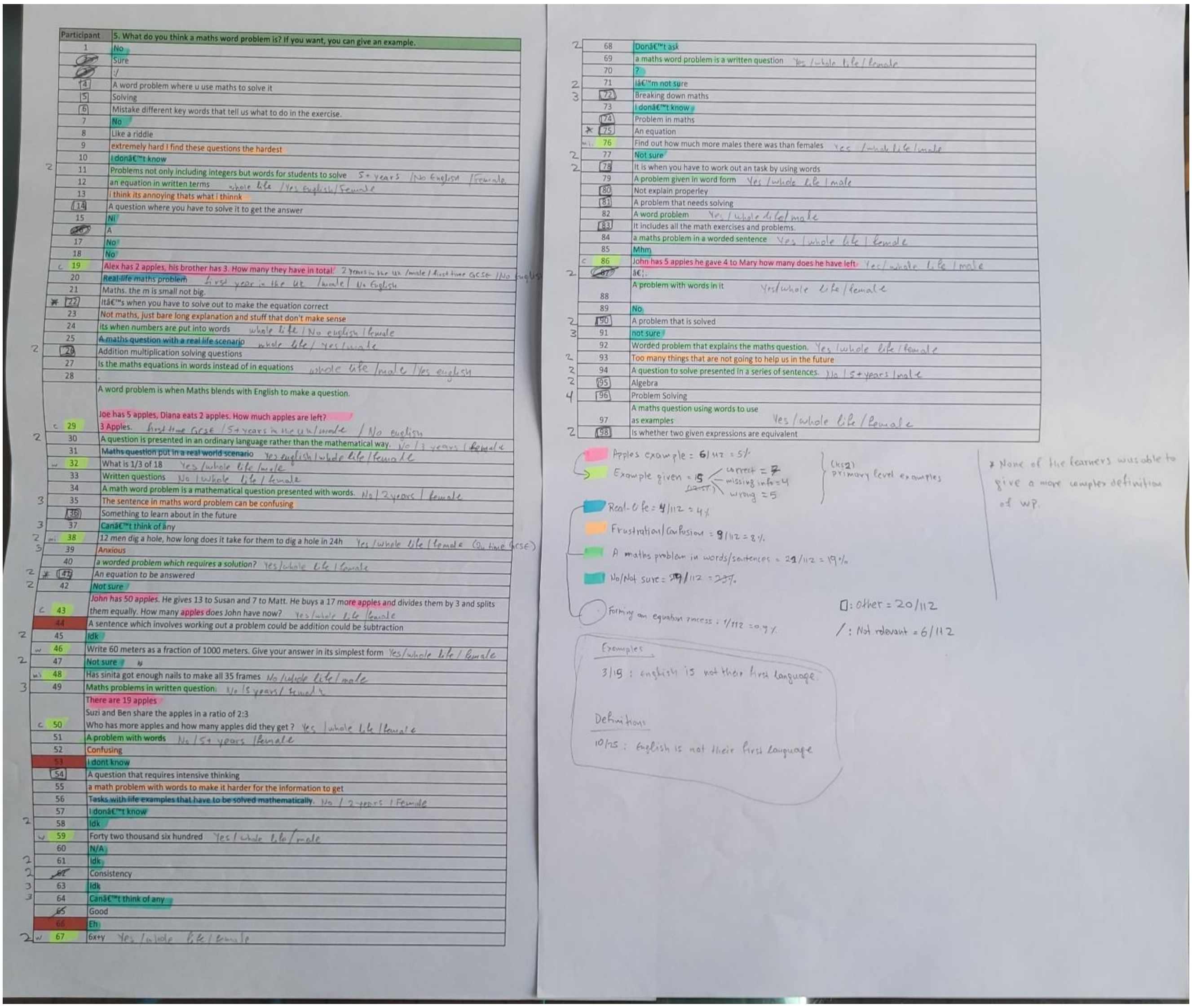
**College A Part B Question 3 Thematic Analysis Process** - How would you describe yourself as a mathematics student?



PART B-Q3

| Participant | 3. How would you describe yourself as a maths student? |
|---|---|
| 1 | Meh |
| 2 | Good |
| 3 | Iâ€™m nice |
| 4 | I think I'm pretty oh kay at maths |
| 5 | A good student |
| 6 | A good student that wants to learn the most |
| 7 | I am a good student |
| 8 | Lazy |
| 9 | decent but struggles a lot |
| 10 | Average |
| 11 | Responsible |
| 12 | hard working |
| 13 | I am very interactive , I try to ask questions to help me and my teacher understand where im at with my learning |
| 14 | Okay |
| 15 | Good |
| 16 | A |
| 17 | Cood |
| 18 | Good |
| 19 | No the best but pretty average |
| 20 | Hardworking |
| 21 | Very good. |
| 22 | Eager to learn and interested. |
| 23 | Demotivated, because I find it hard to understand and I failed all ready |
| 24 | decent |
| 25 | Lazy |
| 26 | Not motivated |
| 27 | Good |
| 28 | Extremely good in math. |
| 29 | I have ways away to be able to progress further. I will do my best in pushing forward. |
| 30 | A trying student |
| 31 | Good, keen learner |
| 32 | A good student |
| 33 | Amazing |
| 34 | Absolutely not. |
| 35 | Not a good maths student |
| 36 | I can learn fast when I have enough time |
| 37 | A good student |
| 38 | A slow progress |
| 39 | Bad |
| 40 | okay |
| 41 | Decent |
| 42 | If I try I can pass it easy but I donâ€™t have any motivation but I donâ€™t care about passing it much I will still try though |
| 43 | Stupid |
| [redacted] | Not that good |
| 45 | Not well |
| 46 | Stressed |
| 47 | Iâ€™m good. |
| 48 | Below average |
| 49 | Weak in maths |
| 50 | Lazy, bored ,slow |
| 51 | Decent |
| 52 | I understand work and get it done when exams come I donâ€™t |
| [redacted] | Too smart |
| 54 | Good |
| 55 | focused |
| 56 | Good maths student with potential. |
| 57 | A good person |
| 58 | Average |
| 59 | Engaged |
| 60 | Average learner trying to pass |
| 61 | Hardworking |
| 62 | Iâ€™m m not that great of a mathematician, Im sometimes lazy when it comes to maths and unfocused |
| 63 | Idk |
| 64 | A good student |
| 65 | Respectful |
| [redacted] | Bad |
| 67 | annoyed |
| 68 | Dillegent |
| 69 | not that good |
| 70 | ? |
| 71 | I am alright I need to revise for my real exams |
| 72 | Decent worker |
| 73 | Alright |
| 74 | Amazing |
| 75 | I could be better |
| 76 | Eager too learn |
| 77 | Confused |
| 78 | I would describe myself hard driven and persistent. |
| 79 | Could be better |
| 80 | Good at it just need help sometimes |
| 81 | A good one |
| 82 | Smart |
| 83 | A good student |
| 84 | i donâ€™t know |
| 85 | Money making |
| 86 | Continuous |
| 87 | Noting much |
| 88 | A unsuccessful |
| 89 | Good |
| 90 | Dedicated |
| 91 | fine |
| 92 | Eager to learn. |
| 93 | Good |
| 94 | Slightly adequate |
| 95 | Simple |
| 96 | Motivated |
| 97 | Average |
| 98 | I want to improve my maths skills. |

**College A Part B Question 5 Thematic Analysis Process** – What do you think a maths word problem is? If you want, you can give an example.



| Participant | 5. What do you think a maths word problem is? If you want, you can give an example. |
|---|---|
| 1 | No |
| 2 | Sure |
| 3 | :/ |
| 4 | A word problem where u use maths to solve it |
| 5 | Solving |
| 6 | Mistake different key words that tell us what to do in the exercise. |
| 7 | No |
| 8 | Like a riddle |
| 9 | extremely hard I find these questions the hardest |
| 10 | I donâ€™t know |
| 11 | Problems not only including integers but words for students to solve |
| 12 | an equation in written terms |
| 13 | I think its annoying thats what I think |
| 14 | A question where you have to solve it to get the answer |
| 15 | Nl |
| 16 | A |
| 17 | No |
| 18 | No |
| 19 | Alex has 2 apples, his brother has 3. How many they have in total |
| 20 | Real-life maths problem |
| 21 | Maths. the m is small not big. |
| 22 | Itâ€™s when you have to solve out to make the equation correct |
| 23 | Not maths, just bare long explanation and stuff that don't make sense |
| 24 | Its when numbers are put into words |
| 25 | A maths question with a real life scenario |
| 26 | Addition multiplication solving questions |
| 27 | Is the maths equations in words instead of in equations |
| 28 | A word problem is when Maths blends with English to make a question. Joe has 5 apples, Diana eats 2 apples. How much apples are left? |
| 29 | 3 Apples. |
| 30 | A question is presented in an ordinary language rather than the mathematical way. |
| 31 | Maths question put in a real world scenario |
| 32 | What is 1/3 of 18 |
| 33 | Written questions |
| 34 | A math word problem is a mathematical question presented with words. |
| 35 | The sentence in maths word problem can be confusing |
| 36 | Something to learn about in the future |
| 37 | Canâ€™t think of any |
| 38 | 12 men dig a hole, how long does it take for them to dig a hole in 24h |
| 39 | Anxious |
| 40 | a worded problem which requires a solution? |
| 41 | An equation to be answered |
| 42 | Not sure |
| 43 | John has 50 apples. He gives 13 to Susan and 7 to Matt. He buys a 17 more apples and divides them by 3 and splits them equally. How many apples does John have now? |
| 44 | A sentence which involves working out a problem could be addition could be subtraction |
| 45 | Idk |
| 46 | Write 60 meters as a fraction of 1000 meters. Give your answer in its simplest form |
| 47 | Not sure |
| 48 | Has sinita got enough nails to make all 35 frames |
| 49 | Maths problems in written question. |
| 50 | There are 19 apples Suzi and Ben share the apples in a ratio of 2:3 Who has more apples and how many apples did they get? |
| 51 | A problem with words |
| 52 | Confusing |
| 53 | i dont know |
| 54 | A question that requires intensive thinking |
| 55 | a math problem with words to make it harder for the information to get |
| 56 | Tasks with life examples that have to be solved mathematically. |
| 57 | I donâ€™t know |
| 58 | Idk |
| 59 | Forty two thousand six hundred |
| 60 | N/A |
| 61 | Idk |
| 62 | Consistency |
| 63 | Idk |
| 64 | Canâ€™t think of any |
| 65 | Good |
| 66 | Eh |
| 67 | 6x+y |
| 68 | Donâ€™t ask |
| 69 | a maths word problem is a written question |
| 70 | ? |
| 71 | Iâ€™m not sure |
| 72 | Breaking down maths |
| 73 | I donâ€™t know |
| 74 | Problem in maths |
| 75 | An equation |
| 76 | Find out how much more males there was than females |
| 77 | Not sure |
| 78 | It is when you have to work out an task by using words |
| 79 | A problem given in word form |
| 80 | Not explain properley |
| 81 | A problem that needs solving |
| 82 | A word problem |
| 83 | It includes all the math exercises and problems. |
| 84 | a maths problem in a worded sentence |
| 85 | Mhm |
| 86 | John has 5 apples he gave 4 to Mary how many does he have left |
| 87 | â€¦ |
| 88 | A problem with words in it |
| 89 | No |
| 90 | A problem that is solved |
| 91 | not sure |
| 92 | Worded problem that explains the maths question. |
| 93 | Too many things that are not going to help us in the future |
| 94 | A question to solve presented in a series of sentences. |
| 95 | Algebra |
| 96 | Problem Solving |
| 97 | A maths question using words to use as examples |
| 98 | Is whether two given expressions are equivalent |

The Pilot responses from College A were also considered in the final sample:

| Participant | 1. How would you describe your relationship with mathematics from when you started school onward?<br><br>I changed the last part of the question as there was a bit of confusion on what 'started school' meant, some thought it was since they | 2. Do you remember experiencing any of the following styles of teaching? (Tick all that apply and/or add your own) | 3. How would you describe yourself as a maths student? | 4. What do you remember about Year 11 and CSE Maths preparation? Were there any incidents that affected your learning?<br><br>After the first day of the survey, I added this: 'If yes, how did it affect | 4. What do you think a maths word problem is? If you want, you can give an example. | 5. Do you remember working on maths word problems in any of your maths classes |
|---|---|---|---|---|---|---|
| P1 M | iâ€™ve always hated maths | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to investigate the validity of mathematical statements/problems. | intelligent & fast learner | Covid-19 ruined everything, put stress on students as to everything was online learning. Didnâ€™t feel as authentic as real life | problem solving | Yes |
| P2 M | Difficult | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are encouraged to discuss or present their work to their peers. | Determined | I didnâ€™t have a teacher | A maths problem could be to work out how much money there is<br>Yes/whole life/male | Yes |
| N P3 2 M | Always struggled with maths never enjoyed it | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work. | Not very good | Never listened or done any work just slept during lessons | A problem based on wording like â€œif James has â€¦ balls and â€¦ are red and â€¦ are blue how many are greenâ€¦ Yes/whole life/male | Yes |
| P4 F | Umm not easy but once I get it itâ€™s ok | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc) | Iâ€™m not sure | It wasnâ€™t good | A problem | Yes |
| N P5 2 M | Bad | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work. | Feels like i wasted my time | I didn't do tests in year 11<br>Covid | Idk | Yes |
| P6 PNS | Not good | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc) | Not the best | Covid | When it needs to many steps | No |
| N P7 2 F | Terrible Iâ€™m not really good at maths itâ€™s really difficult for me | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to work on groups or pairs to solve a problem. | Bae Iâ€™m bad at maths | It was covid so it wasnâ€™t really great it was online so I never really understood | Idk | Yes |
| P8 F | Love and hate relationship | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work. | Always annoyed at myself for not passing maths | No | Iâ€™m not really sure the first thing that comes to mind is complicated | No |
| P9 F | 50% good. | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to work on groups or pairs to solve a problem.;Different methods are presented for the same question/problem. | Good. | No incidents affected my learning. | a question written as a sentence so that people can think about the question and what exactly is it asking.<br>Yes/whole life/female | Yes |
| P10 M | Good | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Different methods are presented for the same question/problem.;Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc) | Amazing | Being forgetful | Written maths<br>Yes/whole life/female | Yes |
| N P11 2 F | I don't think I've had a good experience with maths, it's something I've always struggled with. | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to work on groups or pairs to solve a problem.;Learners are asked to investigate the validity of mathematical statements/problems.;Different methods are presented for the same question/problem.;Learners are encouraged to discuss or present their work to their peers.;Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc) | I never thought I was good at this subject | I'm not too sure | Mathew has eight apples. He gives half of his apples to his friend. How many apples does he have left?<br>C<br>Yes/whole life/female | Yes |
| P12 F | Terrible. Never made sense to me but I was ok at it the more I studied but I couldn't make sense of a lot of things I just knew how to do it. | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to work on groups or pairs to solve a problem.;Different methods are presented for the same question/problem.;Learners are encouraged to discuss or present their work to their peers.;Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc) | I hate maths I never want to do it again. I don't talk much because I'll get something wrong. | I don't know why I was doing the higher paper and none of the teachers switched me to foundation so by the beginning of April I asked to be moved to foundation because I didn't want to completely fail maths. I regret not doing this sooner. | I question with numbers or mathematical terms in it that allow you to form your own equation. You have to piece everything together to get your answer.<br>Yes/whole life/female | Yes |
| N P13 2 M | Dislike it | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to investigate the validity of mathematical statements/problems.;Different methods are presented for the same question/problem. | Quiet | No | I don't know | Yes |
| ? P14 2 F | It's getting better | Examples are demonstrated on the board, learners are asked to answer/solve similar questions, the teacher marks their work.;Learners are asked to investigate the validity of mathematical statements/problems.;Different methods are presented for the same question/problem.;Learners are encouraged to discuss or present their work to their peers.;Visual tasks are used to help with understanding (e.g. graphs, drawing pictures, use of real objects, etc) | Average | I didnâ€™t do year 11 | | No |

The data from College B followed the same analysis process using the same colours and similar themes.

Finally, all findings were saved on a word document for clarity and more effective comparison as seen below:

## PART A: Participants' demographics (149 participants)

| **College A (n=112)** | **Number of times resitting GCSE Maths** |
|---|---|
| **1st time** | 75 (67%) |
| **2 or more times** | 37 (33%) |
| | **English as first language** |
| **Yes** | 74 (66%) |
| **No** | 38 (34%) |
| | **Years of studying in the UK** |
| **Whole life** | 83 (74%) |
| **Less than 5 years** | 17 (15%) |
| **More than 5 Years** | 12 (11%) |
| | **Gender** |
| **Female** | 60 (53%) |
| **Male** | 50 (45%) |
| **Prefer not to say** | 2 (2%) |

| **College B (n=37)** | **Number of times resitting GCSE Maths** |
|---|---|
| **1st time** | 22 (59%) |
| **2 or more times** | 13 (35%) |
| **1st sitting GCSE Maths** | 2 (6%) |
| | **Have you achieved 4+ in GCSE English** |
| **Yes** | 13 (35%) |
| **No** | 22 (59%) |
| | **English as first language** |
| **Yes** | 14 (38%) |
| **No** | 23 (62%) |
| | **Years of studying in the UK** |

| | |
|---|---|
| **Whole life** | 14 (38%) |
| **Less than 5 years** | 13 (35%) |
| **More than 5 Years** | 10 (27%) |
| | **Gender** |
| **Female** | 16 (43%) |
| **Male** | 20 (54%) |
| **Prefer not to say** | 1 (3%) |

| **Persistent Low Attainers** | **College A** | **College B** | **Total** |
|---|---|---|---|
| **Female** | 23 | 5 | 28 |
| **Male** | 13 | 7 | 20 |
| **Total** | 36 | 12 | **48** |

## PART B: Questions about your experience with maths

*** All percentages have been rounded to the nearest whole number.*

***1. How would you describe your relationship with mathematics since the beginning of schooling (this can include memories from primary, secondary, and/or college)?***

**College A:**

- Positive relationship: 34/112 = 30.4% **(16 female, 18 male)** **(8 PLAs: 5 female, 3 male)**
    - Not great but positive: 32/34 = 94%
    - Good but needs improvement: 2/34 = 6%
- Negative relationship: 47/112 = 45% **(33 Female, 12 male, 2 pns)** **(18 PLAs: 13 female, 5 male)**
- Mixed feelings: 19/112 = 17% **(2 PLAs)**
- Average relationship: 8/112 = 6% **(2 PLAs)**
- No relevant answer: 3/112 = 3%

**College B:**

- Positive relationship: 14/37 = 38% **(7 Male, 6 Female) - (3 PLAs: 2 female, 1 pns)**
- Negative relationship: 10/37 = 27% **(5 Male, 5 Female)** - **(5 PLAs: 2 female, 3 male)**
- Mixed feelings: 6/37 = 16% **(4 Male, 2 Female)** - **(2 PLAs: 2 male)**
- Average relationship: 5/37 = 14% **(3 Male, 2 Female)** - **(1 PLA:  male)**
- Not relevant: 2/37 = 5%

**Colleges A + B:**

- Positive relationship: 48/149 = 32% **(22 female, 25 male) (11 PLAs: 7 female, 3 male, 1 pns)**
- Negative relationship: 57/149 =38% **(38 Female, 17 male, 2 pns) (23 PLAs: 15 female, 8 male)**
- Mixed feelings: 25/149 = 17% **(7 female, 18 male) (4 PLAs)**
- Average relationship: 13/112 = 9% **(5 female, 7 male, 1 pns) (3 PLAs)**
- No relevant answer: 5/149 = 3%

***3. How would you describe yourself as a maths student?***

**College A:**

- Positive self-image (key words: good, responsible, hardworking, respectful, diligent, eager to learn, smart): 57/112 = 51% **(27 Female, 30 Male**) **(14 PLAs: 10 female, 4 male)**
- Average self-image (key words: average, could do better, decent): 20/112 = 18% **(7 Female, 13 Male) (7PLAs)**
- Negative self-image (key words: unmotivated, lazy, hard to understand, bored, below average, confused): 26/112 = 22% **(18 Female, 8 Male) (11 PLAs: 8 female, 3 male)**
- Unsure: 4/112 = 4%
- No relevant answer: 6/112 = 5%

**College B:**

- Positive self-image (key words: good, responsible, hardworking, respectful, diligent, eager to learn, smart): 17/37 = 46% **(7 Male, 10 Female)** - **(4 PLAs: 2 Male, 2 Female)**
- Average self-image (key words: average, could do better, decent): 7/37 = 19% **(7 Male, 1 Female)** – **(1 PLA: Female)**
- Negative self-image (key words: unmotivated, lazy, hard to understand, bored, below average, confused): 6/37 = 16%) **(3 Male, 3 Female)** – **(4 PLAs: 2 Male, 2 Female)**
- Unsure: 2/37 = 5% **(1 Male, 1 Female)** – **(1PLA: Male)**
- No relevant answer: 4/37 = 11%

**Colleges A + B:**

- Positive self-image (key words: good, responsible, hardworking, respectful, diligent, eager to learn, smart): 74/149 = 50% **(37 Female, 37 Male**) **(18 PLAs: 12 female, 6 male)**
- Average self-image (key words: average, could do better, decent): 27/149 = 18% **(8 Female, 20 Male)** **(8 PLAs)**
- Negative self-image (key words: unmotivated, lazy, hard to understand, bored, below average, confused): 32/149 = 21% **(21 Female, 11 Male)** **(115 PLAs: 10 female, 5 male)**
- Unsure: 6/149 = 4%
- No relevant answer: 10/149 = 7%

***4. What do you remember about Year 11 and GCSE Maths preparation? Where there any incidents that affected your learning? If yes, how did that incident affect your learning?***

**College A:**

- Pandemic: 30/112 = 27%
- Teacher relationship: 6/112 = 5%
- Self-responsibility: 8/112 = 7%
- Other: 13/112 = 12%
    - Tier change: 1/13 = 8% (1/112 = 0.9%)
    - New to English education: 1/13 = 8% (1/112 = 0.9%)

    - Schooling circumstances: 5/13 = 39% (5/112 = 4.5%)
    - No GCSE exams before: 3/13 = 23% (3/112 = 2.7%)
    - Medical: 3/112 = 3%
- No incident: 42/112 = 38%

**College B:**

- Pandemic: 3/37 = 8% **(3 PLAs)**
- Other: 11/37 = 30%
    - New to English education: 3/11
    - Limited resources: 4/11
    - Schooling circumstances: 3/11
    - Personal needs: 1/11
- No incident: 18/37 = 49% **(5 PLAs)**
- Not relevant: 5/37 = 14%

**Colleges A + B:**

- Pandemic: 33/149 = 22% **(17 PLAs)**
- Teacher relationship: 6/149 = 4%
- Self-responsibility: 8/149 = 5%
- Schooling circumstances: 8/149 = 5%
- Other: 16/149 = 11%
    - Tier change: 1/16 = 6%
    - Limited resources: 4/16 = 25%
    - New to English education: 4/16 = 25%
    - No GCSE exams before: 3/16 = 19%
    - Medical: 3/16 = 19%
    - Personal needs: 1/16 = 6%
- No incident: 60/149 = 40%
- Not relevant: 5/149 = 3%

***5. What do you think a maths word problem is? If you want, you can give an example.***

**College A:**

- Example given: 15/112 = 13% **(6 male, 9 female)** – **(4 PLAs)**
    - Mathematically correct (all the apple examples): 7/14 = 50% **(2 PLAs)**
    - Missing information: 4/14 = 29% **(1 PLA)**
    - Not a WP: 5/14 = 36% **(1 PLA)**
- Definition given: 26/112 = 22% **(7 male, 9 female)** - **(5 PLAs)**
    - Real-life definition: 4/26 = 15%
    - Maths in words/sentences: 22/26 = 81% **(5 PLAs)**
- Not sure: 29/112 = 26% **(11 PLAs)**
- Frustration/Confusion: 9/112 = 8% **(2 PLAs)**
- Other (key words: solving, problem solving, equation): 20/112 = 18% **(7 PLAs)**
- Not relevant: 6/112 = 5%

**College B:**

- Example given: 6/37 = 16% **(4 male, 2 female)** – **(1 PLA: male)**
    - Mathematically correct (2 apples, 1 sweets, 1 pencils, 1 ratio, 1 percentage): 6/6
- Definition given: 15/37 = 41% **(8 male, 7 female)** - **(3 PLAs: 2 male, 1 female)**
    - Real-life definition:  4/15
    - Maths in words/sentences/scenario/story: 11/15
- Frustration/Confusion: 1/37 = 3% **(PLA: female)**
- Other (key words: solving, problem solving, equation, puzzles, riddles): 7/37 = 19% **(4 male, 3 female)** - **(3 PLAs: 1 male, 2 female)**
- Not relevant: 10/37 = 27%

**Colleges A + B:**

- Example given: 21/149 = 14% **(10 male, 11 female)** – **(5 PLAs)**

    - Mathematically correct (9 apple, 1 sweets, 1 pencils, 1 ratio, 1 percentage examples): 13/21 = 62%
    - Missing information: 4/21 = 19%
    - Not a WP: 5/21 = 24%
- Definition given: 41/149 = 28% **(15 male, 16 female)** - **(8 PLAs)**
    - Real-life definition: 8/41 = 20%
    - Maths in words/sentences/scenario/story: 33/41 = 80%
- Not sure: 29/149 = 19% **(11 PLAs)**
- Frustration/Confusion: 10/149 = 7% **(3 PLAs)**
- Other (key words: solving, problem solving, equation, puzzles, riddles): 27/149 = 18% **(10 PLAs)**
- Not relevant: 16/149 = 11%

***9. What words would you use to describe your feelings when you are asked to work on a maths word problem?***

**College A:**

- Positive feelings: 38/112 = 34% **(25 male, 12 female)** – **(7 PLAs)**
- Neutral/Not sure: 18/112 = 16% **(9 PLAs)**
- Mixed feelings: 10/112 = 9% **(3 male, 7 female)** – **(1 PLA: male)**
- Negative feelings: 40/112 = 36% **(9 male, 30 female)** – **(21 PLAs: 4 male, 17 female)**
- Not relevant (not a feeling): 4/112 = 4%

**College B:**

- Positive feelings: 12/37 = 32% **(6 male, 6 female)** – **(4PLAs: 2 male, 2 female)**
- Neutral/Not sure: 5/37 = 14% **(4 male, 1 female)** – **(2 PLAs: 1 male, 1 female)**
- Mixed feelings: 3/37 = 8% **(2 male, 1 female)** – **(1PLA: male)**
- Negative feelings: 13/37 = 35% **(5 male, 8 female)** – **(4PLAs: 2 male, 2 female)**
- Not relevant (not a feeling): 4/37 = 11%

**Colleges A + B:**

- Positive feelings: 50/149 = 34% **(31 male, 18 female)** – **(11 PLAs)**
- Neutral/Not sure: 23/149 = 15% **(11 PLAs)**
- Mixed feelings: 13/149 = 9% **(5 male, 8 female)** – **(2 PLAs: 2 male)**
- Negative feelings: 53/149 = 36% **(14 male, 38 female**) – **(25 PLAs: 6 male, 19 female)**
- Not relevant (not a feeling): 8/149 = 5%

***10. At home or in class, what is the first thing you do when you face a maths word problem that you don't understand?***

**College A:**

- External help: 50/112 = 45% **(23 male, 27 female)** - **(20 PLAs: 6male, 14 female)**
    - Ask someone else (teacher, friend, family): 20/50 = 40%
    - Online search: 30/50 = 60%
    - Book: 3/50 = 6%
- Rely on self: 35/112 = 31% **(22 male, 13 female)** - **(5 PLAs)**
    - Highlight Key words/facts: 9/35 = 26%
    - Read the problem again (several times): 11/35 = 31%
    - Just try it: 11/35 = 31%
    - Other: 5/35 = 14%
- Skip: 17/112 = 15% **(5 male, 12 female)** – **(6 PLAs)**
- Not relevant: 10/112 = 7%

**College B:**

- External help: 22/37 = 59% **(11 male, 11 female)** - **(6 PLAs: 3 male, 3 female)**
    - Ask someone else (teacher, friend, family): 12/22
    - Online search: 13/22
- Rely on self: 7/37 = 19% **(4 male, 3 female)** - **(2 PLAs: 2 male)**
- Skip: 4/37 = 11% **(2 male, 2 female)** – **(3 PLAs: 1 male, 2 female)**
- Not relevant: 10/37 = 27%

**College A + B:**

- External help: 72/149 = 48% **(34 male, 38 female)** - **(26 PLAs: 9 male, 17 female)**
    - Ask someone else (teacher, friend, family): 32/72 = 44%
    - Online search: 43/72 = 60%
    - Book: 3/72 = 4%
- Rely on self: 42/149 = 28% **(26 male, 16 female)** - **(7 PLAs)**
- Skip: 21/149 = 14% **(7 male, 14 female)** – **(9 PLAs)**
- Not relevant: 20/149 = 14%

***11. In an exam, what is the first thing you do when you face a maths word problem that you don't understand?***

**College A:**

- Take action: 70/112 = 63% **(37 male, 33 female)** - **(20 PLAs)**
    - Come back to the problem later: 34/70 = 49%
    - Look for key words: 11/70 = 16%
    - Read the problem again: 14/70 = 20%
    - Ask for help (teacher): 3/70 = 4%
    - Other: 7/70 = 10%
- No action: 25/112 = 22% **(14 male, 11 female) - (11 PLAs)**
    - Skip: 20/25 = 80%
    - Panic/worry: 2/25 = 8% **(2 female)** - **(2 PLAs)**
    - Stare at the problem: 3/25 = 12%
- Do my best: 15/112 = 13% **(5 PLAs)**
- Not relevant: 6/112 = 5%

**College B:**

- Take action: 26/37 **(13 male, 13 female)** - **(5 PLAs: 5 female)**
    - Come back to the problem later: 12/26
    - Look for key words: 1/26
    - Read the problem again: 5/26
    - Other: 8/26

- No action (skip): 3/37 **(2 male, 1 female) – (0 PLAs)**
- Do my best: 4/37 **(1 PLA: male)**
- Not relevant: 4/37

**College A + B:**

- Take action: 96/149 = 64% **(50 male, 46 female)** - **(25 PLAs)**
    - Come back to the problem later: 46/96 = 48%
    - Look for key words: 12/96 = 13%
    - Read the problem again: 19/96 = 20%
    - Ask for help (teacher): 3/96 = 3%
    - Other: 15/96 = 16%
- No action: 28/149 = 19% **(16 male, 12 female) - (11 PLAs)**
    - Skip: 23/28 = 82%
    - Panic/worry: 2/28 = 7% **(2 female)** - **(2 PLAs)**
    - Stare at the problem: 3/28 = 11%
- Do my best: 15/112 = 13% **(5 PLAs)**
- Not relevant: 10/149 = 7%

## PART C: Word Problems Task

**College A:**

| *On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem (A-D)?* | | | | |
|---|---|---|---|---|
| **n = 112** | **A** | **B** | **C** | **D** |
| **Not confident at all** | 2% (n=2) | 15% (n=17) | 18% (n=20) | 11% (n=12) |
| **Not confident** | 12% (n=13) | 21% (n=23) | 16% (n=18) | 7% (n=8) |
| **Neutral** | 23% (n=26) | 27% (n=30) | 32% (n=36) | 35% (n=39) |
| **Confident** | 28% (n=31) | 22% (n=25) | 18% (n=20) | 30% (n=34) |
| **Extremely confident** | 36% (n=40) | 15% (n=17) | 16% (n=18) | 17% (n=19) |

| *Thinking of Problem (A, B, C, D) do you feel you understand the context of the problem?* |
|---|

| n = 112 | A | B | C | D |
|---|---|---|---|---|
| **YES** | 69% (n=77) | 46% (n=51) | 46% (n=52) | 50% (n=56) |
| **NO** | 5% (n=6) | 22% (n=25) | 21% (n=23) | 13% (n=15) |
| **MAYBE** | 26% (n=29) | 32% (n=36) | 33% (n=37) | 31% (n=35) |

| *Thinking of Problem (A, B, C, D) do you feel that you know the maths that you need to use to be able to solve it?* | | | | |
|---|---|---|---|---|
| **n = 112** | **A** | **B** | **C** | **D** |
| **YES** | 71% (n=80) | 41% (n=46) | 44% (n=49) | 49% (n=55) |
| **NO** | 6% (n=6) | 19% (n=21) | 21% (n=24) | 16% (n=18) |
| **MAYBE** | 23% (n=26) | 40% (n=45) | 35% (n=39) | 35% (n=39) |

| *Thinking of Problem (A, B, C, D) which of the following did you struggle with the most? (Tick all that apply and/or add your own)* | | | | |
|---|---|---|---|---|
| **n = 112** | **A** | **B** | **C** | **D** |
| **There are words I don't understand their meaning** | 13% (n=15) | 13% (n=15) | 17% (n=19) | 10% (n=11) |
| **I don't know what maths to use** | 11% (n=12) | 35% (n=39) | 32% (n=36) | 16% (n=18) |
| **I don't understand the maths words used** | 10% (n=11) | 15% (n=17) | 18% (n=20) | 12% (n=13) |
| **The context of the problem is confusing/doesn't make any sense for me** | 18% (n=20) | 27% (n=30) | 25% (n=28) | 15% (n=17) |
| **I can't understand what it is asking me to find** | 12% (n=13) | 13% (n=15) | 13% (n=14) | 14% (n=16) |
| **None of the above** | 55% (n=61) | 37% (n=41) | 38% (n=43) | 51% (n=57) |

**College B:**

| *On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem (A-D)?* | | | | |
|---|---|---|---|---|
| **n = 37** | **A** | **B** | **C** | **D** |
| **Not confident at all** | 3% (n=1) | 8% (n=3) | 11% (n=4) | 8% (n=3) |
| **Not confident** | 3% (n=1) | 19% (n=7) | 19% (n=7) | 16% (n=6) |
| **Neutral** | 19% (n=7) | 39% (n=14) | 32% (n=12) | 27% (n=10) |
| **Confident** | 43% (n=16) | 24% (n=9) | 30% (n=11) | 32% (n=12) |
| **Extremely confident** | 32% (n=12) | 11% (n=4) | 8% (n=3) | 16% (n=6) |

| *Thinking of Problem (A, B, C, D) do you feel you understand the context of the problem?* | | | | |
|---|---|---|---|---|
| **n = 37** | **A** | **B** | **C** | **D** |
| **YES** | 84% (n=31) | 54% (n=20) | 49% (n=18) | 70% (n=26) |
| **NO** | 5% (n=2) | 16% (n=6) | 24% (n=9) | 20% (n=7) |
| **MAYBE** | 11% (n=4) | 30% (n=11) | 27% (n=10) | 11% (n=4) |

| *Thinking of Problem (A, B, C, D) do you feel that you know the maths that you need to use to be able to solve it?* | | | | |
|---|---|---|---|---|
| **n = 37** | **A** | **B** | **C** | **D** |
| **YES** | 81% (n=30) | 54% (n=20) | 40% (n=15) | 54% (n=20) |
| **NO** | 11% (n=4) | 16% (n=6) | 22% (n=8) | 19% (n=7) |
| **MAYBE** | 8% (n=3) | 30% (n=11) | 38% (n=14) | 27% (n=10) |

| *Thinking of Problem (A, B, C, D) which of the following did you struggle with the most? (Tick all that apply and/or add your own)* | | | | |
|---|---|---|---|---|
| **n = 37** | **A** | **B** | **C** | **D** |
| **There are words here I don't understand their meaning** | 8% (n=3) | 11% (n=4) | 11% (n=4) | 8% (n=3) |
| **I don't know what maths to use** | 8% (n=3) | 27% (n=10) | 32% (n=12) | 16% (n=6) |

| | | | | |
|---|---|---|---|---|
| **I don't understand the maths words used** | 5% (n=2) | 11% (n=4) | 19% (n=7) | 22% (n=8) |
| **The context of the problem is confusing/doesn't make any sense for me** | 11% (n=4) | 24% (n=9) | 22% (n=8) | 5% (n=2) |
| **I can't understand what it is asking me to find** | 5% (n=2) | 16% (n=6) | 19% (n=7) | 2% (n=1) |
| **None of the above** | 73% (n=27) | 40% (n=15) | 38% (n=14) | 54% (n=20) |

**College A + B:**

| *On a scale of 1 to 5 where 1 is 'not confident at all' and 5 is 'extremely confident', how confident do you feel of being able to solve this maths word problem (A-D)?* | | | | |
|---|---|---|---|---|
| **n = 149** | **A** | **B** | **C** | **D** |
| **Not confident at all** | 2% (n=3) | 13% (n=20) | 16% (n=24) | 10% (n=15) |
| **Not confident** | 9% (n=14) | 13% (n=20) | 17% (n=25) | 9% (n=14) |
| **Neutral** | 22% (n=33) | 30% (n=44) | 32% (n=48) | 33% (n=49) |
| **Confident** | 32% (n=47) | 23% (n=34) | 21% (n=31) | 31% (n=46) |
| **Extremely confident** | 35% (n=52) | 14% (n=21) | 14% (n=21) | 17% (n=25) |

| *Thinking of Problem (A, B, C, D) do you feel you understand the context of the problem?* | | | | |
|---|---|---|---|---|
| **n = 149** | **A** | **B** | **C** | **D** |
| **YES** | 72% (n=108) | 48% (n=71) | 47% (n=70) | 55% (n=82) |
| **NO** | 5% (n=8) | 21% (n=31) | 21% (n=32) | 15% (n=22) |
| **MAYBE** | 22% (n=33) | 32% (n=47) | 32% (n=47) | 26% (n=39) |

| *Thinking of Problem (A, B, C, D) do you feel that you know the maths that you need to use to be able to solve it?* | | | | |
|---|---|---|---|---|
| **n = 149** | **A** | **B** | **C** | **D** |
| **YES** | 74% (n=110) | 44% (n=66) | 43% (n=64) | 50% (n=75) |

| | | | | |
|---|---|---|---|---|
| **NO** | 7% (n=10) | 18% (n=27) | 21% (n=32) | 17% (n=25) |
| **MAYBE** | 19% (n=29) | 38% (n=56) | 36% (n=53) | 33% (n=49) |

| *Thinking of Problem (A, B, C, D) which of the following did you struggle with the most? (Tick all that apply and/or add your own)* | | | | |
|---|---|---|---|---|
| **Total Participants** | **Word Problem** | | | |
| **n = 149** | **A** | **B** | **C** | **D** |
| **There are words I don't understand their meaning** | 12% (n=18) | 13% (n=19) | 15% (n=23) | 9% (n=14) |
| **I don't know what maths to use** | 10% (n=15) | 33% (n=49) | 32% (n=48) | 16% (n=24) |
| **I don't understand the maths words used** | 9% (n=13) | 14% (n=21) | 18% (n=27) | 14% (n=21) |
| **The context of the problem is confusing/doesn't make any sense for me** | 16% (n=24) | 26% (n=39) | 24% (n=36) | 13% (n=19) |
| **I can't understand what it is asking me to find** | 10% (n=15) | 14% (n=21) | 14% (n=21) | 11% (n=17) |
| **None of the above** | 59% (n=88) | 38% (n=56) | 38% (n=57) | 52% (n=77) |

## D. Teacher survey questions with notes on the selection behind each question category.

***Information Sheet***

Hi amazing people! I would like to invite you to contribute to my research project, *GCSE Mathematics resit students' experiences and approaches to word problems.* This project is part of my doctoral studies at UCL Institute of Education.

I am hoping to find out what kind of experiences and approaches our resit learners have developed in relation to word problems in mathematics. Some of our resit Further Education learners will have the opportunity to talk about the experiences they have had with mathematics throughout their schooling life and the ways they have been taught and developed to approach word problems. Through their individual stories, I wish to understand the factors that shaped the dispositions they hold towards mathematics and the kind of characteristics they might share, so as to improve their teaching (*change this to learning experience*). More specifically, the focus of this project will be on word problems an important part of their GCSE Maths exam papers and evidence shows that the majority of resit students find it hard to answer them: they seem to comprise a 'threshold' demand for a grade 4+. There is also evidence that students who participate in such activity benefit from the reflection involved and come to understand their own learning better.

To have a holistic view of the way word problems are taught and approached in their classes, I would like to ask for your input, as a colleague who is closely involved with our GCSE Mathematics resit programme. Your responses will not impact on your role in the college and will only be used to inform my research. Pseudonyms will be used in all reporting and no personal information will be disclosed to other parties.

* Indicates required question

***Consent***

If you are happy to participate in this study, please complete the consent form below.

1. I have read and understood the information about the research. *

    - Yes
    - No

2. I understand that if any of my words are used in reports or presentations they will not be attributed to me but a pseudonym might be used. *

    - Yes
    - No

3. I understand that the results will be shared in research publications and/or presentations. *

    - Yes
    - No

4. I agree for the data I provide to be curated securely, and with no links to me, for further research use or research validation, in line with UCL guidelines. *

    - Yes
    - No

**A few things about yourself!**

5. What is your name? *
6. How many years have you been teaching mathematics? *
7. How many years have you been teaching mathematics in Further Education? *

The questions in Part A were taken from the TIMSS 1999 Teacher Questionnaire and adapted to suit the purpose of this study. For instance, the term 'mathematics' was replaced with 'GCSE Mathematics' to make the context clearer for the teachers.

**Part A**

In this first part, I would like you to share your views around the teaching of GCSE Mathematics. This will take around 5 minutes.

1. ***To be able to progress with GCSE Mathematics, how important do you think it is for resit students to...***
   *TIMSS: To be good at mathematics at school, how important do you think it is for students to...* – I changed 'be good at mathematics' to 'progress with GCSE mathematics' to emphasise growth and development rather than just competence and added 'for resit students' to make the question more specific to GCSE resit students.

a) remember formulas and procedures. *

- Not important
- Somewhat important
- Very important

b) think in a sequential and procedural manner. *

- Not important
- Somewhat important
- Very important

c) understand GCSE mathematical concepts, principles, and strategies. *

- Not important
- Somewhat important
- Very important

d) be able to think creatively. *

- Not important
- Somewhat important
- Very important

e) understand how mathematics is used in the real world. *

- Not important
- Somewhat important
- Very important

f) be able to provide reasons to support their written solutions. *

- Not important
- Somewhat important
- Very important

***2. To what extent do you agree or disagree with each of the following statements?***

a) GCSE Mathematics is primarily an abstract subject. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ○ | ○ | ○ | ○ | ○ | Strongly agree |

b) GCSE Mathematics is primarily a formal way of representing the real world. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ○ | ○ | ○ | ○ | ○ | Strongly agree |

c) GCSE Mathematics is primarily a practical and structured guide for addressing real situations. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ○ | ○ | ○ | ○ | ○ | Strongly agree |

d) If resit students are having difficulty, an effective approach is to give them more practice by themselves during the class. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Stronglydisagree | ○ | ○ | ○ | ○ | ○ | Strongly agree |

e) Some students have a natural talent for mathematics and others do not. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Strongly disagree | ○ | ○ | ○ | ○ | ○ | Strongly agree |

f) More than one representation (picture, concrete material, symbol set, method, etc.) should be used in teaching GCSE Mathematics topic. *

1 2 3 4 5

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

g) GCSE Mathematics should be learned as sets of algorithms or rules that cover all possibilities. *

1 2 3 4 5

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

h) An understanding of resit students' characteristics is essential for teaching GCSE mathematics. *

1 2 3 4 5

Strongly disagree ◯ ◯ ◯ ◯ ◯ Strongly agree

***3. In your GCSE mathematics lessons, how often do you usually ask students to do the following?***

a) Explain the reasoning behind an idea (written or verbally). *

- ◯ Never or almost never
- ◯ Some lessons
- ◯ Most lessons
- ◯ Every lesson

b) Represent and analyse relationships using tables, charts, or graphs. *

- ◯ Never or almost never
- ◯ Some lessons
- ◯ Most lessons
- ◯ Every lesson

c) Work on problems for which there is no immediately obvious method of solution. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

d) Use computers to solve questions or problems. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

e) Write equations to represent relationships. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

f) Practice numeracy skills *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

***4. In GCSE mathematics resit lessons, how often do students:***

a) work individually without assistance from the teacher. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

b) work individually with assistance from the teacher. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

c) work together as a class with the teacher teaching the whole class. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

d) work together as a class with students responding to one another. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

e) work in pairs or small groups without assistance from the teacher. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

f) work in pairs or small groups with assistance from the teacher. *

- Never or almost never
- Some lessons
- Most lessons
- Every lesson

**Part B**

**This is the second and last part of the survey. I would like you to share your thoughts on the teaching and learning of word problems. This part will take about 15-30 minutes.**

1. Describe any difficulties that your resit students face when working on mathematical word problems. *

2. How important is the ability to solve word problems for your resit students? *

3. What do you think the cause of their difficulty to solve word problems is? *

4. How do you feel about teaching word problems? *

5. What specific strategies do you use when teaching word problems?
   Where did you learn them? *

6. What specific strategies do you teach the students to use to solve word problems?
   Where did you learn them? *

7. Is there anything else you would like to add? *

**THE END**

Thank you so much for taking the time to complete the survey. Your contribution is highly appreciated!

## E. The rationale behind the selection of the literature review topics

This appendix provides the rationale for the selection and structure of the topics explored in Chapter 2. The chapter was designed to place the study within the broader educational and policy landscape, explore the unique challenges of the GCSE Mathematics resit context, and examine key curriculum and learner-related factors that influence engagement and outcomes in mathematics (further) education.

Policy Context: GCSE Mathematics in Post-16 Education in England

This section was included to highlight how national policy has shaped the role of mathematics in the post-16 Further Education sector, especially following the 2014 reform that made GCSE Maths resits a condition of funding for students who did not achieve a grade 4. It sets the picture for understanding why GCSE Mathematics resit courses exist and the policy attached to them.

Resit Learners Context: Current Knowledge of GCSE Mathematics Resit Students and their Learning Experiences

The aim of this section was to review literature on those often referred to as "the forgotten third", students who fail to pass their GCSE Maths the first time and are required to resit.

Curriculum Context: GCSE Mathematics in Further Education

This section focuses on how the curriculum, as delivered in FE settings, may not meet the needs of resit learners and explores calls for curriculum rethinking.

Word Problems as a Threshold in GCSE Mathematics

This part focuses on word problems as a key barrier for (resit) mathematics learners. It defines what word problems are and since this study investigates how learners respond to such problems, this section is necessary to understand their place in the mathematics curriculum.

Self-perceptions and Affective Issues in Mathematics Education

This section explores the emotional and psychological aspects of learning mathematics. It includes themes such as self-image, self-efficacy, mathematics anxiety, and teachers' beliefs.

These affective dimensions were included because they often influence students' engagement with the subject, especially for those with a history of failure. Understanding these issues helps interpret the ways learners interact with maths content, particularly in high-stakes exam contexts.

## F. Part D - Analysis of the online student survey to identify participants mathematical experience within the FE setting, by totals and also split by gender and by PLA.

**Questions 1-8: Liking Maths**

| 1. I enjoy learning maths. | Count of 1. I enjoy learning maths. |
|---|---|
| Strongly disagree | 31 |
| Disagree | 17 |
| Neutral | 39 |
| Agree | 39 |
| Strongly agree | 23 |
| **Grand Total** | **149** |

| 2. I wish I did not have to study maths. | Count of 2. I wish I did not have to study maths. |
|---|---|
| Strongly disagree | 20 |
| Disagree | 12 |
| Neutral | 35 |
| Agree | 25 |
| Strongly Agree | 57 |
| **Grand Total** | **149** |

| 3. Maths is often boring. | Count of 3. Maths is often boring. |
|---|---|
| Strongly disagree | 17 |
| Disagree | 35 |
| Neutral | 42 |
| Agree | 27 |
| Strongly agree | 28 |
| **Grand Total** | **149** |

| 4. I sometimes learn interesting things in maths. | Count of 4. I sometimes learn interesting things in maths. |
|---|---|
| Strongly disagree | 12 |
| Disagree | 16 |
| Neutral | 51 |
| Agree | 31 |
| Strongly Agree | 39 |
| **Grand Total** | **149** |

| 5. I like any schoolwork that involves numbers. | Count of 5. I like any schoolwork that involves numbers. |
|---|---|
| Strongly disagree | 38 |
| Disagree | 25 |
| Neutral | 47 |
| Agree | 21 |
| Strongly agree | 18 |
| **Grand Total** | **149** |

| 6. I enjoy trying to solve maths problems. | Count of 6. I enjoy trying to solve maths problems. |
|---|---|
| Strongly disagree | 37 |
| Disagree | 23 |
| Neutral | 43 |
| Agree | 27 |
| Strongly agree | 19 |
| **Grand Total** | **149** |

| 7. I usually look forward to maths class. | Count of 7. I usually look forward to maths class. |
|---|---|
| Strongly disagree | 45 |
| Disagree | 19 |
| Neutral | 45 |
| Agree | 24 |
| Strongly agree | 16 |
| **Grand Total** | **149** |

| 8. Maths is one of my favourite subjects. | Count of 8. Maths is one of my favourite subjects. |
|---|---|
| Strongly disagree | 57 |
| Disagree | 26 |
| Neutral | 33 |
| Agree | 15 |
| Strongly agree | 18 |
| **Grand Total** | **149** |

| Count of 1. I enjoy learning maths. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 32% | 28 | 19 | 22 |
| Neutral | 26% | 18 | 20 | 12 |
| Strongly agree/Agree | 42% | 30 | 30 | 16 |

| Count of 2. I wish I did not have to study maths. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 21% | 15 | 16 | 8 |
| Neutral | 23% | 17 | 17 | 10 |
| Strongly agree/Agree | 55% | 46 | 34 | 32 |

| Count of 3. Maths is often boring. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 35% | 28 | 23 | 18 |
| Neutral | 28% | 21 | 20 | 11 |
| Strongly agree/Agree | 55% | 27 | 26 | 21 |

| Count of 4. I sometimes learn interesting things in maths. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 19% | 15 | 12 | 11 |
| Neutral | 34% | 27 | 23 | 19 |
| Strongly agree/Agree | 47% | 34 | 34 | 20 |

| Count of 5. I like any schoolwork that involves numbers. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 42% | 41 | 21 | 26 |
| Neutral | 32% | 21 | 24 | 14 |
| Strongly agree/Agree | 26% | 14 | 24 | 10 |

| Count of 6. I enjoy trying to solve maths problems. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 40% | 40 | 19 | 22 |

| | | | | |
|---|---|---|---|---|
| Neutral | 29% | 16 | 25 | 15 |
| Strongly agree/Agree | 31% | 20 | 25 | 13 |

| **Count of 7. I usually look forward to maths class.** | **Percentage** | **Female** | **Male** | **PLAs** |
|---|---|---|---|---|
| Strongly disagree/Disagree | 43% | 36 | 27 | 20 |
| Neutral | 30% | 22 | 21 | 17 |
| Strongly agree/Agree | 29% | 18 | 21 | 13 |

| **Count of 8. Maths is one of my favourite subjects.** | **Percentage** | **Female** | **Male** | **PLAs** |
|---|---|---|---|---|
| Strongly disagree/Disagree | 56% | 52 | 30 | 33 |
| Neutral | 22% | 15 | 16 | 11 |
| Strongly agree/Agree | 22% | 9 | 23 | 6 |

**Questions 9-15: Instructional Clarity in Mathematics Lesson**

| **9. I usually know what my maths teacher expects me to do.** | **Count of 9. I usually know what my maths teacher expects me to do.** |
|---|---|
| Strongly disagree | 9 |
| Disagree | 11 |
| Neutral | 44 |
| Agree | 42 |
| Strongly agree | 43 |
| **Grand Total** | **149** |

| **10. My maths teacher is easy to understand.** | **Count of 10. My maths teacher is easy to understand.** |
|---|---|

| | |
|---|---|
| Strongly disagree | 12 |
| Disagree | 13 |
| Neutral | 31 |
| Agree | 38 |
| Strongly agree | 55 |
| **Grand Total** | **149** |

| **11. My maths teacher has clear answers to my questions.** | **Count of 11. My maths teacher has clear answers to my questions.** |
|---|---|
| Strongly disagree | 10 |
| Disagree | 8 |
| Neutral | 37 |
| Agree | 31 |
| Strongly agree | 63 |
| **Grand Total** | **149** |

| **12. My teacher is good at explaining maths.** | **Count of 12. My teacher is good at explaining maths.** |
|---|---|
| Strongly disagree | 9 |
| Disagree | 7 |
| Neutral | 27 |
| Agree | 36 |
| Strongly agree | 70 |
| **Grand Total** | **149** |

| **13. My maths teacher does a variety of thing to help us learn.** | **Count of 13. My maths teacher does a variety of thing to help us learn.** |
|---|---|

| | |
|---|---|
| Strongly disagree | 10 |
| Disagree | 9 |
| Neutral | 31 |
| Agree | 38 |
| Strongly agree | 61 |
| **Grand Total** | **149** |

| 14. My maths teacher links new lessons to what I already know. | Count of 14. My maths teacher links new lessons to what I already know. |
|---|---|
| Strongly disagree | 7 |
| Disagree | 13 |
| Neutral | 37 |
| Agree | 45 |
| Strongly agree | 47 |
| **Grand Total** | **149** |

| 15. My maths teacher explains a topic again when we don't understand. | Count of 15. My maths teacher explains a topic again when we don't understand. |
|---|---|
| Strongly disagree | 9 |
| Disagree | 11 |
| Neutral | 32 |
| Agree | 30 |
| Strongly agree | 67 |
| **Grand Total** | **149** |

| Count of 9. I usually know what my maths teacher expects me to do. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 13% | 12 | 7 | 9 |
| Neutral | 30% | 21 | 22 | 14 |
| Strongly agree/Agree | 57% | 42 | 40 | 27 |

| Count of 10. My maths teacher is easy to understand. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 17% | 14 | 10 | 9 |
| Neutral | 21% | 15 | 15 | 11 |
| Strongly agree/Agree | 64% | 47 | 44 | 30 |

| Count of 11. My maths teacher has clear answers to my questions. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 12% | 8 | 9 | 6 |
| Neutral | 25% | 21 | 16 | 17 |
| Strongly agree/Agree | 63% | 47 | 44 | 27 |

| | | | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 11% | 8 | 7 | 4 |
| Neutral | 18% | 15 | 12 | 10 |
| Strongly agree/Agree | 71% | 53 | 50 | 36 |

| Count of 13. My maths teacher does a variety of thing to help us learn. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 13% | 9 | 8 | 5 |
| Neutral | 21% | 15 | 16 | 14 |
| Strongly agree/Agree | 66% | 52 | 45 | 31 |

| Count of 14. My maths teacher links new lessons to what I already know. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Strongly disagree/Disagree | 13% | 12 | 7 | 6 |
| Neutral | 25% | 18 | 19 | 16 |
| Strongly agree/Agree | 62% | 46 | 43 | 28 |

| Count of 15. My maths teacher explains a topic again when we don't understand. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 13% | 9 | 10 | 6 |
| Neutral | 21% | 16 | 16 | 13 |
| Strongly agree/Agree | 65% | 51 | 43 | 31 |

**Question 16-24: Confidence in Mathematics**

| 16. I usually do well in maths. | Count of 16. I usually do well in maths. |
|---|---|
| Strongly disagree | 15 |
| Disagree | 22 |
| Neutral | 57 |
| Agree | 35 |
| Strongly agree | 20 |
| **Grand Total** | **149** |

| 17. Maths is more difficult for me than for many of my classmates. | Count of 17. Maths is more difficult for me than for many of my classmates. |
|---|---|
| Strongly disagree | 28 |
| Disagree | 27 |
| Neutral | 49 |
| Agree | 25 |

| | |
|---|---|
| Strongly agree | 20 |
| **Grand Total** | **149** |

| 18. Maths is not one of my strengths. | Count of 18. Maths is not one of my strengths. |
|---|---|
| Strongly disagree | 21 |
| Disagree | 19 |
| Neutral | 31 |
| Agree | 25 |
| Strongly agree | 53 |
| **Grand Total** | **149** |

| 19. I learn thinks quickly in maths. | Count of 19. I learn thinks quickly in maths. |
|---|---|
| Strongly disagree | 16 |
| Disagree | 26 |
| Neutral | 53 |
| Agree | 32 |
| Strongly agree | 22 |
| **Grand Total** | **149** |

| 20. Maths makes me nervous. | Count of 20. Maths makes me nervous. |
|---|---|
| Strongly disagree | 32 |
| Disagree | 32 |
| Neutral | 29 |
| Agree | 32 |

| | |
|---|---|
| Strongly agree | 24 |
| **Grand Total** | **149** |

| 21. I am good at working out difficult maths problems. | Count of 21. I am good at working out difficult maths problems. |
|---|---|
| Strongly disagree | 23 |
| Disagree | 30 |
| Neutral | 63 |
| Agree | 21 |
| Strongly agree | 12 |
| **Grand Total** | **149** |

| 22. My maths teacher tells me I am good at maths. | Count of 22. My maths teacher tells me I am good at maths. |
|---|---|
| Strongly disagree | 27 |
| Disagree | 19 |
| Neutral | 51 |
| Agree | 28 |
| Strongly agree | 24 |
| **Grand Total** | **149** |

| 23. Maths is harder for me than any other subject. | Count of 23. Maths is harder for me than any other subject. |
|---|---|
| Strongly disagree | 42 |
| Diagree | 41 |
| Neutral | 25 |
| Agree | 22 |

| | |
|---|---|
| Strongly agree | 19 |
| **Grand Total** | **149** |

| **24. Maths makes me confused.** | **Count of 24. Maths makes me confused.** |
|---|---|
| Strongly disagree | 22 |
| Disagree | 20 |
| Neutral | 46 |
| Agree | 26 |
| Strongly agree | 35 |
| **Grand Total** | **149** |

| **Count of 16. I usually do well in maths.** | **Percentage** | **Female** | **Male** | **PLAs** |
|---|---|---|---|---|
| Strongly disagree/Disagree | 25% | 21 | 14 | 15 |
| Neutral | 38% | 31 | 26 | 24 |
| Strongly agree/Agree | 37% | 24 | 29 | 11 |

| **Count of 17. Maths is more difficult for me than for many of my classmates.** | **Percentage** | **Female** | **Male** | **PLAs** |
|---|---|---|---|---|
| Strongly disagree/Disagree | 37% | 33 | 20 | 15 |
| Neutral | 33% | 22 | 24 | 21 |
| Strongly agree/Agree | 30% | 21 | 24 | 14 |

| **Count of 18. Maths is not one of my strengths.** | **Percentage** | **Female** | **Male** | **PLAs** |
|---|---|---|---|---|
| Strongly disagree/Disagree | 27% | 16 | 23 | 7 |
| Neutral | 21% | 15 | 16 | 11 |
| Strongly agree/Agree | 52% | 45 | 30 | 32 |

| Count of 19. I learn thinks quickly in maths. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 28% | 29 | 11 | 15 |
| Neutral | 36% | 23 | 30 | 20 |
| Strongly agree/Agree | 36% | 24 | 28 | 15 |

| Count of 20. Maths makes me nervous. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 43% | 30 | 31 | 17 |
| Neutral | 19% | 12 | 16 | 9 |
| Strongly agree/Agree | 38% | 34 | 22 | 24 |

| Count of 21. I am good at working out difficult maths problems. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 36% | 35 | 17 | 18 |
| Neutral | 42% | 32 | 29 | 26 |
| Strongly agree/Agree | 22% | 9 | 23 | 6 |

| Count of 22. My maths teacher tells me I am good at maths. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 31% | 29 | 15 | 15 |
| Neutral | 34% | 26 | 24 | 16 |
| Strongly agree/Agree | 35% | 21 | 30 | 18 |

| Count of 23. Maths is harder for me than any other subject. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 56% | 24 | 22 | 12 |
| Neutral | 17% | 15 | 24 | 11 |
| Strongly agree/Agree | 28% | 37 | 23 | 27 |

| Count of 24. Maths makes me confused. | Percentage | Female | Male | PLAs |
|---|---|---|---|---|
| Strongly disagree/Disagree | 28% | 23 | 18 | 9 |

| | | | | |
|---|---|---|---|---|
| Neutral | 31% | 21 | 23 | 19 |
| Strongly agree/Agree | 41% | 37 | 23 | 22 |

## G. Thesis-related papers

### BSRLM Proceedings papers

**June 2024:** *Mathematics GCSE resit students: heterogeneous patterns of affect, participation and attainment*

Mathematics GCSE resit students: heterogeneous patterns of affect...

**June 2023:** *What GCSE Maths resit learners say about Word Problems: Collecting data through a revision workshop*

What GCSE Maths resit learners say about Word Problems: Collecting data...

**July 2020:** *GCSE Mathematics resit students' narratives of their relationship with mathematics*.

GCSE Mathematics resit students' narratives of their relationship with mathematics.....

**March 2019:** *The use of Socratic Method to improve problem solving skills among Further Education students*.

The use of Socratic Method to improve problem solving skills among Further Education students.

### Other relevant publications

**February 2024:** *This Worked for Me!* - Edited by Fiona Allan. The book contains a collection of activities and approaches that teachers felt worked for them and their students resitting GCSE Mathematics.

ACT143 - This Worked for Me! - All Books - SHOP

**July 2022:** Action research for CfEM - *Using mastery-based approaches to improve the progress of FS Level 1 achievers towards GCSE grade 4: identifying skills gaps and mapping across skillsets through bar modelling, variation, and collaboration.*

Using mastery-based approaches to improve the progress...