MEd Dissertation Submission - Ciaran Sweeney

by CIARAN MICHAEL SWEENEY

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How can I implement effective strategies to support children's use of mathematical language and their problem-solving skills in my First Class classroom?

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I confirm that I have read and understand the Department assignment guidelines. I have also retained a copy of the assignment for myself.

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Declaration

I certify that this research, submitted for the degree of Master of Education, Maynooth University, is entirely my own work, has not been taken from the work of others and has not been submitted in any other university. The work of others, to an extent, has been cited and acknowledged within the text of my work. I acknowledge that the use of Generative artificial intelligence tools is prohibited on the MEd (Research in Practice) programme and has not been used in this body of work.

Ciaran Michael Sweeney

Date: 12th September 2025

Abstract

This self-study action research set out to address the question: *How can I implement effective strategies to support children's use of mathematical language and their problem-solving in my First Class classroom?* Motivated by a desire to make mathematical thinking more visible and accessible to young learners, I designed and implemented a twelve-lesson intervention focused on developing precise language and collaborative reasoning in mathematics.

Each lesson followed a three-part structure. To begin, I introduced key vocabulary, and question stems through structured mathematics talk routines designed to model clear mathematical communication. This was followed by a story-based component, where I used mathematical picture books to prompt discussion, reinforce new language, and build conceptual understanding in context. Lessons concluded with student-led problem-posing activities, encouraging children to apply language meaningfully by creating their own mathematical problems and engaging in peer explanation.

Data collection included reflective journaling, student work samples, classroom observations, critical friend's questionnaires and lesson feedback, student's questionnaires, and informal dialogue with pupils. The analysis revealed three key themes. First, adapting my teaching approaches to include discussion, storytelling, and collaborative tasks created more space for mathematical thinking. Second, building and scaffolding mathematical language through modelling, repetition, and meaningful use was crucial in helping students articulate their reasoning. Third, promoting student ownership and autonomy through problem creation and peer teaching fostering deeper engagement, confidence, and responsibility for learning.

Engaging in this self-study deepened my understanding of the role language plays in early mathematics and highlighted the value of reflective, responsive teaching. The process not only improved my pupils' ability to express and apply mathematical ideas but also supported my ongoing development as a learner and educator.

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Acknowledgements

Firstly, I would like to thank my supervisor, Patsy Stafford, for all her encouragement and support throughout this action research project. I truly appreciated your insightful guidance and how you consistently helped me to grow and improve in a constructive and supportive way. I have been very fortunate to have your expertise and kindness throughout this journey.

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List of Abbreviations

ACARA	Australian Curriculum, Assessment and Reporting Authority
BERA	British Educational Research Association
DEY	Department of Education and Youth
FNBE	Finnish National Board of Education
FNCC	Finnish National Core Curriculum
GAA	Gaelic Athletics Association
GDPR	General Data Protection Regulation
LTHC	Low Threshold/High Ceiling
PMC	Primary Mathematics Curriculum
MU	Maynooth University
NCCA	National Council for Curriculum and Assessment
PDST	Professional Development Service for Teachers
RME	Realistic Mathematics Education

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Introduction

1.1 Introduction

I began my teaching career in 2021, moving from First Class to Second Class, and now entering my third year teaching First Class. From the beginning, I had a strong interest in mathematics and a desire to share that enthusiasm with my students. However, I often felt I was not fully using passion to create engaging, meaningful, and challenging mathematics lessons.

The release of the Primary Mathematics Curriculum (2023) encouraged me to reflect more critically on my teaching. Its focus on playful, integrated learning and meaningful experiences made me consider whether my current approach truly supported children's mathematical development. I began to question how I could better promote problem-solving and mathematical language in my classroom.

This led me to explore the use of picture books as a teaching tool in mathematics. I was curious to see if integrating story with number concepts could make learning more engaging and relevant for young children. The idea of linking literacy and numeracy felt like a natural way to capture interest and deeper understanding.

This thesis presents a reflective account of my professional learning journey. Using a self-study action research approach, I examined and enhanced my teaching practice while prioritising the needs of the children in my class. Through reading relevant literature and designing structured intervention lessons, I grew in confidence and competence in teaching mathematics. I became more aware of the importance of language, reasoning, and communication in developing mathematical thinking.

My core values of student autonomy, inclusion, and real-world mathematics played a key role in shaping my decisions throughout this process. These values influenced how I planned lessons, interacted with students, and viewed the purpose of mathematics education in the early years. A reflection on Ken Robinson's (2006) TED Talk *Do Schools Kill Creativity?* stayed with me during this journey. His story of the child who was not "sick" but "a dancer" challenged me to see every child's potential differently. It reminded me in my reflective journal that all children learn in different ways, and it reinforced my belief that creativity, curiosity, and connection must be part of how we teach mathematics in the primary classroom (Ciaran Sweeney, 12th September 2025).

1.2 Context

The context for this self-study action research project was the co-educational, Catholic ethos, Junior National School where I work as a First Class teacher. The school, located in a suburban area, serves a predominantly middle-class community and includes four streams at First Class level. The research was carried out in my own classroom between January and April 2025, involving all twenty-one pupils, twelve girls and nine boys, for whom appropriate permissions had been obtained. Conducting the study in my own classroom setting allowed for natural integration into daily teaching and learning.

1.3 Rationale

After three years of teaching experience, I realised I rarely challenged myself to critically analyse my pedagogical practice. I often relied on tried and trusted methods that ensure classroom management but limited student empowerment. A visit from Dr. Natthapoj Vincent Trakulphadetkrai from MathsThroughStories.org inspired me to use picture books as powerful stimuli in my lessons, encouraging students to take ownership of their learning, make meaningful connections, and move beyond rote memorisation of mathematical concepts.

During my undergraduate studies, specialising in Mathematics Education as part of my Bachelor of Education, I had already gained valuable insights into the benefits of using picture books in mathematics lessons. This experience, combined with Dr. Trakulphadetkrai's visit, highlighted how picture books can create rich opportunities for developing mathematical language and reasoning.

This led me to recognise that I had been a 'living contradiction' (Whitehead, 2021) in my practice. I valued student autonomy and real-world mathematics but had not fully aligned my teaching methods with these beliefs. This prompted me to begin critically reflecting on my pedagogy and ask; if I truly value student ownership and authentic mathematical learning, how can I improve my practice to better reflect these values? I chose to start by focusing on the role of mathematical language and its importance in supporting problem-solving skills.

Guided by McNiff's (2002) emphasis on values-led action research, I recognised that my core beliefs about empowerment, inclusion, and meaningful learning must remain central throughout this inquiry. This study is therefore grounded not only in improving practice, but in ensuring that my teaching aligns with the values I hold as a professional educator.

1.4 Self-Study Action Research

This study adopts a self-study action research approach, which allows teachers to investigate their own practice with the aim of making meaningful improvements. According to Bassey (2002), there are three main research paradigms: positivist, interpretivist, and action research. Positivist paradigms seek objective truths though measurable data. Interpretivist approaches focus on understanding subjective experiences. Action research centres on change and development in context. It empowers practitioners to generate theory from their experiences and use it to guide future actions. McNiff (2002) highlights that action research involves learning with and from others. This process fosters collaborative inquiry and shared reflection. Brydon-Miller et al. (2003) argue that theory is most valuable when it arises from practice and supports positive social change.

This approach suited my focus on supporting children's mathematical problem-solving, especially developing their mathematical language. Through critical reflection, I examined how language was modelled and scaffolded in lessons to build conceptual understanding. Self-study action research provided a flexible framework to adapt and refine my teaching. It helped pupils become more confident, independent, and articulate mathematical thinkers.

1.5 Values

Teaching is shaped by the values that underpin our professional practice, and action research provides an opportunity to reflect critically on these values and how they influence learning in the classroom. The self-study approach supports this by placing the practitioner at the centre of the study and encouraging personal accountability (McNiff & Whitehead, 2011). From an ontological perspective, how I see myself in relation to my pupils, my role is that of a facilitator. I aim to create a learning environment where children are supported to explore ideas, ask questions, and take increasing responsibility for their learning.

My epistemological beliefs are grounded in social constructivism, which holds that knowledge is actively constructed through experience, interaction, and reflection (Vygotsky, 1978; Piaget, 1952). This perspective recognises that learning occurs not only individually, but also through language, collaboration, and guided participation. This approach is closely linked to Bruner's (1960) theory that education should promote transferable thinking and problem-solving skills. It also draws on Vygotsky's (1978) emphasis on language and social interaction as key to learning. This is especially important for helping children move from everyday understanding to more subject-specific vocabulary, which is crucial when supporting the development of mathematical language. Dewey's (1933) view of education is rooted in experience further supports my belief that learning is more effective when it is meaningful, active, and connected to real life.

In line with these values, I place great importance on fostering student autonomy and promoting inclusive learning environments where every child feels supported. I focus on helping children develop the language and strategies they need to express their thinking and solve problems, especially in mathematics, where confidence with language can make a real difference. This approach aligns closely with the goals of the Irish Primary Mathematics Curriculum (Department of Education and Youth [DEY], 2023), which emphasises creativity, collaboration, and reasoning skills to prepare children for real-world mathematical challenges.

1.6 Thesis structure

This thesis is structured across five chapters. Each chapter contributes to an exploration of mathematical language and problem-solving in mathematics lessons, using an action research approach.

Chapter One introduced the rationale for the study, the research aims, and the core values guiding the work: It also outlined my role as a practitioner-researcher and why action research was chosen as the most suitable methodology.

Chapter Two presents a critical review of literature related to problem-solving in mathematics. It examines the development of mathematical language and the concept of nurturing children's 'maths eyes' as part of building their mathematical thinking. The chapter explores the connection between mathematical language and effective problem-solving, as well as the influence of different teaching approaches. It also considers common barriers to successful problem-solving in primary schools and reviews interventions designed to address these challenges. Finally, a range of strategies to support the development of 'maths eyes' in classroom settings is discussed.

Chapter Three outlines the research methodology and design. It explains the rationale for choosing action research and describes the intervention used to promote mathematical problem-solving. The chapter details the data collection methods and analysis processes, including how data was coded and triangulated. Ethical considerations, such as consent, confidentiality, and participant assent are addressed. The chapter also reflects on the role of the practitioner values and the influence of critical pedagogy throughout the research process.

Chapter Four presents the findings of the research. These are organised around three key themes: the teaching approaches impact on mathematics lessons, the building and scaffolding of mathematical language to support conceptual understanding, and the student ownership and autonomy shown by the children. The themes are used to evaluate the changes in students' engagement, understanding, and independence in mathematical problem-solving.

Chapter Five concludes the thesis. It summarises the key findings and discusses their implications for classroom practice, school-wide teaching of problem-solving, and future research. The limitations of the study are acknowledged. The chapter ends with a personal reflection on my development as a teacher-researcher. It also highlights the importance of reflective practice in ongoing professional learning.

Literature Review

2.1 Introduction

This chapter will seek to review literature of problem-solving within the domain of mathematics, mathematical language, and 'maths eyes'. There will be an outline of the importance of these three concepts within the domain of mathematics education and the barriers that can prevent the development of these three key concepts. The research aims to provide an overview of both national and international curricula's views regarding problem-solving, mathematical language, and 'maths eyes'. Strategies for supporting the development of problem-solving, mathematical language, and 'maths eyes' will be discussed in this literature review. The literature review will illuminate the interplay between problem-solving, mathematical language, and 'maths eyes', revealing both the challenges and strategies that are available for enhancing mathematical understanding and engagement in education.

2.2. Problem Solving

We, as humans, encounter problems that need solving regularly throughout each day. Problems are varied in difficulty depending on the individual and their own experiences. Everyday problems from peeling a banana and making breakfast requires a different skillset and abilities to finding cures for diseases and predicting global weather disasters (Baher & Maker, 2015). In Mathematics, Căprioară (2015) elicits that the process of solving problems allows for the "most effective concept to contextualisation and re-contextualisation of concepts", (p.1859) allowing for the basic mathematical knowledge and operations to aid meaningful learning. While English & Gainsburg (2015) acknowledge that there have been many decades of research on problem-solving that give recommendations that may contradict each other. Problem-solving continues to be explored as a concept relevant across educational contexts, including teaching and learning in primary school.

Dewey (1933) emphasised that reflective thinking is a critical part of problem-solving and education. His ideas advocate for a dynamic and interactive approach to learning that prepares individuals to navigate complex problems in an informed and engaged manner (Dewey, 1933). He outlines that the act of reflective thinking proves to be the foundation for the most developed skills required for global learning; he includes problem-solving amongst these skills (Landorf & Wadley, 2022). Nuraini et al. (2020) outline that reflective thinking can also help develop students' critical thinking skills in primary schools, a skill that coincides with the skill of problem-solving. He outlines that the construction of fruitful links between one piece of knowledge and another is important in searching for solutions for global problems (Landorf & Wadley, 2022), an idea I will delve further into by focusing on real-world contexts during problem-solving. Kaitera & Harmoinen (2022) say that it is important to learn mathematical procedures, but it is even more important to develop students' mathematical reasoning, reflective thinking skills, and to be strong problem-solvers. Engaging in problem-solving tasks provide children with a motivating way to engage in deep mathematics according to a study by Burmeister et al. (2018).

2.2.1 Problem-Solving in Real World Contexts

The idea of reflective thinking and in turn, reflective understanding gives the problem-solver the capacity to apply mathematical ideas to culturally appropriate contexts (Li & Disney, 2023). Baher and Maker (2015) state that educators and policy makers agree on the important role of problem-solving skills both in real life success and in school. Cheeseman et al. (2017) advocate in their general principles for introducing problem-solving tasks that the children should be able to connect to the task, drawing on their own experiences. This is an idea that Gutstein (2003) has advocated for, that mathematics must be culturally relevant in schools as it connects to the lives of the learners.

Pratiwi & Widjajanti (2020) acknowledge that problem solving is a complex learning process that requires consistent development and that students must be facilitated in improving their problem-solving ability. Burmeister et al. (2018) suggest that selecting meaningful tasks, with multiple entry points and various approaches, helps ensure all children can engage in problem-solving, thereby facilitating improvement.

These multiple entry point tasks, discussed further in this literature review, align with the principles of Realistic Mathematics Education (RME), an approach developed by the Freudenthal Institute in the Netherlands (Gravemeijar, 1994). RME aims to connect mathematical learning to real-world contexts, allowing students to construct understanding through problem-solving. According to Pratiwi & Widjajanti's (2020), RME supports the process of mathematical realisation alongside problem-solving and is believed to enhance students' abilities to solve mathematical word problems. Pozas et al. (2020) mentions some of the benefits of the inclusion of context-based problem-solving as part of RME. He references that context-based approaches to different curricular areas can promote a positive student attitude as researched by Bennett et al. (2007). While additionally, he references Kuhn & Muller's (2014) claim that context-based approaches can have a desirable impact on a students' intrinsic motivation and interest towards the curricular area.

2.2.2 What Curricula's say about Problem-Solving

As per the new Irish Mathematics Primary Curriculum, problem-solving is listed as an element (DEY, 2023). A huge emphasis is being placed on these elements (processes of how children learn) as each element is to be included in the teaching and learning of any topic of each strand and strand unit (DEY, 2023). For example, when the children in First Class are learning about the numbers ten to twenty under the strand of Number, there must be opportunities for children to "investigate, develop… and compare a variety of problem-solving situations and strategies as they explore Mathematics", (DEY, 2023, p.17). This is an extension of the 1999 Primary Mathematics Curriculum which also highlights the importance of using mathematics in a constructive way though problem-solving based on the children's environment (Department of Education and Science, 1999, p.14).

The ideas of the Irish Primary Mathematics Curriculum (PMC) align well with the Australian Primary Mathematics Curriculum. There is a clear correlation between the two countries as both look to promote mathematics in meaningful situations. Problem-solving is named as one of the key ideas of Mathematics in the Australian Curriculum, Assessment and Reporting Authority (ACARA, n.d.). Problem-solving as a proficiency strand is encouraged to students when engaging with and learning mathematical content but not applicable to all content (ACARA, n.d.). Problem-solving skills has also been pinpointed as an important goal of the Finnish National Core Curricula (FNBE, 2016). Kaitera & Harmoinen (2022) highlight that the

Finnish Curriculum (FNBE, 2016) encourages collaborative problem-solving situations as they emphasise the learning of communicating ideas and collaboration with peers when it comes to mathematical problem-solving. In Finland, they also like to address everyday situations in their problem-solving which is solved using both mathematical thinking and operations (FNBE, 2015).

2.2.3 Barriers to Problem-Solving in Classrooms

One of the barriers to the development of mathematical problem-solving in classrooms is what Stewart and Ball (2024) refer to as 'struggle time'. 'Struggle time' refers to the time given to students to participate in solving-problems and engaging with mathematical concepts either independently or collaboratively (Stewart & Ball, 2024). This barrier to problem-solving being that the teachers involved in this study experienced difficulties in choosing the appropriate time to intervene to support the children. There are factors to consider from both the students' and teachers' points of view that act as barriers to problem-solving. For students, DiNapoli and Miller (2022) state that perseverance is integral for the learning of mathematics, as this productive struggle when confronted by one or numerous mathematical obstacles, is a process by which conceptual understandings are developed (DiNapoli & Miller, 2022). For students, excessive amounts of time struggling with a concept without support can lead to frustration and disengagement causing a challenging balancing act between fostering student independence and offering a necessary intervention while problem-solving (Stewart & Ball, 2024).

Boaler (2016) emphasises a positive outlook on making mistakes in mathematics and believes in having a 'growth mindset' where mistakes are valued by all students. In her work, she found that students who realise that mistakes are helpful for their brains. They are more willing to persevere and struggle when engaging with mathematics (Boaler, 2016). This echoes Dweck's (2006) foundational work on cultivating a growth mindset, which encourages learners to view challenges and setbacks as opportunities for growth rather than signs of failure. This struggle that Boaler (2016) speaks of is important, as Stewart & Ball (2024) reveal from their study that students were using more problem-solving during the allocated struggle time than when the teacher modelled the approach for solving the given problem. This idea aligns with earlier definitions of mathematical problems by Silver (1985) and Schoenfeld (1985), who describe problems as tasks where the solver does not immediately know how to find a solution and faces uncertainty about which strategies to apply (English & Gainsburg, 2016).

For teachers, intervention during the struggle time period of problem-solving can be in different ways. The level of teacher assistance given to the children is highlighted to be an important consideration in Stewart and Ball's study (2024), as the teacher can have a direct impact on the potential for engagement with the problems. Some of the effective problem-solving interventions mentioned included Sullivan et al.'s (2016) strategy of helping students understand language in a problem, Ingram et al.'s (2016) advocacy for collaboration and sharing knowledge time amongst students, and Cheeseman et al.'s (2017) methodology of a struggle time allowance for students before teachers provide scaffolding prompts.

Tasks that allow for multiple entry points are mentioned by Stewart and Ball (2024) as activities to promote mathematical reasoning and problem solving for students both individually and collectively. These classroom tasks that have multiple entry points are referred to as low-floor/high-ceiling tasks by DiNapoli and Miller (2022). They revealed that students reverted to their initial understanding of a mathematical concept to pass a problem when they reached an impasse during problem-solving and allow them keep making progress developing their mathematical understanding. This suggests that scaffolding students aids their perseverance and encourages them to embrace challenges to keep learning.

2.2.4 Dyscalculia as a Barrier to Problem-Solving

According to Dyslexia Ireland (n.d.), dyscalculia is a learning difference that can cause difficulties with core mathematics such as number concepts that affects between 6-8% of the population. According to Jeya and Albina (2019), students who present with dyscalculia also have difficulties with solving mathematical word problems. Santos (2021) notes that this could also be impacted by other cognitive disorders, such as dyslexia, which will be discussed in more depth as a barrier to mathematical language later in this literature review.

In Ziadat's (2022) study of interventions to improve word problem-solving amongst children with dyscalculia, he investigates two strategies, developing children's working memory and the use of sketchpads. Working memory is the process of holding onto the information we learn (temporary storage), using the information (assimilation), and making connections with the prior knowledge that we already know (Ziadat, 2022). Fuchs et al (2020) mentions that good problem solvers have a greater working memory capacity than poor problem solvers. This backs up Ziadat's (2022) claim of working memory as a responsible factor for word problem differences amongst students. Ziadat's (2022) working memory-based training program was at 3rd grade level and consisted of sixteen, thirty-minute-long sessions that aimed at developing children's rehearsal strategy, mental imagery, narrative strategy, visuospatial strategy, encoding strategy and grouping strategies. His results found a 17.6% improvement in mathematical word problem-solving amongst the participants with dyscalculia in the program (Ziadat, 2022).

The intervention of sketchnote and the idea of using drawings as a way of developing children's mathematical problem-solving is more applicable to my own research as I have been teaching First Class for the duration. Ziadat (2022) had four sessions of forty minutes in which children were told of the main concept of sketchnote, to draw freely in relation to the given problems without any constraints of texts or symbols. He revealed that the sketchnote approach to solving word problems had a distinctively positive impact on reducing negative attitudes and beliefs of children towards problem-solving and increased their motivation and engagement (Ziadat, 2022).

While focused on a different age group, Osman et al. (2018) encouraged students to draw the bar model as a strategy to help students to improve their mathematical problem-solving skills as it helps students to understand and solve by visualising and conceptualising a problem using a bar drawing. This method also had a positive impact on the participants' attitude towards problem-solving questions, which he mentions as elevating confidence amongst the students (Osman et al, 2018). Dyslexia Ireland (n.d.) details drawing, sketches, drawings, and models to visualise the problem when detailing support for students with dyscalculia as it provides a multi-sensory teaching approach that can assist the students visually.

2.2.5 Low-Threshold/High Ceiling Problem Solving Tasks:

Low-threshold, high-ceiling (LTHC) tasks are designed to be accessible to all students, regardless of their current level of mathematical understanding, while also offering opportunities for deeper exploration and challenge. These tasks provide an entry point that all learners can engage with and the potential for extended thinking and complexity, allowing students to work at their own level while still being pushed further when ready. The Irish PMC (DEY, 2023) emphasised that "tasks should provide all children with the opportunity to access Mathematics, while offering the potential for deeper engagement", (p.31). The PMC (DEY, 2023) elaborates further on LTHC tasks by pointing out that these tasks should provide opportunities to freely explore different methods of solving problems. Outside the benefits mentioned of allowing all children to be mathematicians while still retaining a level of challenge for all learners, LTHC also has a positive impact on motivating learners. Blankman (2023) tells us of his experiences of LTHC and the accessibility for multilingual learners to engage with these tasks because of the lack of emphasis placed on the language complexity. He analogies it by saying "All students can take off, but some will need a longer runway", (Blankman, 2023).

Low-threshold/high-ceiling tasks have undergone a lot of development by NRICH Maths. They outline the benefits of using LTHC tasks as offering the opportunity for all learners to get started and for everyone to get involved (NRICH, 2019). They link the idea of LTHC tasks to Boaler's (2019) belief of mathematics as an open and growing subject that encourages communication, reasoning, and justifications in the works of mathematics. They refer to this in relation to a growth mindset belief, believing that everyone can demonstrate the abilities they can do without stressing about their incapabilities (NRICH, 2019).The tasks that they have designed focus on valuing the learner's multiple approaches of attempting a task, which in turn is developing the ideology of all children as mathematicians (NRICH, 2019).

This aligns with the Irish PMC (DEY, 2023) in terms of every child being mathematical and that we are consistently developing as mathematicians through engagement with mathematical concepts and ideas, deepening their learning as they both experience mathematics, and over time.

2.2.6 Peer-Posing Mathematical Problems

Peer-posing of mathematical problems is gaining recognition as an effective strategy to develop both mathematical language and problem-solving skills in primary classrooms. In this approach, students are encouraged to create and share their own mathematics problems with their peers, fostering active engagement with mathematical concepts and vocabulary. Leavy and Hourigan (2022) explored this practice through a mathematical letter-writing initiative involving prospective primary teachers, showing that generating problems required a deeper understanding of mathematical language and structure. While their study focused on teachers in training, the findings have implications for early primary classrooms constructing problems that help learners clarify mathematical meanings and make more deliberate choices.

Zhang et al. (2024) conducted a meta-analysis of problem-posing interventions and concluded that teacher modelling, structured prompts, and real-world contexts significantly enhanced learning outcomes. These supports are especially important in early primary classrooms where language development and problem-solving must go hand in hand. English (1998) similarly found that children as young as six construct meaningful problems when supported in both formal and informal contexts. This connection between language, thinking, and mathematics is also highlighted by Clements and Samara (2004), who emphasise the role of mathematical learning trajectories and mathematics talk in supporting conceptual development in the early years. Burns (2007) also advocates for the use of storytelling, hands-on manipulatives, and real-word connections as key strategies to make abstract mathematical ideas more accessible and engaging for young learners. The NCCA echoes these ideas, promoting the use of guided play, construction tasks, and rich classroom dialogue as essential strategies for fostering mathematical understanding in young learners (NCCA, 2018).

Research with younger children also shows that peer-posing enriches language through interaction. Van Oers (2010) demonstrated that during socio-dramatic play, children engage in meaningful peer interactions that support the co-construction of mathematical understanding. This highlights how shared discourse and contextualised language use foster early mathematical thinking. These findings align with Vygotsky's perspectives on language development through social interaction (1978). Peer interactions create opportunities for scaffolded use of mathematical vocabulary in a socially meaningful way. Kwon and Capraro (2021) further highlight that when learners create problems based on real-life interests, their reasoning and vocabulary become more sophisticated and meaningful.

The Irish PMC (DEY, 2023) stresses the importance of mathematical communication, encouraging children to use appropriate language to describe their thinking and strategies. This focus on expressive language has been influenced by other international curricula. New Zealand's curriculum promotes visible thinking and collaborative reasoning through dialogue, supported by frameworks like the Mathematics Communication and Participation Framework (Ministry of Education, 2007). In the United States, the Common Core State Standards for Mathematics emphasise constructing viable arguments, critiquing reasoning, and attending to precision in language as key mathematical practices (NGA & Council of Chief State School Officers, 2010). Peer-posing supports these shared curricular goals by positioning language as a tool for thinking, communication, and collaborative problem-solving.

2.3 Mathematical Language and Mathematical Vocabulary

Research suggests that mathematical language is one of the strongest and earliest predictors of early mathematical success for children (Purpura et al., 2016). These thoughts are echoed on the Professional Development Service for Teachers (PDST, 2024) website as they acknowledge research that suggests mathematical language as having a vital component in a students' learning and success in numeracy (Delaney, 15th November 2011). It can also be applied the other way around where children who struggle with both mathematics and language usually tend to have more difficulties than children who just struggle with mathematics alone (Jordan & Hanich, 2000; Viesel-Nordmeyer et al., 2021). This mathematical knowledge does not improve by having interventions in place to develop children's general language skills (Jordan et al., 2012).

Words can take on different meanings in mathematical contexts, and Sherman & Gabriel (2017) state that every word matters in mathematics, which they brilliantly analogise through the contrasting way that the word 'gave' can be interpreted in a word problem. Depending on the surrounding language in the posed problem, the problem could suggest that the word requires an additional strategy or a subtraction strategy to solve. As Myhill and Fisher (2005) argue, explicit attention to language is helping in helping learners understand and use subject-specific vocabulary effectively, particularly in subjects like mathematics where language and reasoning are closely linked.

Jones and Seilhamer (2019) explain that for children to harness new conceptual understandings in mathematics to facilitate the development of problem-solving, input may be required as there may be a lack of prior learning experiences in relation to the mathematical language. Prepositions, conjunctions and comparatives can take on different meanings in mathematics and can have a corresponding mathematical symbol that requires activities for children to manipulate and connect it with mathematical concepts in order to develop one's ability to learn the subject (Jones & Seilhamer, 2019). Smith (2022) believes that there are three ways for a teacher to know if students are failing to understand the mathematical vocabulary for an associated mathematical concept. They are a lack of response to questions and disengagement, the inability to complete learning tasks that have heavy written instructions, and the inability to apply knowledge and understanding from mathematics lessons to mathematics assessment (Smith, 2022).

2.3.1 Relationship between Mathematical Language and Problem-Solving

The impact of being comfortable understanding and manipulating mathematical language has been researched in different components in the field of mathematics. The language can be technical, containing specific definitions that can vary across the different domains of mathematics (Barnes & Stephens, 2019). Vanluydt et al. (2020) explored the idea of mathematical language in relation to proportional reasoning. This study found that there was a significant difference between children in their conceptual knowledge of specific mathematical vocabulary (Vanluydt, 2020). They highlight that while general vocabulary can assist students when learning proportional language, there is specific mathematical vocabulary that plays an important role in proportional reasoning and solving associated problems such as doubles (Vanluydt, 2020).

Barnes & Stephens (2019) highlight that there has been a shift from strict formulaic computation in mathematics more to solving story problems that require a strong understanding of mathematical language. Riccomini et al. (2015) mention the frequency to which students are exposed to the new mathematical vocabulary, and this is important in building the fluency that allows learners to recognise a strategy that may solve a problem. This has a positive impact on a student's cognitive energy as they can expend themselves trying to strategise the task (Riccomini et al., 2015).

Contrastingly, children who are not yet well-versed in mathematical language and vocabulary may struggle when attempting to solve word problems (Barnes & Stephens, 2019). Barnes and Stephens' (2019) study of four different curricula in relation to supporting mathematics vocabulary instruction highlighted that there was a significant difference of the number of target words ranging from 6 to 51 per unit. While acknowledging that there is no agreed upon number of mathematical words to target, they reference Fathman et al. (1992) of twelve or fewer words being an optimal quantity per lesson. To support children's mathematical vocabulary growth, Barnes and Stephens (2019) make reference to studies that support definitional support for mathematical terms with contextual information is more effective than providing just definitional support alone. Like having meaningful problems in contexts discussed earlier in this literature review, mathematical vocabulary can also be supported by referring to contextual information (Marulis & Neuman, 2010).

2.3.2 Approaches to Developing Mathematical Language: Exploratory Talk:

Mercer and Sam (2006) speak of the teacher being a 'discourse guide' when speaking of shaping children's use of language for solving mathematical problems. There is a high emphasis on the teacher modelling exploratory talk. Mercer (1995) defined exploratory talks as talk where students "engage critically but constructively with each other's ideas" and are made more publicly accountable and reasoning is more visible (p.104). This aligns with Wood, Bruner, and Ross's (1976) concept of scaffolding. The teacher supports learners through modelling and structured dialogue, gradually transferring responsibility as students develop deeper conceptual understanding.

The idea of children co-constructing mathematical concepts through engagement with each other's ideas provides a platform for children to develop their mathematical language from their peers (Patterson, 2016). Patterson outlines the indicators that exploratory talk is being included amongst a group, and they range from the ideas of all group members being valued and respected to reasoning being given for challenges on ideas. Supporting this type of peer interaction also helps fulfil students' basic psychological needs, such as relatedness and competence, which Deci and Ryan (1985) identify as essential for intrinsic motivation and deeper engagement in learning.

Practices that act as barriers to exploratory talk, that both Mercer and Sam (2006), and Murphy (2015) have alluded to in their respective research, include the management of interactions in group work and the introduction of the didactic strategies when developing conceptual understandings of new mathematical concepts. From the research, if a teacher is to be an effective discourse guide, they must engage the children in questioning that elicits children's mathematical reasoning or explore their understanding (Mercer & Sams, 2006).

While Murphy (2015) outlines that exploratory talk can be interpreted and included in a teacher's practice to different levels, her study revealed that exploratory talk encourages children collaborating on mathematical problems in groups, and values contrasting views which are then supported by open ended questioning prompts. For example, what do you think we should do? Murphy (2015) also outlines that one of the key elements of exploratory talk is that the children reach a consensus as they work on problems across the curriculum. For this to happen, the motivation of children to participate has to be evident. Research found that children had more potential to engage in enhanced cognitive level of discussions when the mathematical problems that they encountered had meaningful contexts which engaged their imaginations (Patterson, 2016).

2.3.3 Mathematics Through Story:

Skelton (2022) states that story not only helps to embed mathematical language in familiar and relatable contexts for the child but also allows the children to build their conceptual understanding and develop their mathematical thinking. These relatable contexts allow the children to relate the mathematics to their own lives which inspires motivation to delve into a mathematical concept further (Larson & Rumsey, 2018). When listening to a story, children are able to create their own mental images and make connections to the mathematical concepts which make the learning experience more meaningful (Arneja & Tyagi, 2020). Arneja and Tyagi (2020) support the idea of a more meaningful learning experience by pointing out that stories appeal to the learner's imagination and emotions.

Furner (2018) believes that using picture books to teach mathematics, that children feel less intimidated and threatened by the idea of learning new mathematical concepts and language than some of the traditional approaches of teaching mathematics. She advocates for the use of literature as a way of helping to reduce the mathematics anxiety that a lot of children struggle with, referencing that only 7% of Americans recalling positive experiences from respective mathematics classes from the beginning of kindergarten through to college (Furner, 2018). I will be exploring dyslexia as a barrier to developing mathematical language further below but Furner's idea (2018) of children's literature as a form of therapy (bibliotherapy) could be a strategy of easing a child with dyslexia's mathematics anxiety. By easing the frustrations of learners who feel taunted and teased by the idea of not excelling in mathematics, Furner (2018) supports Barnaby's (2015) research that literature creates a less math anxious classroom ambiance. This inclusion of mathematics through story correlates well with the Irish PMC and Australian PMC in relation to promoting mathematics in meaningful situations under the key element of problem-solving.

Bilewicz-Kuźnia (2021) outlines that visual-spatial modelling that we see in stories helps children to understand the content, mathematical or not, and sequence of actions which is important when approaching and solving mathematical problems. The development of mathematical problem-solving through storybooks is aided by the mathematical discussion that takes place between the educator and students. These mathematical conversations, that also promote the use of mathematical language, allow children to explain the reasoning about a problem using their own words (Stites & Sonnenschein, 2020). This supports Bilewicz-Kuźnia (2021) that it is not necessary for students to do mathematical activities physically to be mathematically active, they can formulate and solve theoretical and practical problems. Sianturi (2024) outlined that one of the educators involved in his research in Indonesia highlighted the benefits of creating contexts to solve math problems across different cultures. She also mentioned the extent to which these child-orientated settings foster interdisciplinary learning, which allows children to make connections between the different curricular areas (Sianturi, 2021).

2.3.4 Barriers to Developing Mathematical Language - Dyslexia

Dyslexia can be a barrier for children developing and understanding mathematical language. The Dyslexia Association of Ireland (2020) states that children with dyslexia can struggle to read and understand the vocabulary in mathematics questions, which can lead to difficulties in understanding what the task is asking them to do. Dyslexia Scotland (2018) echo the same thoughts surrounding the vocabulary of mathematics, both associations mentioning that having more than one expression for the same operation can be confusing for a child with dyslexia, for example, ‘addition’, ‘plus’, ‘sum’. Steve Chinn (2014) tells us that the language and vocabulary of early mathematics having multiple meanings inside of mathematics settings can cause confusion for children with dyslexia and represents bad communication of what the task requires.

An area that children with dyslexia tend to run into difficulties in mathematics is word-problem solving as this component of mathematical performance requires children to process text (Fuchs et al., 2020). Fuchs et al. (2020) then goes on to emphasise that word-problem solving requires a combination of both language comprehension and mathematical problem-solving processes, which can be problematic for children with dyslexia. Both the Dyslexia Association of Ireland (2020) and Dyslexia Scotland (2018) encourage the use of a multi-sensory teaching approach for the areas of mathematics a child with dyslexia finds challenging. Such as visual imagery being used to depict birds flying away off a wall to illustrate the word problem requires subtraction.

Dekker (n.d.) points out that children with dyslexia and dyscalculia may excel in some areas of mathematics, but 50-60% of children with dyslexia have some degrees of difficulty with mathematics. She too supports the idea of multisensory classrooms as a way of supporting children with dyslexia in mathematics contexts (Dekker, n.d.). It places an onus on the educator to understand the learning style (aural, visual, or kinaesthetic) that suits the needs of the students in their respective classroom. Following the general principles outlined by Dekker (n.d.) that focus on giving learners with dyslexia the best opportunity of understanding concepts through activities that allow children to explore the new mathematical concept will aid their conceptual understanding in a stark contrast to rote learning concepts to which they find it difficult to understand. These approaches reflect Florian and Black-Hawkins' (2011) concept of inclusive pedagogy. This emphasises the importance of extending what is available to all learners, rather than creating separate or reduced experiences for those with additional needs.

2.3.5 Curriculum Perspectives:

Mathematical language is prominent across the sequence of content in the Australian PMC (ACARA, 2015). The sequence of content under the strand 'Measurement and Geometry' elicits to students in their foundation year in primary school using everyday language to explain their reasoning to decide indirect comparisons of objects with regards to their length, weight, and capacity (ACARA, 2015). There is clear development in expectations of mathematical language to year 3 where the students are encouraged to use the metric units of length, mass, and capacity for measuring, ordering, and comparing objects (ACARA, 2015). In the recent ACARA (2021) review of the primary mathematics curriculum, they make reference to the literacy skills that are required to understand and interpret the language features of mathematics that may appear in problems through the formulation of mathematical questions. There is an emphasis placed on the children learning that common words may take on a different meaning when placed in a mathematical context (ACARA, 2021).

While the Finnish National Core Curriculum (FNCC) for Basic Education (2017) does not make a specific reference to the term 'mathematical language', the concept is clearly emphasised through other related terminology. Under Ama5, Mathematical problem-solving, the curriculum emphasises that students must be given opportunities in practicing presenting mathematical information with the aid of tables and diagrams (Finnish National Board of Education, 2017). Teachers are encouraged to help students to express their mathematical thinking using mathematical language supported by concrete manipulatives, speech, writing, and imagery (FNBE, 2017). FNCC refers to the teacher on a number of occasions as being both a facilitator and scaffolder of helping students to make observations from a mathematical perspective and to interpret these observations into different situations such as word problems.

The Irish PMC (DEY, 2023) references “Being a communicator and using language” as part of the curriculum's seven key competencies (p.5). It elaborates on this key competency by giving the example “Expressing thinking using mathematical language, signs and symbols” (p.6). Mathematical language or the language of mathematics is then referenced to support every child being mathematical, and mathematics as a tool that helps us to make sense of our world. It is important to note that the PMC (DEY, 2023) aims to develop mathematical language so that children can communicate and solve problems using mathematics. There is a clear emphasis in the curriculum on ‘maths talk’, with the development of mathematical language seen as essential to supporting it. This connection is further reinforced in the NCCA’s (n.d.) Maths Talk Toolkit, which highlights how purposeful classroom dialogue strengthens conceptual understanding and encourages learners to verbalise their mathematical thinking. The idea of using topics and issues that the students are interested in is brought up by the FNBE (2017), and the Irish PMC (DEY, 2023) connects with the idea by encouraging ‘maths talk’ through the medium of play, providing a platform where mathematical language can be spoken and enjoyed through an area the children are interested in.

2.4 Maths Eyes

Mathematical Eyes is the act of using different types of mathematics in what a person is doing in their everyday lives, and the idea is accredited as the brainchild of Maguire (2003). Maguire et al. (2023) informs us that by viewing the world through a ‘maths eyes’ lens, it provides us with opportunities to develop our use of mathematical language, knowledge and skills. To follow this developmental path, we have to begin looking at mathematical activity through a different starting point, one which most people may perceive to be ‘invisible’ mathematics. The real world is used as the entry point (Figure 2.1) for the development of ‘maths eyes’ and as a context for further mathematical development (Maguire et al., 2023).

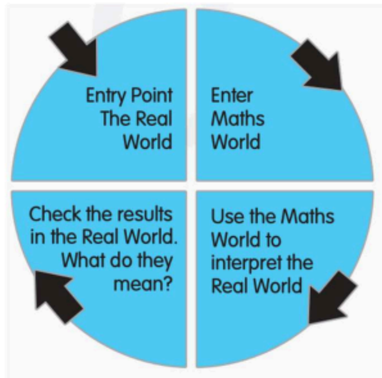


Figure 2.1: *The Real-World Maths Cycle by Maguire et al., (2023).*

2.4.1 Development of Mathematical Eyes

Use of Mathematics Problem Pictures or Posters: Mathematics problem pictures give learners the opportunity to stimulate discussion on key elements of the Irish PMC (2023) such as pattern, shape, measurement and number. Maguire et al. (2023) emphasises the importance of using pictures the children can relate in order to stimulate interest. For example, pictures of their own locality. Pictures that allow for the children of different ability groups to apply their knowledge and skills are recommended by Maguire et al., and this correlates back to the idea of Burmeister et al. (2018) that the best problem-solving tasks have multiple entry points and allow for multiple approaches. Children should be given the time to discuss the picture or poster themselves first in order to allow the learners time to develop their own mathematical eyes and not see the picture through the eyes of the teacher (Maguire et al., 2023). Initial prompt questions are encouraged to be very general for all types of pictures and posters, but follow-up questions can be used by the teacher to guide the class (Maguire et al., 2023).

Math trails: Maguire et al. (2023) tells us that mathematics trails are an excellent way of helping children to develop their 'maths eyes' further. A study by Lee & Bailie (2020) found that inquiry-based learning activities on nature trails allow children to form their own explanations of mathematical concepts based on evidence provided by mathematical exploration through their senses rather than memorisation.

Mathematics Solve It Exhibition: This strategy involves children taking their own photograph and formulating a problem to accompany the picture for others to solve. For instance, 'How many squares can you see?' in a picture of the child's choosing. By having an exhibition of problem pictures, the children are able to pick a photograph that is a meaningful context to their own interests and encourages others to look at others picture problems with questions in mind that help support the development of 'maths eyes' (Maguire et al., 2023) such as, which is your favourite poster and why?

Mathematics investigations: Math investigations are a way of encouraging children to use their 'maths eyes' as they allow children to come up with their own strategies for solving investigations (Maguire et al., 2023). The investigation titled 'Who Lives Where' (Maguire et al., 2023, p.59) allows children to think strategically about who lives in what house as each clue gets revealed. These types of mathematical investigations are similar to the ideas that Makar and Fielding-Wells (2018) outline when discussing inquiry-based learning in mathematics. Inquiry-based mathematics aligns with mathematics investigations as both methodologies encourage children to cope with uncertainties surrounding approaches, taking calculated risks and using mathematical evidence to display their findings to other learners (Makar & Fielding-Wells, 2018).

Mathematics Diaries: Mathematics Diaries involves learners being asked to record, either drawing pictures or words, the mathematics they have used or seen each day (Maguire et al., 2023). Sharing ideas with mathematical trails outlined above, mathematics diaries involve children using their senses to outline something they have learned about mathematics on that day or something they would like to learn about mathematics in the future. The examples below depict ways children have used their 'maths eyes' (Figure 2.2). Maguire et al. (2023) outlines that these 'maths eyes' diaries can also be used as a form of assessment as children's diaries display what they have learned and potential future insights they would like to know.

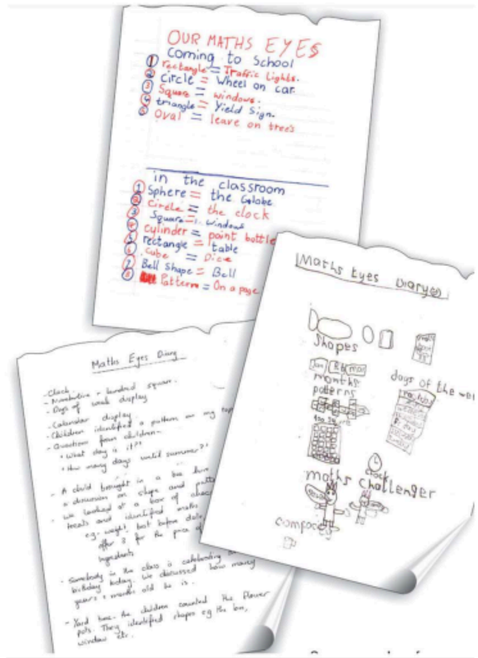


Figure 2.2: *Examples of children's 'Maths Eyes' Diary entries.*

2.4.2 Barriers to the Implementation of Maths Eyes

Damon Whitten told Maths Eyes (2017) that he believes that the stigma people have about not being good at mathematics is a barrier to the successful development of 'maths eyes'. He, alongside others in the Waikato Literacy and Numeracy Network, developed a 1.6km-long mathematics trail with sixteen activity signs that are designed to instigate discussions about mathematics and encourage positive attitudes towards mathematics through the lens of their 'maths eyes' (Have You Got Maths Eyes, 2017). I perceive that the norm in schools of mathematics as an activity where we answer questions quickly and correctly using the teacher's method (Makar & Fielding-Wells, 2018) as a barrier to positive mathematics in schools and prevent the development of 'maths eyes'. The practice of the teacher only questioning a strategy of an incorrect answer does not promote the use of mathematical reasoning and the children only see the mathematics through the lens of the teacher, an idea that Maguire et al. (2023) mentioned when discussing mathematical pictures or posters to promote the development of 'maths eyes'.

While there has not been a lot of research on barriers to 'maths eyes', focusing on the narrative of parents not encouraging children to use 'maths eyes' at home could be perceived as a barrier. Parents have the opportunity to share mathematics in their everyday lives with their children. One point from the guidelines 'Supporting the Development of Maths Eyes at Home and in the Community' (NCCA, 2023) is that the parents can engage with their child in real-world mathematics even if the child feels they are not good at school mathematics. Parents can emphasise the perception of mathematics in a positive light and move away from the idea of 'school mathematics', seeing mathematics in the world we live in and in school.

The Department of Education and Youth made a support material available when drafting the new PMC in 2023, focusing on helping teachers develop 'maths eyes' in the classroom (DEY, 2023). A barrier to this could be the relative newness of the concept to teaching in Ireland, as it was a concept that was not overly emphasised in the 1999 PMC (DEY, 2023). A lot of the teaching force in Ireland would have graduated between the 1999 and 2023 curricula which suggests the majority of teachers would not have been overly exposed to the idea of 'maths eyes' while in college. While it may be a new way of referencing the concept, there are areas where it would have been covered without referencing the terms 'maths eyes'. For example, the identification of lines of symmetry in shapes and the identification of shape and symmetry in the environment would require children to use 'maths eyes', there just has not been reference made to the term 'maths eyes' (Department of Education and Science, 1999, p.12).

2.5 Conclusion

A review of both national and international literature identifies the role of problem-solving in preparing children for life. Problem-solving skill development equips children with the necessary abilities to complete daily tasks they encounter in society. The Irish PMC (2023) should support each child in reaching their full potential as a problem solver that will greatly enhance their capacity in understanding and engaging with the world around us. The literature suggests that teachers have an important role in guiding, scaffolding, and designing suitable learning activities that provide children with the opportunity to engage in inquiry learning through both independent and collaborative problem-solving. Fostering problem-solving skills in children not only helps to prepare them for the immediate challenges in primary school but equips them with the critical thinking skills that are critical for our society. The next chapter will outline how the study was conducted.

Methodology

3.1 Introduction

This self-study action research emerged from my aspiration to develop my teaching of mathematics with the aim of improving students' confidence in approaching mathematical problem-solving tasks. I used action research as my methodological approach to answer the research question:

How can I implement effective strategies to support children's use of mathematical language and their problem-solving skills in my First Class classroom?

The chosen methodologies and my standards of judgement in this research have been influenced by both my epistemological and ontological values of student autonomy, inclusion, and learning for the real world.

It is my belief that we are not prepared in the Irish education system to connect new mathematical concepts and strategies to solving life problems fluidly. I believe that the high expectations placed on students' understanding of mathematical language puts them under pressure that can cause children to become 'anxious problem-solvers'. I believe that by implementing daily practices that focus on developing children's 'maths eyes', encouraging child-led use of mathematical language, and supporting peer-posing of content-specific problems can be hugely beneficial. These strategies can help prevent children from becoming 'anxious problem-solvers'. I chose to reflect on and analyse my own teaching practice to elucidate the teaching strategies I was implementing in my classroom and their desired effects on allowing the children in my class to develop as more confident problem-solvers. As I am both the researcher and the participant of this research, the paradigm chosen for this research is self-study action research (Figure 3.1).

Figure 3.1: *Five Stages of my Self-Study Action Research.*

3.2 Rationale for Action Research as the chosen Research Paradigm

Jean McNiff (1988) outlined the three most prominent research paradigms in the field of educational research as; The Positivist Research Paradigm, The Interpretative Research Paradigm, and The Critical Theoretic/Action Research Paradigm. Each paradigm is a way of viewing or researching phenomena (Cohen et al., 2011). Kuhn (1970) outlines how a paradigm is an intellectual framework that allows research to exist.

A Positivist Research Paradigm is used when researchers want to measure, test and find patterns that apply to many people. It is often used in large-scale studies and requires data collection tools such as questionnaires and surveys, where the focus is obtaining clear, reliable, and often factual results using quantitative data.

The Interpretative Research Paradigm is used when researchers want to understand participants' experiences, thoughts, and feelings to a deeper extent. Instead of focusing on statistics, it reflects on the meaning behind behaviours or scenarios. It is often used in smaller, more personal research studies, using qualitative data collection tools such as interviews or observations, to explore how people make sense of their world.

The Critical Theoretic Paradigm is often used when researchers want to solve real problems and instigate a change in the field of education. The goal of this paradigm is to improve practices. It involves working closely with teachers, students, or other stakeholders within the education community to identify issues, take action, and then reflect on the results. As such, the data collection tools can be varied between quantitative and qualitative depending on the issue that the researcher is delving into. This aligns with the purpose of this research, as the primary objective was to improve my teaching practices.

3.3 Self-Study Action Research

In a self-study action research approach, students are viewed as knowledge creators, rather than just being the focus of the study. Action research is a collaborative process where the interactions with others, including the students, play a central role in the research process. McNiff (2002) refers to this self-study as an enquiry-based form of self-evaluation conducted by the self into the self. Coghlan and Brannick (2014) share McNiff's thoughts on defining Action Research as research in action, rather than research about action, a collaborative democratic partnership, and a sequence of events and an approach to problem-solving, (2014, p.6). This type of action research is conducted within the practitioner's own workplace, in my case, my classroom, and the practitioner is positioned at the core of the research as they investigate ways to enhance their own professional practice (Whitehead & McNiff, 2006, & McDonagh, Roche, Sullivan & Glenn, 2012).

McDonagh et al. (2012) states that the values of the researcher are used to guide the action research process and can be used in the formation of the research question. The idea of 'we know through doing' is a belief incorporated into action research and shared by Coghlan & Brannick (2014) and encourages the researcher to take accountability for their practice through honest reflection (Brydon-Miller, Greenwood & Maguire, 2003 and McNiff, 2002).

In educational settings, action researchers focus on examining their own teaching, rather than relying on external researchers (McLaughlin, 2004, cited in Sullivan et al., 2016). They formulate a theory or sometimes identify a problem/issue, implement it in practice, and engage in critical reflection to improve their methods (Bassey, 1990, cited in Pollard, 2011). Dewey (1933) highlighted the use of reflective teaching as an essential approach to professional development. Lewin (n/d, cited in Adelman, 1993) described action research as a cyclical process of action and reflection. Likewise, McNiff (2002) emphasized its open-ended nature and advocated for a continuous, cyclical approach which supports the idea of teachers as life-long learners. As an evidence-based methodology, reflection and data collection play crucial roles (Sullivan et al., 2016).

Reflection can be enhanced by the collaboration of others. In the context of educational action research, colleagues who have agreed to offer support, share perspectives, and help clarify ideas are referred to as 'critical friends'. Altricher et al. (1993) outlines that critical friends have empathy for the teacher's research context and concerns but also provide honest and constructive feedback. This provides a platform for action researchers to be open in discussions related to their work with others and allow for non-biased criticism as stated by Hammersley (1993, cited in Sullivan et al., 2016).

3.4 Living Theory

Individuals engaging in self-study action research begin to develop their own living theory by creating knowledge through self-reflection and personal practice, which leads to the evolution of ideas. Whitehead (1989) introduced living theory as a way of producing knowledge that emerges from the lived experiences of practitioners. It is an evolving and dynamic process that is rooted in personal experience, reflective practice, and the values of the practitioner (McNiff & Whitehead, 2006). It emphasises the integration of theory and practice through action research, with the objective of improving the learning experience for students. Whitehead (2021) outlines that although you can significantly value an aspect of teaching and learning, in his case, inquiry learning, it is not until you take time to critically reflect on your practice do you realise this value is being upheld in your practice. Whitehead described himself as a 'living contradiction' as although he valued inquiry learning, it was not present in his practice. O'Sullivan et al. (2016) argue that we must be prepared to be wrong when engaging in critical reflection on our own practice. This idea is echoed by Brydon-Millar et al. (2003) who state, "You have to be willing to be wrong," (p.21) particularly in the context of teacher training that can foster the belief that teachers are intellectually superior to others in society.

3.5 Critical Reflection

Critical Reflection is a key component of action research as it provides practitioners with tools for assessing, refining, and transforming their practice. Dewey (1933) states that reflective thinking is a process of allowing individuals to engage thoughtfully with their experiences, address assumptions, and then make appropriate decisions to improve their future practice. Pollard (2011) specifies that critical reflection encourages the process of deliberate inquiry which allows for more meaningful learning to take place and can lead to both immediate and long-term changes in the practitioner's practice. Changes in our practice are enabled by critical reflection as it forces the researcher to uncover the hidden dimensions that exist in our practice, such as power dynamics, values, and ethical concerns as stated by O'Sullivan et al. (2016). They highlight that reflection should not only focus on what is working, but also on what might be overlooked or undervalued.

3.6 Purpose of Critical Reflection

Brydon-Miller (2019, in McDonagh et al.) acknowledges action research as an encouragement of a person's professional growth and well-being as they look to deepen their understanding of their practice. In order for one to enhance their own practice, critical reflection, although difficult to engage with, is essential to this process. Brookfield (2017) underlines the importance of critical reflection by pointing out the purpose of it, checking the accuracy and validity of our teaching assumptions. In order for the whole picture of our assumption to be addressed, Brookfield (2017) encourages the use of four sets of lenses – colleagues, students, the literature, and our own perspective. By covering all lenses, McDonagh et al. (2019) state Brookfield's (2017) two main purposes of critical reflection: uncovering hegemony and illuminating power in terms of power dynamics in schools and teacher power. He is encouraging us to critically reflect in order to think about how powers operate in schools and certain dominant ideas shape what we learn and how we learn it.

3.7 Action Research Model

The action research cycle I used for this study is a simplified version adapted from the models of Kemmis and McTaggart (1988), and Whitehead and McNiff (2006), which were emergent cycles from Kurt Lewin's (1946) original model. This model follows a four-step cyclical process of reflection, planning, action and observation. The component of this action research model that stands out is the opportunities for me to engage in ongoing critical reflection and active engagement that fosters growth and development. By being these active agents, as described by Sullivan et al. (2016), we open a dialogue with ourselves that helps to raise an awareness to flaws in our practice that we have the power to change.

3.7.1 Kemmis and McTaggart's Model (1988)

Kemmis and McTaggart's model (1988) is a cyclical process involving the four steps of plan, action, observe, and reflect before moving into another cycle beginning with a revised plan. This cyclical process represents a practical approach to classroom research as the final stage is about correlating your findings to future learnings and possibilities (McDonagh et al., 2019). Kemmis and McTaggart's model of reflection can be seen below in Figure 3.2.

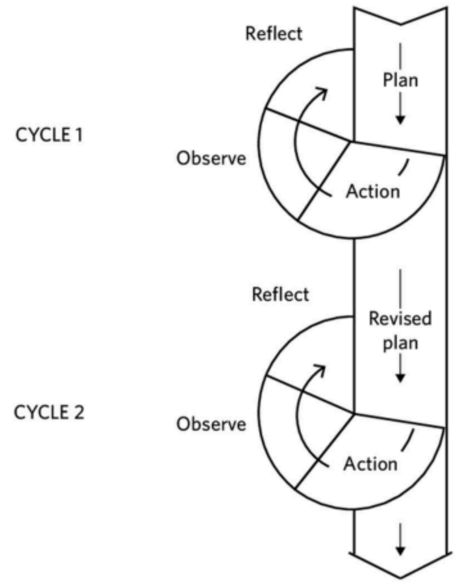


Figure 3.2: *Kemmis and McTaggart's (1988) action research cycle.*

3.7.2 Whitehead and McNiff's Model (2006)

Whitehead and McNiff's (2006) action research cycle (Figure 3.3) contains an additional fifth step to that of Kemmis and McTaggart's model (1988). The five steps involved in this cycle are observing, reflecting, acting, evaluating and modifying action so that the researcher can move in a new and improved direction. While this model has the additional step, there are a lot of similarities with Kemmis and McTaggart's model. Both models encourage ongoing reflection that led to the next cycle. Both of these action research cycles are expansions of Kurt Lewin's (1946) model of planning, acting, observing, and reflecting (Figure 3.4). Kurt Lewin is looked upon as the intellectual father of action research as his experiments started a whole generation of research in group dynamics and change programs during the time of World War II (Burnes, 2004).

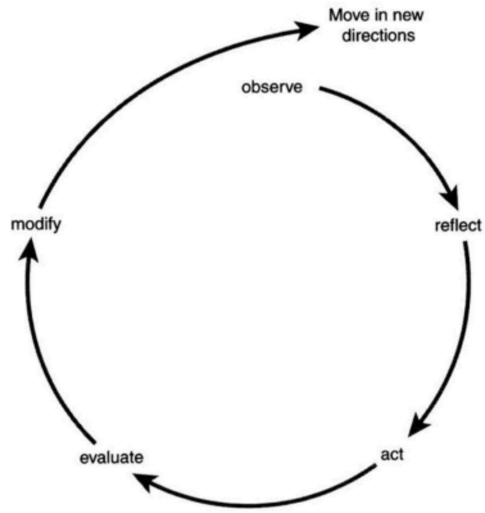


Figure 3.3: *Whitehead and McNiff's (2006) action research cycle.*

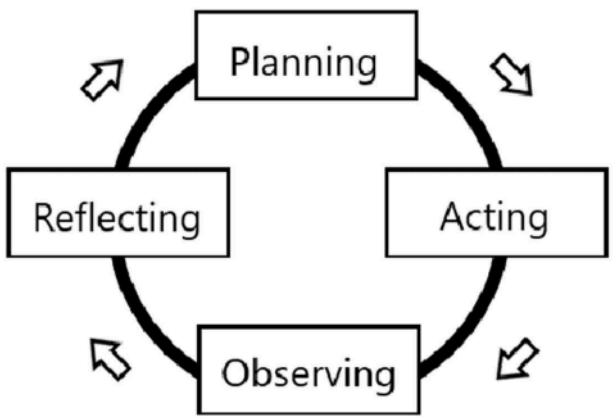


Figure 3.4: *Kurt Lewin's (1946) action research cycle.*

3.8 The Reflective Practitioner

When listing the qualities of a reflective practitioner, Dewey (1933) singles out three for special mention: open mindedness, whole-heartedness, and intellectual responsibility. Roche (2016) adds intellectual curiosity to Dewey's list (McDonagh et al., 2016). Intellectual curiosity is the quality that has reaffirmed me throughout this process. When I have questioned why I have engaged in self-study action research, I come back to the same answer time and again. I want to know the answers to questions that are not easily found in a textbook or internet search.

Hooks (2010) believes that reflective practices promote a classroom culture where reflection is a shared, ongoing practice by both teachers and students. This requires practitioners to display levels of emotional intelligence and empathy in order to connect with students (Hooks, 1994). Practitioners should be able to question ideologies that exist in the education system in order to create an inclusive and transformative learning environment (Hooks, 2010).

3.9 Ethical Considerations

The setting of this research, as alluded to previously, is a co-educational urban Catholic junior school in which I am one of four First Class teachers. An ethics form was submitted and approved by both the university's ethics board and my supervisor before data collection for this research began. Subsequently, permission from the Board of Management and my Principal to conduct this research in my class was sought and granted in December 2024. Letters outlining my research were sent to my critical friends and participants of my validation group to gain their consent for contributions they may have for this research.

The children participating in this study were all under the age of eight and prior to engaging in the action research, an ethical statement containing ethical considerations and potential ethical issues was submitted to and approved by Maynooth University (Appendix A). The children were given the right to informed consent prior to the research. The parents/guardians of the children received a detailed letter explaining the research and the extent of their child's involvement. In all research circumstances, parental/guardian consent is required for the processing of the participant's personal data if they are aged under 18 years old (Tusla, n.d.), however, I emphasised that the primary focus of the research is for my personal professional development, reiterating that the children are not there for their teacher's development (Doyle, 2007).

The parents were asked to speak to their children before the children's consent to participate as co-researchers was sought. Parents/guardians were provided with the option of withdrawing their consent for their child's participation in the research at any point up until the data collected was anonymised, should they choose to do so. Similarly, participants themselves were also granted the right to withdraw at any stage. The children's assent was monitored throughout the research process, with visual cues and body language taken into account to respect each child's dignity and agency throughout the cycles. As per the British Educational Research Association guidelines (BERA, 2012), the children's best interests should be the primary consideration throughout the research.

The epistemological value of inclusiveness and ensuring all participants feel included in the research is important to me. As such, it was outlined that participation was on a voluntary basis and that all students would still be taking part in the same learning activities in the classroom whether they were taking part in the research process or not. This conversation was important to ensure the children were under no false pretences that there were incentives involved by being a participant in the research in order to please their teacher (Sullivan et al., 2016).

3.10 Research participants

The children's names and pseudocodes were stored in a password protected document and stored in line with ethical practice outlined by MU. These pseudocodes were used to guarantee the children's confidentiality and anonymity (Midgley et al., 2013) throughout the action research process unless a child protection issue arose (Sullivan et al., 2016). Throughout the data collection, I valued the children as co-researchers, whose feedback and contributions were pivotal to the research (Shaw et al., 2011).

3.11 Data collection

The data collected was securely stored following both ethical standards and General Data Protection Regulation guidelines. Digital files were kept in a password-protected folder, while physical copies were stored in a locked filing cabinet. Personal identifiers such as full names, were removed from physical data, which was also stored in a secure folder accessed by a password.

Any data transfers were done using a password-protected USB, that is stored in a locked filing cabinet. All data, whether electronic or physical, was managed in accordance with the school's Data Protection Policy. The data will be securely destroyed at the end of the research project, either by confidential shredding or digital deletion in line with MU guidelines.

The data collection tools I used included my reflective journal, recorded observations, photographs of children's work samples on whiteboards, transcripts of interviews, transcripts of conversations, analysis of children's drawing/worksheets/activities and teacher questionnaires/surveys. Data was collected both before and after my interventions had taken place in the classroom, and throughout the process I was aware that there could be both anticipated and unanticipated findings (Kemmis, McTaggart and Nixon, 2014).

3.11.1 Teacher Reflective Journal

My reflective journal has been the data collection tool that has allowed me to reflect on my practice using Stephen Brookfield's (2017) self-reflective lens. I have allocated time once a week to reflect in my journal, especially during times where I have implemented interventions in my classroom, or the learning activities outside of the interventions have manifested another idea. It is a data collection tool that I have found challenging but making time for reflection became a habit, a habit which Brookfield (2017) outlines helps us identify, and check our assumptions that inform our actions as teachers when discussing critically reflective teaching. The heightened awareness for the teaching and learning in my classroom was supported by my reflective journal, as it highlighted the need for me to be a critical thinker throughout my action research (Sullivan et al., 2019).

3.11.2 Transcripts of interviews and photographs of children's work samples

Children's work samples provided an access point for me to engage in conversations on my research question with the children prior to interventions taking place. As the idea of talking aloud to the whole class can be daunting for some children, informal conversations focused on their work samples provides a safe space for a child to have their voice heard in the context of the research.

Cohen et al. (2018) makes reference to children being a respected source of information and I was keen to have their knowledge at the forefront of my research through group interviews. Morrison (2013) outlines how important it is to make the strange setting of an interview to the children more familiar. Throughout the school year, I have endeavoured to establish a strong rapport with each child in my class, which aligns with the qualities the BERA's (2012) details that each participant should be treated with fairness, sensitively, with dignity and freedom from prejudice by the researcher. Arksey and Knight (1999) further advocate for the establishment of trust between the interviewer and the children being interviewed.

3.11.3 Teacher observations and teacher conferencing

Teacher observations present the opportunity for the researchers to collect first-hand data, Cohen et al. (2018) stating that these observations have the potential to provide data that is more valid or authentic than other mediated or inferential data collections methods. Structured observations are highly planned and controlled, with predefined goals that guide the observation process. Semi-structured observations allow for a balance between predefined categories and flexibility, specific themes are planned in advance, but the researcher has the freedom to explore other relevant information that comes to light during the observation time period. Unstructured observations are more open-ended, where the researcher has no predefined focus. The aim of these observations is that a spontaneous revelation may emerge, but it may only become evident when the qualitative data is being analysed.

A blend of the three various levels of observations that Cohen et al. (2018) outlined on a spectrum, allowed me to collect first-hand data from real social interactions that happened in my classroom. By taking a step back and observing as a participant, I could gather insights in the form of natural interactions between the children during my intervention lessons. This helped me assess the impact of the interventions and how the children used new learning strategies to assist in problem-solving.

In addition to my observations, I also used individual child conferencing as a means to gain a deeper insight into pupils' mathematical thinking and learning processes. As Shrum (2019) highlights, conferencing empowers students by giving them a voice and a personalized opportunity to reflect on their learning. These brief, focused conversations helped me to identify not just what mathematical language children understood, but how they were approaching problems, where misconceptions lay, and how confident they felt using mathematical language introduced during the intervention.

3.11.4 Teacher Questionnaire and Survey

The colleagues who I selected and agreed to be my critical friends and formed as part of my validation group came from four different teaching streams and assistance roles in the school – one from my own stream of First Class, one teacher from Junior Infants, one teacher from the Special Educational Teaching team, and the Special Needs Assistant in my classroom. Three further teachers from the First Class stream joined in as part of my validation group and one teacher from Senior Infants. These colleagues work closely with me and helped me to identify any inaccurate assumptions I might have had throughout the action research self-study.

Brookfield (2017) states that critical friends are at the core of the critical reflection process by helping you come to terms with new insights about your practice and addressing uncertainties that may come to light during the action research cycle. They all played an important role in listening, questioning, and suggesting improvements and alternatives (Sullivan et al., 2016). A validation group that consisted of teachers with a varying range of teaching experience allowed me to get honest feedback when it came to picking holes in my research and questioning assumptions I had made throughout the research (Sullivan et al., 2016).

3.12 Research Plan

Over the course of my self-study action research, I sought to make changes to my teaching of mathematics by shifting from a didactic teaching approach, where I have been giving children strategies to help solve mathematical problems, to a more student-centred and led approach to engaging children in mathematical problem-solving. The intervention was conducted in my own classroom with my own mainstream First Class, where I served as teacher, researcher and participant. The data collected from the students was solely used to inform my teaching practice. The intervention lasted eight school weeks in total starting the 20th January to the 21st March 2025. The first action research cycle lasted one week with three lessons. While the second cycle lasted seven weeks with two intervention lessons most weeks. My research plan is outlined below (Figure 3.5).

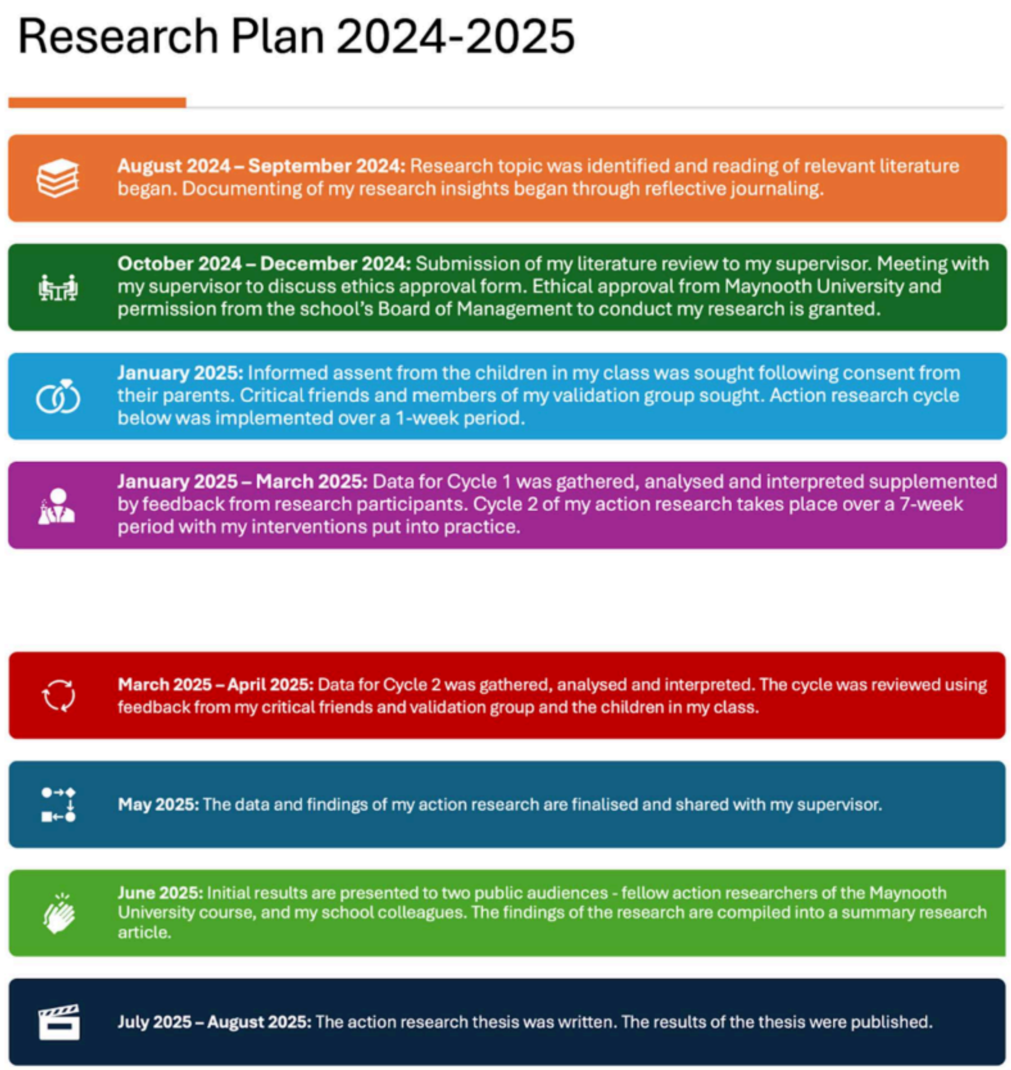


Figure 3.5: *Action Research Plan.*

3.13 Research Cycles

Research Cycle 1, which served as the baseline data collection phase, took place from Monday 20th January to Friday 25th January. During this week, I delivered three mathematics lessons using my traditional, teacher-centred approach. These lessons focused primarily on procedural methods to solve mathematical word problems, rather than encouraging pupils to use their 'maths eyes' to interpret mathematical language and develop a deeper conceptual understanding. This approach limited opportunities for student-led inquiry and the application of conceptual thinking in problem-solving. Data was collected during this phase using the tools previously discussed and was used to identify key issues in current practice. These findings directly informed the planning of interventions for Research Cycle 2, allowing for a meaningful comparison between traditional and revised teaching methods.

Research Cycle 2 involved a total of twelve lessons being taught over the course of seven school weeks beginning the week of 27th January to the 21st March (Figure 3.6). In this cycle, I implemented the changes to a didactic style of teaching to a student-centred approach that allows them to take ownership over their learning and development as mathematical problem-solvers. I planned my lessons focused on using the three following resources: 1st Grade Math Talks by Rebecca Robins, a curated selection of mathematics storybooks, and an anchor chart that scaffolded students' approaches to solving mathematical word problems in a supportive, non-formulaic way.

TIMELINE OF THE INTERVENTIONS

Research Cycle 1	Research Cycle 2
Pre-Interventions	Interventions Implemention
1 week	7 weeks
3 lessons	12 lessons
20th January - 25th January 2025	27th January - 21st March 2025

Figure 3.6: *Timeline of the Interventions.*

3.13.1 Research Cycle Resources

1st Grade Math Talks by Rebecca Robins (n.d.) was an important starting point for each of these 12 lessons. These images allow pupils to share their ideas through the lens of their mathematical eyes, highlighting mathematics in the environment around us and promoting mathematical and encouraging classroom mathematical discussion through a given daily problem to solve, and the opportunity to create our own mathematical word problems.

The second resource I used was an array of mathematical storybooks to link what can be difficult mathematical concepts to their everyday lives (Trakulphadetkrai, n.d.). The contexts of these mathematical stories provide children with an access point to engage with new mathematical concepts and encourage them to view mathematics through a different lens. Mathematical thinking and problem-solving can be encouraged and developed through storytelling as there are entry points for reading, auditory, and visual learners.

My final resource was an anchor chart that provided scaffolding for students when approaching word problems. In my previous two years of teaching First Class, I have found that solving word problems independently is one of the bigger jumps' children undertake from Senior Infants to First Class. Children not only are still developing as readers in First Class but are still learning the language of mathematics which can lead to challenges blending the two skills together. An anchor chart that focused on providing children with a mechanism for approaching word problems, as opposed to feeding the children strategies, enabled me to implement lessons where the children could approach mathematical word problems in an active, hands-on and student centred manner.

In the baseline phase, pupils were observed to rely heavily on teacher-led strategies when solving word problems. This approach tended to prioritise procedural steps over conceptual understanding. Anecdotal observations during this phase also suggested that some pupils appeared disengaged or hesitant when faced with reading mathematical tasks. These initial observations informed the design of the intervention in Cycle 2, which aimed to promote deeper engagement and reduce potential barriers to problem-solving. Figure 3.7 captures one child's response to the baseline survey "Don't read the numbers, just the words!", a remark that encapsulated the very reason for this self-study, highlighting the need to better understand how young learners make sense of mathematical language and problem-solving.

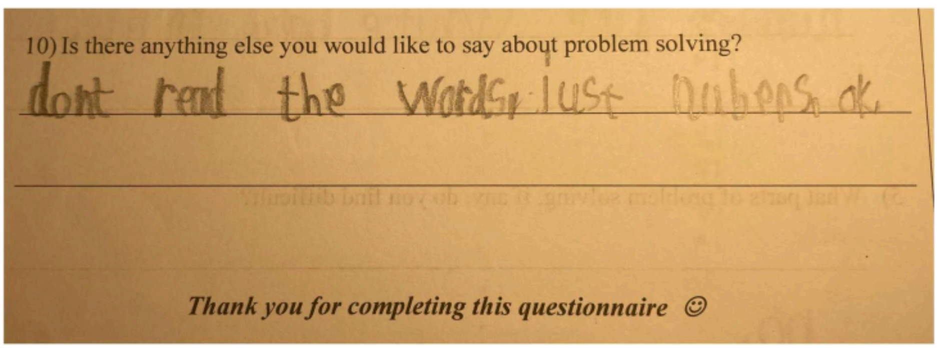


Figure 3.7: *Child 21's insight from a baseline survey "Don't read the numbers, just the words!".*

3.14 Conclusion

In summary, this chapter has outlined the rationale behind the intervention resources selected for this self-study, including child conferencing, and the use of scaffolding strategies such as the anchor chart. Each resource was chosen to support pupils in developing their confidence and competence in solving mathematical word problems, with a focus on fostering independent thinking and use of mathematical language. The baseline data collected through my own observations and pupil voice provided crucial insights into students' initial challenges and informed the design of targeted interventions. The following chapter will present and analyse the findings from Cycle 2 of the study, exploring how the implemented strategies influenced pupils' engagement, understanding, and approaches to problem-solving in my mathematics classroom.

Data Analysis

4.1 Introduction

This chapter presents an in-depth analysis of the qualitative data gathered during the research process. The central question guiding this research process was: "*How can I implement effective strategies to support children's use of mathematical language and their problem-solving skills in my First Class classroom*?". It begins by outlining the data analysis methodology employed, providing clarity and transparency regarding how the findings were derived. The analysis then centres on three key themes that emerged from the data: teaching approach, building and scaffolding mathematical language, and student engagement and ownership. Finally, the chapter explores the validity and significance of these findings, with a view to contributing to the development of a theory of practice.

Figure 4.1: *Gibbs' reflective cycle (1988).*

This study adopted a self-study action research approach as outlined in the previous chapter. Action research serves as both a tool for self-evaluation and a form of professional development, allowing the practitioner-researcher to take ownership of their practice (McNiff, 2002). Guided by Gibbs' (1988) reflective cycle, I engaged in a structured process of reflection that involved describing events, exploring my emotional responses, evaluating the effectiveness of my teaching strategies, analysing contributing factors, drawing conclusions, and formulating action plans for future practice. Data collected from my reflective journal, alongside other sources offered varied perspectives on my teaching, informed ongoing changes in my pedagogy. This cyclical process of reflection enabled continuous professional growth and deeper insight into my approach to teaching mathematical language and problem-solving.

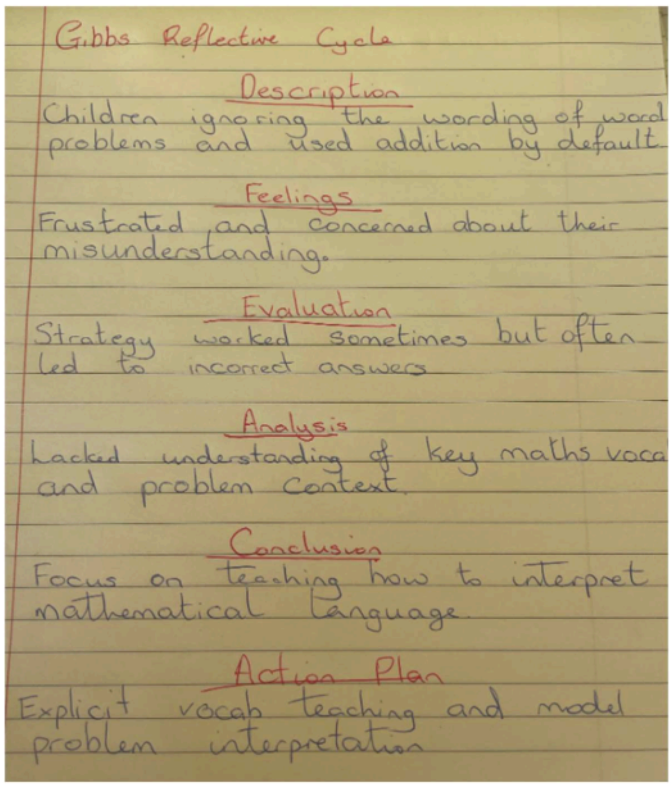


Figure 4.2: *My application of Gibbs reflective cycle (1988) to evaluate changes in my teaching approach prior to my intervention lessons.*

4.2 Data Analysis

Theme 1 - Teaching Approaches

Categories	Codes
1. Use of concrete and visual tools	1. Hands-on materials 2. Visual prompts 3. Mini-whiteboards 4. Digital illustrations
2. Lesson structure for deeper thinking	5. Fewer problems 6. Clear transitions and pacing 7. Effective time management
3. Integration of storytelling	8. Picture books as a springboard 9. Picture books enhance engagement 10. Story-based lesson integration 11. Book as a context 12. Picture books support understanding
4. Warm-ups, routines, reflection	13. Varied warm-up strategies 14. Discussion routines 15. Structured reflection
5. Student involvement and adaptability	16. Maths eyes 17. Mixed response to term 'maths eyes' 18. Think time 19. Student choice
6. Teacher modelling and visual support	20. Teacher models maths maths language 21. Visual scaffolds for language 22 Modelling vocabulary across activities

Figure 4.3: *Data Analysis Table: Theme 1 - Teaching Approaches.*

Theme 2 - Building and Scaffolding Mathematical Language

Categories	Codes
1. Connecting literacy and mathematics	1. Integration of literacy and mathematics. 2. Book language scaffolding writing 3. Story structure reinforced mathematical concepts 4. Memorable vocabulary
2. Developing and using vocabulary	5. Familiarity with basic terms 6. Linking every-day and mathematical language 7. Sentence starters 8. Gaps in understanding vocabulary
3. Student communication and peer learning.	9 Peer-to-peer language 10. Prompting maths eyes
4. Inclusive language practices	11. Word problem creation 12. Verbal reasoning 13. Not verbalizing thinking 14. Vocabulary as a barrier 15. Home-school language link

Figure 4.4: *Data Analysis Table: Theme 2 - Building and Scaffolding Mathematical Language.*

Theme	Categories	Codes
Theme 3 - Student Engagement and Ownership	1. Autonomy, voice, and choice	1. Student suggestions 2. Independent problem creation 3. Choice in how time is spent 4. Increased challenged 5. Lesson format balanced structure
	2. Enjoyment, interest, and relatability	6. Motivation – reward or novelty 7. Engagement from personal interest 8. Visual arts and drawing requests 9. Kinesthetic learning requests 10. Feedback on books 11. Relatable maths concepts 12. Favourite book
	3. Sense of growth and success	13. Increased confidence 14. Book-based problems – a fun challenge 15. Learning – successful
	4. Tools and supports for participation	16. Mixed response to continue all activities 17. Mini-whiteboards increased participation 18. Inclusion of SEN support facilitated engagement 19. Small group work for SEN 20. Anticipated difficulties

Figure 4.5: *Data Analysis Table: Theme 3 - Student Engagement and Ownership.*

4.3 Teaching approaches

The first theme to be explored is the change in my teaching approach, particularly in embracing the role of the teacher as a facilitator to support independence and responsibility. This shift reflects a deepening of my educational values, which increasingly aligns with the principles outlined by Boaler (2016). Boaler emphasises the importance of cultivating a growth mindset, encouraging meaningful exploration, and promoting student-centred learning environments. Her theory highlights the value of empowering learners to take ownership of their thinking and to engage confidently with challenging tasks through persistence and reflection. Similarly, Vygotsky's theory of the Zone of Proximal Development (1978) underscores the approach of guided support that gradually increases the responsibility to the learner. This reinforces the idea that independence is nurtured in classrooms through appropriate scaffolds a teacher provides.

The children's responses to the questions "What parts of maths do you like best?" and "What parts of maths do you like least?" highlighted the significant role of a teacher's approach in shaping their engagement. Several children identified the game Scoot as one of their favourite parts of mathematics, despite the fact that it involved completing addition and subtraction problems. Interestingly, when asked what they liked least, many of the same children referred to "taking away" or "adding" as their least enjoyable activities. This contrast suggests that it was not the mathematical content itself that influenced their preferences, but rather how it was delivered. The interactive, fast-paced nature of Scoot made familiar operations feel fun and engaging, reinforcing the importance of incorporating active, game-based strategies to support motivation and learning in the classroom.

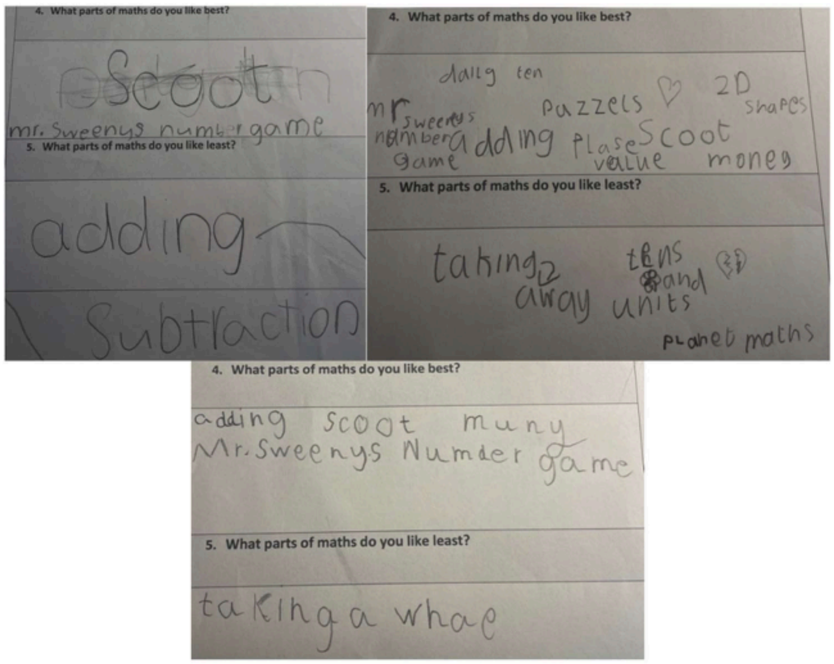


Figure 4.6: *Child 6, Child 10, and Child 16's responses to Attitude to Maths Questionnaire.*

This perspective is also reflected in the Primary Mathematics Curriculum (2023), which encourages teachers to help children understand relationships, connections, and patterns, and to engage fully with the world around them. For instance, during Cycle 1, I used a Maths Brain Box resource as an early finisher, to encourage the use of mathematical language. This was a resource I introduced by chance but soon recognised as highly effective, prompting me to be more intentional in planning for mathematical talk and vocabulary development (Ciaran Sweeney, 22nd January 2025). In response to this shift, I adjusted my practice by providing open-ended tasks, rich resources, clear learning intentions, and structured timeframes. This helped create a space where children could become more active, independent, and reflective learners, and showed that how content is delivered can be just as important as what is taught.

4.3.1 Use of concrete materials and visual tools

Prior to implementing my intervention lessons, survey responses from my students to the question 'What usually helps you when it's a bit of a struggle to problem solve?' revealed that many children relied heavily on number lines, whiteboards, and or the teacher's direct input when problem-solving. A significant number of responses specifically mentioned number lines as their go-to method, indicating a strong dependence on this single strategy.

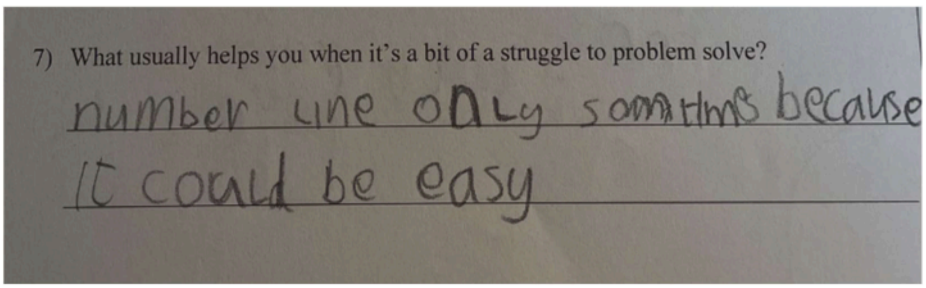


Figure 4.7: *Photograph of a survey response by Child 6.*

In contrast, only one child referred to physical materials, highlighting a limited awareness of or confidence in selecting from a broader range of problem-solving tools. This lack of variety in the strategies children identified pointed to a reliance on teacher-led support and a narrow toolkit for independent learning.

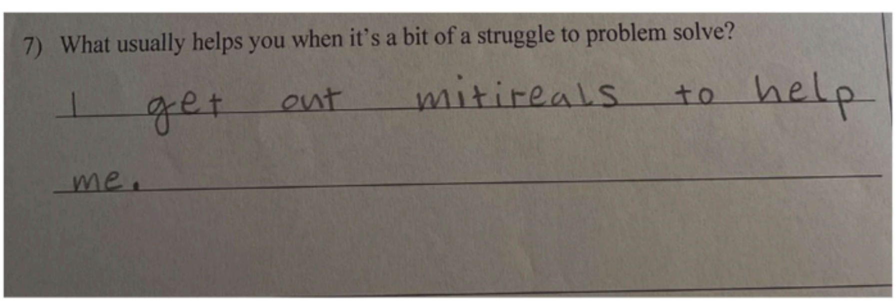


Figure 4.8: *Photograph of a survey response by Child 3.*

There was limited mention of independent strategies or varied resources. This highlighted a reliance on teacher-led support and a narrow range of tools, prompting me to consider how to better support independent problem-solving through the use of concrete and visual resources. Both Critical Friend 5 and I came to the same consensus that the engagement levels of the children in mathematics lessons dropped when concrete and visual resources were not available during lessons in Cycle 1 (Ciaran Sweeney, 23rd January 2025). I found that providing ample resources throughout Cycle 2, through the medium of a mathematics resource box per table, significantly supported the development of the children's independence and sense of responsibility.

Figure 4.9: *Photograph of the resources that make up our class 'Maths Boxes'.*

This approach aligns with Boaler's (2016) emphasis on promoting student agency and fostering a growth mindset in mathematics. By allowing children to choose resources that make sense to them, they are empowered to engage more deeply in problem-solving, develop confidence in their reasoning, and see themselves as capable, independent mathematicians. This perspective is further supported by Dweck (2006), who highlights that cultivating a growth mindset involves encouraging learners to embrace challenges, persist, and see mistakes as learning opportunities.

Figure 4.10: *Photograph of child independently choosing to compare the measurement of five shoes using three rulers, selecting tools that make sense to her.*

Two critical friends noted during my observation lessons about how students freely used the resources and visual tools of the mathematics boxes according to their own preferences.

"*Poster available with maths vocabulary, maths box provided with a choice of concrete materials and whiteboards*" – Critical Friend 3.

"*All children given whiteboards and given a chance to create their own problems, children asked to call out problems and classmates could use 100 squares to solve the problem*" – Critical Friend 2.

Figure 4.11: *Children collaboratively measuring themselves using water bottles as a non-standard unit of measurement.*

4.3.2 Lesson structure for deeper thinking

Setting a clear time structure gave children the freedom to manage their time for specific tasks while working within a defined framework. This approach aligns with Deci and Ryan's (1985) 'Self-Determination Theory', which highlights the importance of supporting student autonomy to enhance intrinsic motivation and engagement. By setting high expectations, offering opportunities for genuine responsibility, and encouraging self-regulation, I aimed to meet students' needs for autonomy and competence.

Critical Friend 1 noted that "*every child understood the task and worked independently, they were clear on what they had to do and every child then formed a unique question for a peer to solve*", when observing one of my intervention lessons.

I supported this by clearly communicating learning objectives and helping students develop their own action plans for managing time during problem-solving activities. I also encouraged learning through mistakes by allowing 'struggle time' without imposing time constraints on the children (Stewart & Ball, 2024). "Critical Friend 4 highlighted that there was "*A brilliant structure to the lesson with the W.A.L.T. (We Are Learning To) and W.I.L.F. (What I am Looking For) crystal clear, this allowed students to work with focus and independence".* The children were encouraged to contribute their own ideas, with Child 5 deciding during the first intervention lesson that she would like her problem to be solved inside a box using visual subtraction.

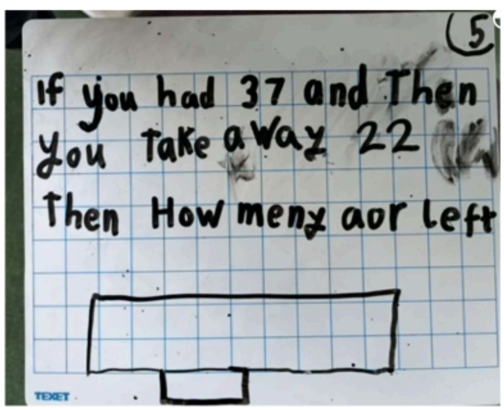


Figure 4.12: *Child 5's preferred problem-solving approach using a box laid out for visual subtraction during the first intervention lesson.*

4.3.3 Integration of storytelling

One significant change in my teaching approach to mathematics was the integration of math picture books into my lessons, which had a notable impact on both student engagement and my own practice. This shift aligned with my values of promoting deeper understanding of mathematics and fostering a more inclusive, creative classroom environment. Critical Friend 1 emphasised how "children could share their learning from the story, allowing them to use their maths vocabulary" from one of my intervention lessons.

Figure 4.13: *Picture books used during intervention lessons to support mathematical concepts and storytelling.*

Using stories to frame mathematical problems helped create meaningful contexts, making abstract concepts (Skelton, 2022), in my case addition, subtraction, and length, more accessible and relatable for the children. A valuable resource in this process was the MathsThroughStories.org (Trakulphadetkrai, 2017) website, which provided practical examples, book recommendations, and lesson ideas that showed how storytelling can enrich mathematical thinking. 18 out 21 students said the mathematics in the picture books was easy or okay to understand. While Critical Friend 5, who was present for all my intervention lessons, and Critical Friend 4, who was present for ten out of twelve intervention lessons, both supported the picture books inclusion as they clearly aligned with mathematical concepts. Storytelling helped me build stronger connections with learners, encouraged participation from reluctant students, and ultimately led to a more student-centred and engaging teaching approach. Child 1 noted that "when we finish our problems, we could read the maths books on our own that we have done with the class", which highlighted how much the children valued and benefitted from the inclusion of mathematics picture books as part of their learning experience.

During Games Club, Critical Friend 4 shared an insightful and affirming interaction with Child 11 that resonated with recent changes made to our mathematics lessons. Child 11 spontaneously mentioned, *"We were learning about how many seeds were in a pumpkin in Maths,"* (Ciaran Sweeney, 25th March 2025), clearly referencing our recent use of the picture book 'How Many Seeds in a Pumpkin?' by McNamara (2007). This brief moment revealed not only the child's engagement and retention of the learning experience but also the impact of integrating literature into mathematical inquiry. This interaction affirmed that small pedagogical shifts, such as integrating narrative into numeracy, can have a significant impact on student engagement and memory.

4.3.4 Warm-ups, routines, and reflections

Incorporating warm-ups, routines, and reflections into my mathematics lessons significantly enhanced the structure and depth of student learning (Landorf & Wadley, 2022). Rebecca Robins (n.d.) 1st Grade Math Slides activated prior knowledge and eased the students into mathematical thinking, setting a positive and focused tone for each lesson.

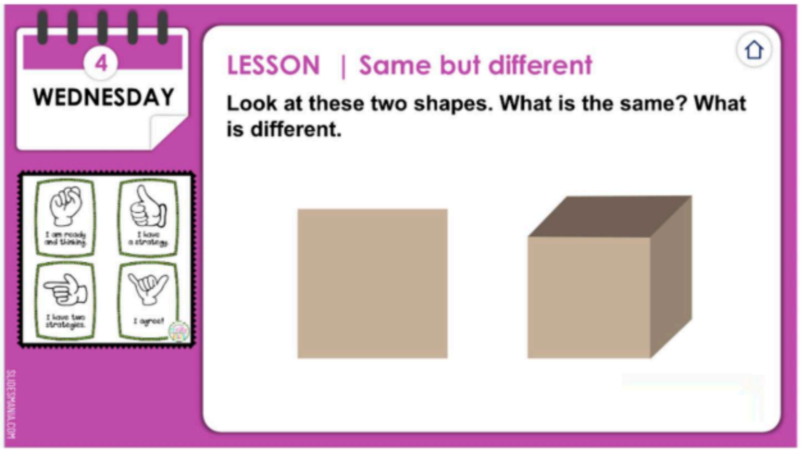


Figure 4.14: *An example of a slide from Rebecca Robins 1st Grade Math Talks Slides.*

Critical Friend 2 emphasised how children were using their 'maths eyes' when discussing the snowman picture from Rebecca Robins' slideshow. Consistent routines like the aforementioned supported students in developing independence and confidence, as they knew what to expect and how to engage meaningfully with tasks. Critical Friend 4 noted that the "use of hand signals engages all levels". Reflections through whole class discussions, think-pair-share, and self-reflection encouraged students to evaluate their thinking processes and learning strategies. This aligns with Dewey's (1933) view of reflection as a key component of meaningful learning, where students connect experience with thought to develop deeper understanding. Critical Friend 4 further elaborated by saying "thinking time is encouraged during discussions and at the end of tasks, this autonomy allows each problem to be set at children's individual ability level". Through these elements, I cultivated a mathematics classroom that supported autonomy, critical thinking, and sustained engagement.

4.3.5 Student involvement and adaptability

In Cycle 1, I noticed that my teaching tended to be overly directed, which sometimes limited student involvement and opportunities for independent thought. Recognising this in my reflective journal:

"I value student autonomy, but I often find myself over-directing. In trying to keep control, I sometimes limit the space students need to think and explore. I am realising that true agency means letting go a little".

Planning for discussion time allowed me to foster Boaler's (2016) emphasis on slowing down the mathematics process to allow deeper exploration and understanding. Critical Friend 1 noted that there was a "very good discussion at the end of the story, children could share their learning from the story, this allowed them to use their mathematical language". By stepping back and allowing the students to dictate the direction of the whole class discussion, I am aligning my practice more closely with my value of student-centered learning. This supports NRICH (2019), showing that mathematics lessons embedding LT/HC tasks engage children by offering accessible yet challenging problem-solving opportunities. This shift not only fosters greater engagement but also helps students develop critical problem-solving skills and adaptability in their mathematical thinking as they listen to their peers' perspectives.

4.4. Building and scaffolding mathematical language

In theme two, I will focus on the importance of building and scaffolding mathematical language to support students' understanding and communication of mathematical concepts. Developing a strong mathematical vocabulary is essential for learners to express their reasoning, engage with problem-solving tasks effectively, and participate in classroom discussions.

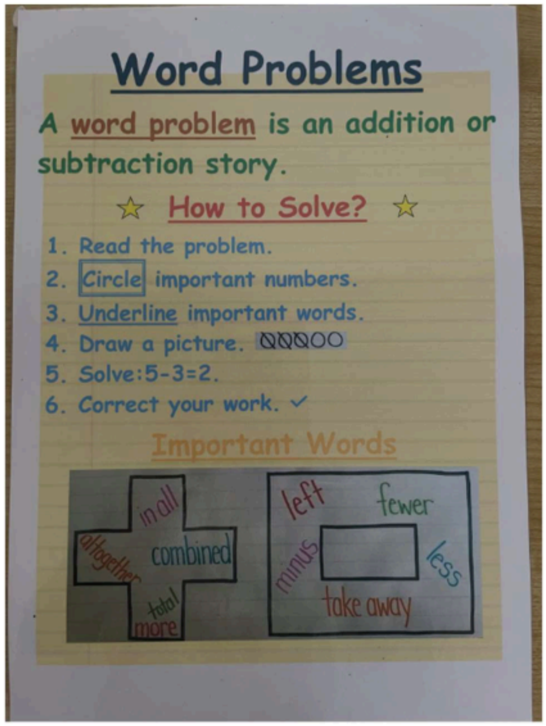


Figure 4.15: *Word Problems poster used to scaffold children's thinking and language during problem-solving tasks.*

Sherman and Gabriel (2017) emphasize the role of targeted language instruction in helping students navigate complex mathematical ideas, which was echoed in Wood, Bruner, and Ross (1976) highlighting how scaffolding language through modeling and structured talk supports deeper conceptual understanding. Drawing on these insights alongside Vygotsky's (1978) sociocultural theory, which underscores the significance of social interaction and language in cognitive development, I implemented strategies such as modelling precise language, the use of visual aids, and providing problem-solving guidelines to help students grasp key terms accurately.

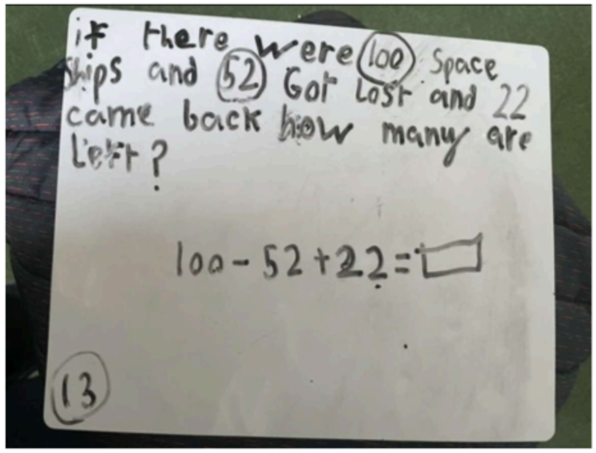


Figure 4.16: *Child 13 using the poster prompt 'Circle important numbers' in assisting his problem-solving process.*

4.4.1 Teacher modelling and visual supports

In my study teacher modelling of mathematical language played a key role in supporting students' development of precise and confident mathematical communication, a finding supported by Zhang et al. (2024). By consistently using and explaining key terms during problem-solving, I provided students with a clear linguistic framework to draw from in their own discussions and written work. Critical Friend 4 stated *"There were open-ended tasks, range of materials, range of language – very child centred, use of visual support as a helpful reminder"*. It drew a stark comparison with an entry into my reflective journal from Cycle 1 – *"someone who does not just follow the textbook… but I have noticed how easy it is to fall back on it for structure and direction, especially when things get busy, convenience can sometimes take over intention"* (Ciaran Sweeney, 23rd January 2025).

During a conversation with Critical Friend 6, Child 11 made a striking comment about our recent shift in mathematics instruction: *"This was better than Planet Maths"*, (Ciaran Sweeney, 11th February 2025). This response followed a lesson where we use the picture book 'The Mission of Addition' (Cleary, 2005) as the central resource, stepping away from the traditional textbook. This moment stood out significantly, as Child 11 has consistently shown enthusiasm for Planet Maths and has often referred to it positively in the past. During Cycle 1, Child 11 had asked specifically "When are we taking out our *Planet Maths* book?" and was surprised to learn that it was not be used that day (Ciaran Sweeney, 25th January 2025).

Modelling reinforced through visual support of mathematics picture books displayed on the interactive whiteboard, can help contextualise vocabulary within engaging narratives and visuals.

Figure 4.17: *Visual and textual depiction of subtraction in the story 100 Mighty Dragons All Named Broccoli.*

The combination of auditory and visual input made abstract language more concrete and memorable for students. Additionally, using a problem-solving plan offered a consistent scaffold that supported students in structuring their thinking and using relevant mathematical terms if needed at each stage. Together, these strategies created a language-rich environment where students felt supported in both understanding and using mathematical language with increasing independence. Child 8 remarked "*I liked the lessons because it was easy to understand each part*", suggesting that the lessons were appropriately pitched in terms of both the scaffolding of the mathematical language and the level of challenge presented by new concepts.

4.4.2 Connecting literacy and mathematics

The use of story structure helped students grasp mathematical concepts by placing them within familiar narrative frameworks, making abstract ideas more concrete and relatable. For example, books that incorporated mathematical problems into a storyline allowed children to see mathematics as part of real-life contexts, encouraging deeper engagement. Unprompted, the children began to use the storylines as narratives for their own word problems:

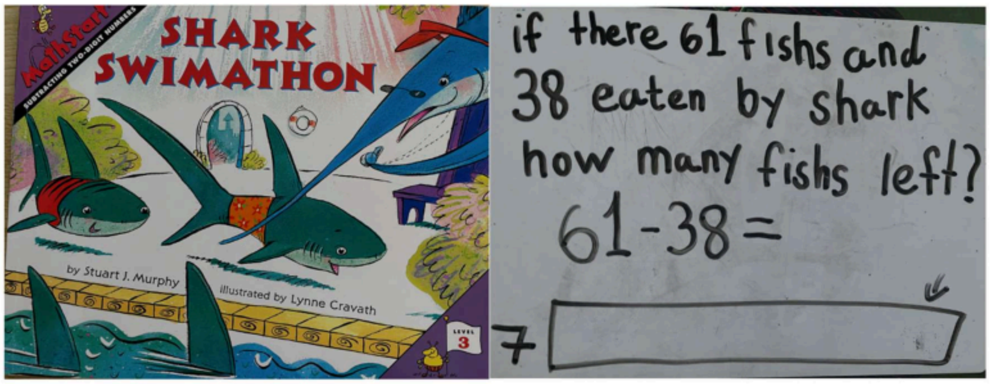


Figure 4.18: *Word problem designed by Child 7 inspired by the book Shark Swimathon (Murphy, 2006).*

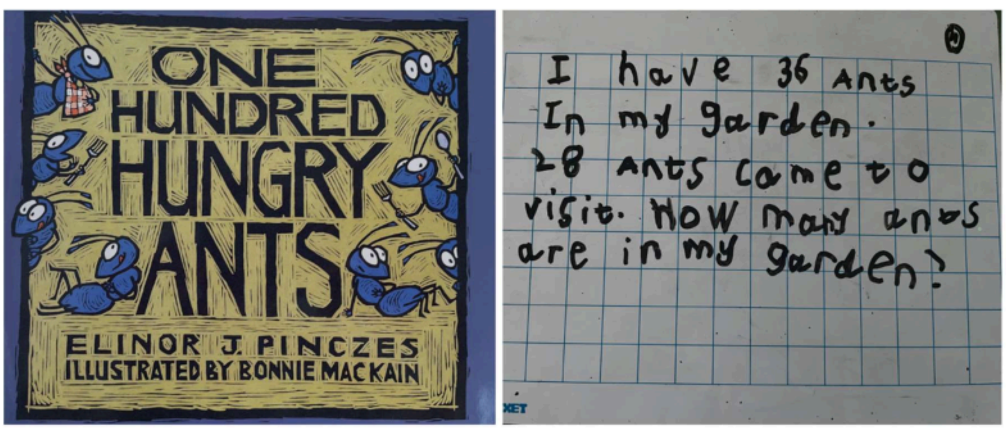


Figure 4.19: *Word problem designed by Child 4 inspired by the book One Hundred Hungry Ants (Pinczes & MacKain,1993).*

The repeated exposure to key vocabulary through these texts made mathematical language more memorable and accessible, especially as they are still young learners. Additionally, the rich language used in picture books served as a scaffold for students' own mathematical writing, offering sentence structures and terminology they could emulate when explaining their thinking as seen in the problems constructed by Child 7 and Child 4 above. This cross-curricular approach highlighted the powerful connection between literacy and mathematics, showing that when taught together, each can enhance the other. This approach is supported in the Australian PMC (ACARA, 2021).

When using the book 365 Penguins (Fromental, 2006) in one of my lessons, I noted in my reflective journal: "*The children were really engaged with the story and made many meaningful connections like that's how many days are in a year, penguins don't live in the North Pole, and they live at the bottom half of the world*" (Ciaran Sweeney, 13th February 2025). We followed their curiosity and looked at a world map together to explore where penguins live. A great example of how a story can spark both mathematical thinking and cross-curricular learning.

4.4.3 Developing and using vocabulary

Developing and using mathematical vocabulary was central to supporting student's conceptual understanding and communication. I made a deliberate effort to introduce key terms using meaningful contexts. Critical Friend 2 pointed out that "*the story was paused and words were explained, synonyms given, after reading the children were asked what maths words they spotted in the story*". Vocabulary was revisited regularly through discussion, problem-solving, and when encouraging students to articulate their reasoning using appropriate mathematical language. One notable moment occurred when a child pointed out the use of the word "*returned*" in the subtraction-themed picture book '100 Mighty Dragons all named Broccoli' by Larochelle (2023). Child 17 immediately commented that "*this is adding not taking away*" without prompt.

Figure 4.20: *Example from a story illustrating the importance of mathematical language - 'returned' used to imply addition in the book 100 Mighty Dragons all named Broccoli.*

This observation opened a valuable discussion about how language can overlap across operations and demonstrated the child's growing awareness of mathematical language in different contexts. In Cycle 1, I kept a tally, to the best of my ability, of how many children used our class mathematics wall to support their learning during mathematics lessons. Only two children used it meaningfully, which suggested to me that it was either overloaded with uninspiring information or lacking in useful content (Ciaran Sweeney, 20th January 2025). By displaying between six and twelve key words (Fathman et al., 1992) on the classroom mathematics wall and integrating them into classroom routines, it helped reinforcement of the vocabulary across various tasks. By embedding vocabulary instruction within hands-on and language-rich activities, I was able to scaffold students' language development in ways that deepened their overall mathematical understanding. It also prompted me to reflect on a moment earlier in the year when a child struggled to recognise that 6+6 is the same as double 6.

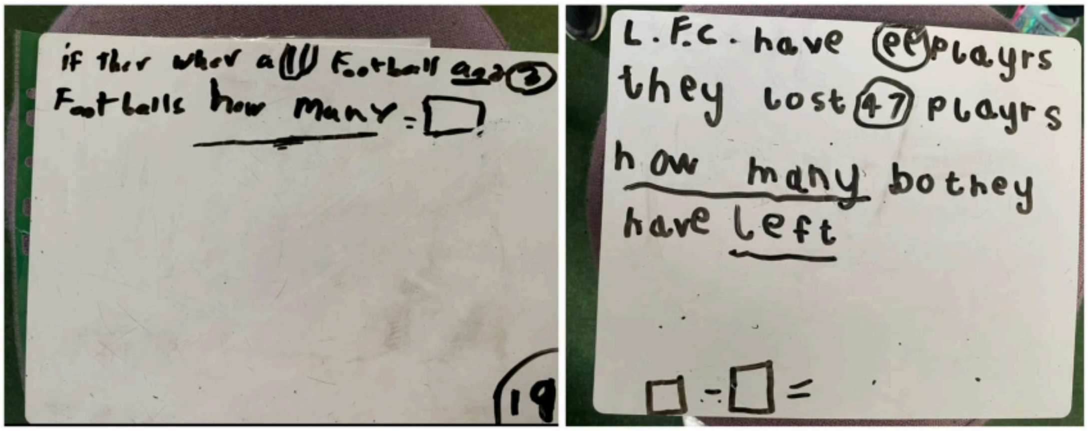


Figure 4.21: *Depicts the mathematical language vocabulary development demonstrated by Child 19, including the use of age-appropriate sentence structure and mathematically accurate wording to conclude the word problem.*

4.4.4 Student communication and peer learning

During the ‘maths eyes’ tasks, students were prompted to describe what they saw mathematically, which helped them practise their mathematical language in real-world contexts. This approach also encouraged peer-to-peer language use, with students building on each other’s ideas and noticing patterns or structures collaboratively, an approach Boaler (2019) advocates for. I had been using Topmarks Daily 10 as a way of introducing lessons, but in Cycle 1, it was striking to hear Child 6 say “*Sometimes I feel the Daily 10 questions on Topmarks are difficult*”. There also was the repetition of the same strategy on ten different occasions, a methodology I was trying to move away from.

Following Cycle 2, student feedback highlighted a shift in engagement and ownership of learning, particularly in how children approached mathematical communication. Child 6 reflected, “*Yes, I would love to keep doing this and keep things like think-pair-share and making word problems*”. The response at the conclusion of Cycle 2 suggests that, over the course of the intervention, the student not only became more comfortable sharing their thinking but also began to appreciate the creative and collaborative aspects of the mathematics lesson. I wanted to foster this creativity not only in the creation of mathematical problems but also in the activities that followed the intervention lessons, as seen, for example, when I asked the children to illustrate their own ideas of what 'a half' means to them.

Figure 4.22: *Maths learning activity titled "When I think of a ½ , I see…" designed to foster children's creativity and conceptual understanding.*

Their preference for 'think-pair-share' and word problem creation also reflected a growing confidence in expressing mathematical ideas, which was a key aim of my intervention. It demonstrated how scaffolding mathematical language and offering space for creativity can foster greater student voice and a stronger sense of agency in the classroom. Twenty out of the twenty-one children believed they had either used lots of mathematical words or used some mathematical words over the course of the intervention lessons. This suggests that the intervention was successful in raising students' awareness and use of mathematical vocabulary, supporting Myhill and Fisher's (2005) view that explicit attention to language in the classroom can significantly enhance students' ability to think and reason effectively.

4.4.5 Inclusive Language Practices

In an effort to make mathematical language more accessible and inclusive, I recognised that vocabulary posed a significant barrier for some students, particularly those with special educational needs such as dyslexia. These students often found it challenging to express their mathematical thinking and represent it on a mini whiteboard (Fuchs et al., 2020). To support them, either the in-class support teacher or the Special Needs Assistant would scribe their ideas, allowing the child to focus on the mathematical reasoning rather than the mechanics of spelling and writing. For example, when problems presented by peers were read aloud to Child 18, I was able to assess his understanding of mathematical vocabulary by encouraging him to explain terms orally. Although he was highly reliant on using cubes to solve problems, he consistently articulated the reasoning behind his approach. This often led to long lines of cubes across the table, but, in his words, "*I like using the cubes the most because it makes it easier*" to solve the problem. This approach not only validated his preferred learning style but also provided an inclusive environment where his mathematical thinking could be fully recognised and developed (Dekker, n.d.).

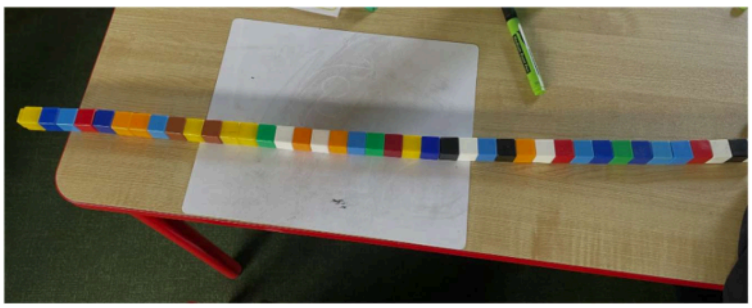


Figure 4.23: *Long line of cubes used to support addition, chosen by Child 18 as it supported their conceptual understanding.*

Following this scenario, I reflected on the nature of traditional mathematics homework and the repetitive learning it often involves whether through online games or nightly 'mental maths' pages. In conversations with my critical friends before implementing my intervention lessons, Critical Friend 2 suggested an alternative: sending home a leaflet to encourage mathematics talk at home, similar to one she had previously used from the NCCA (n.d.) (Appendix K). This idea resonated with me, especially in the context of supporting children like Child 18. These inclusive strategies offer families prompts and activities designed to promote vocabulary development in a familiar and supportive setting. They help scaffold students' understanding and build confidence in using mathematical language, both in school and at home.

As a result, I have since implemented a small but meaningful change, the inclusion of 'maths talk' homework (Appendix L). This approach provides opportunities for students to enjoy mathematics without feeling overwhelmed. With its low floor–high ceiling design, it ensures that all children can access the task at their own level and experience success, especially those who might otherwise struggle with more traditional formats.

4.5 Student engagement and ownership

In rethinking my approach to teaching mathematics, I have become increasingly focused on creating learning experiences that foster deeper student engagement and a stronger sense of ownership. Rather than positioning students as passive recipients of information, I now aim to place them at the centre of their learning. The intervention lessons were aimed at encouraging the children to make choices, express their thinking, and engage with mathematics in ways that feel relevant and achievable. Influenced by the work of Boaler (2016), who emphasises the importance of open, exploratory tasks and learner agency, I have sought to design lessons that place students at the centre of their learning. This approach is further supported by the NCCA (2016), which highlights the value of mathematical talk and reasoning as tools for deepening understanding. My aim is to create learning experiences that not only capture students' interest but also provide the support necessary for all learners to succeed. These shifts in practice are particularly significant for students who may not always feel confident in mathematics, as they help build enjoyment, self-belief, and a sense of progress.

4.5.1 Autonomy, voice, and choice

Creating space for student voice and choice became a key element of my evolving mathematics teaching. I found that when students were given opportunities to influence their learning environment, they became more invested in the process. For instance, several students offered suggestions to improve our lessons, such as requesting time to read the mathematics picture books independently when they have finished a mathematics activity, a concept supported by Leavy and Hourican (2022).

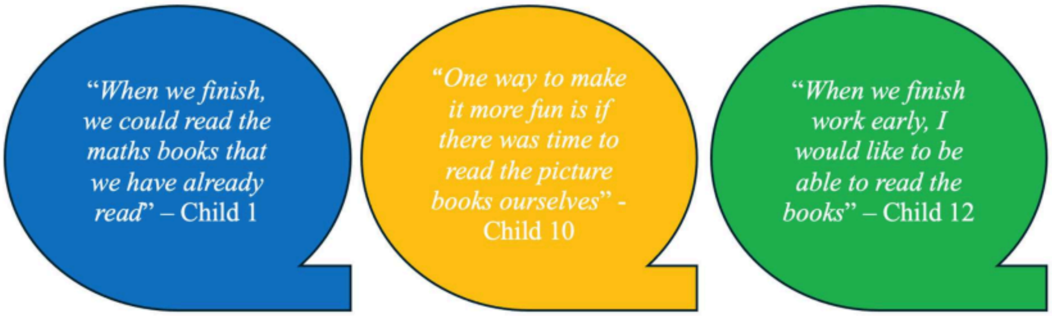


Figure 4.24: *Comments from Child 1, Child 10, and Child 12 on re-visiting the picture books independently after the intervention lessons.*

This led to the creation of a separate 'Maths Picture Book Library' space in our classroom, which we have been adding to since the conclusion of the intervention lessons. This helped highlight both their desire to challenge themselves and use their time meaningfully.

Figure 4.25: *A photograph of our Maths Library space.*

By encouraging students to write and solve their own problems, I observed a shift in classroom dynamics. Learners became more independent, and when faced with a challenge, they often turned to the problem's creator for clarification. This supported both mathematical reasoning and peer collaboration, helping to reduce the teacher's direct involvement during children's 'struggle time' (Ingram et al., 2016). One clear example came from Child 7, who initially created a multi-step word-based problem. When a peer struggled to interpret it, Child 7 adapted the task to a number sentence to guide their thinking. This demonstrated not only flexibility in mathematical representation but also a strong sense of ownership and responsibility for her peer's learning. While some children embraced creating their own problems, Child 15 expressed that he preferred solving problems made by others rather than generating his own. This highlights individual differences in how children choose to engage with mathematical tasks when given ownership.

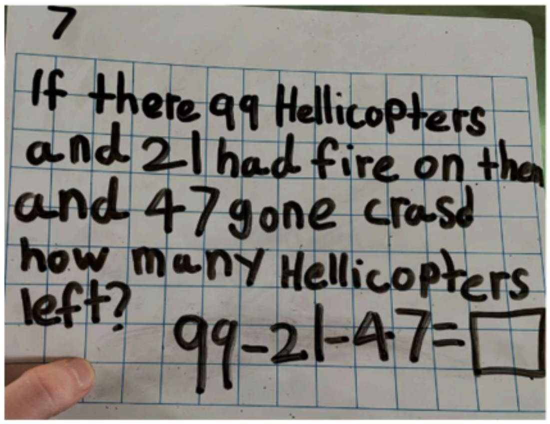


Figure 4.26: *A multi-step word problem created by Child 7.*

4.5.2 Enjoyment, interest, and relatability

To foster greater student engagement and ownership in my teaching of mathematics, I have intentionally shifted towards approaches that prioritise enjoyment, interest, and relatability. This reflects Burns' (2007) advocacy for incorporating storytelling, manipulatives, and real-world connections into mathematics instruction to deepen understanding and motivation. Student feedback supports this shift, particularly in the desire for visual and artistic expression requests such as "*I liked making word problems because we got to be creative*", (Child 6) highlight the value of creative integration. I noted my own enjoyment in my teaching in my reflective journal recently when looking back on one of the 'Always, Sometimes, Never' activities from the Oide (n.d.) website (Appendix M). I believe this example perfectly illustrates the kind of exploratory talk Mercer (1995) describes.

"*Yesterday, I had one of the most meaningful classroom conversations I've experienced, sparked by the statement: "Breakfast is eaten in the morning."* While most *students agreed, one child stood in the Sometimes area and explained that during Ramadan, breakfast isn't always eaten in the morning. Her insight led to a rich discussion about cultural and religious practices. Reflecting on this, I felt a real sense of satisfaction. By slowing down my maths lessons and allowing space for student-led thinking, conversations like this are becoming a natural and valuable part of our classroom*". (Ciaran Sweeney, 14th May 2025).

Literature has proven to be a highly engaging tool because the books capture their interests (FNBE, 2017). Students voiced strong preferences for picture books, with Child 20 remarking that they liked "*all picture books except one*", and Child 21 proposing a regular "*maths picture book once a week*". The class favourite, '100 Mighty Dragons All Named Broccoli', received nearly half the votes, demonstrating how humour and narrative can transform abstract mathematical concepts into memorable, relatable experiences. Critical Friend 4 noted that questions like "*Do we like this kind of maths?*" and later, "*How did you find that?*" as simple questions that opened space for students to reflect on their enjoyment and preferences. By weaving these elements into my teaching, I have seen students engage more willingly and take greater ownership of their mathematical learning.

4.5.3 Sense of growth and success

A growing sense of success and personal growth has become increasingly evident in my classroom since rethinking my mathematics teaching. Eleven students responded as "*Yes, I feel like I am getting better*" when it came to analysing their own problem-solving skills development. Thirteen students responded "*Yes, I learned a lot of new things*", when asked about our intervention lessons, showing increased confidence and awareness of progress. Even those seven children who said they learned "*A few new things*" demonstrated a developing self-reflectiveness. This aligns with Dweck (2006) and her growth mindset theory (NRICH, 2019). Effort and challenge are seen as routes to improvement in her theory. A key factor has been allowing students to design their own problems, an approach fourteen students described as fun. There was a sign of improvement, as a survey conducted during Cycle 1 showed that only seven children out of twenty-one specifically said that they enjoyed mathematics time at school (Ciaran Sweeney, 21st January 2025). This again highlighted how ownership can turn challenges into something enjoyable and empowering.

It is also clear that students are motivated to succeed in mathematics for very personal reasons. The variety in the responses to the questions "*Is there anything that encourages you to work hard, even when the work is difficult?*", Child 9, Child 14, and Child 17's responses varied from making a parent proud to making their own self feel smart. These insights show how learning is tied to emotional connections and identity. Understanding these individual motivations helps me support each learner as a whole person, not just in what they learn, but in why they want to learn.

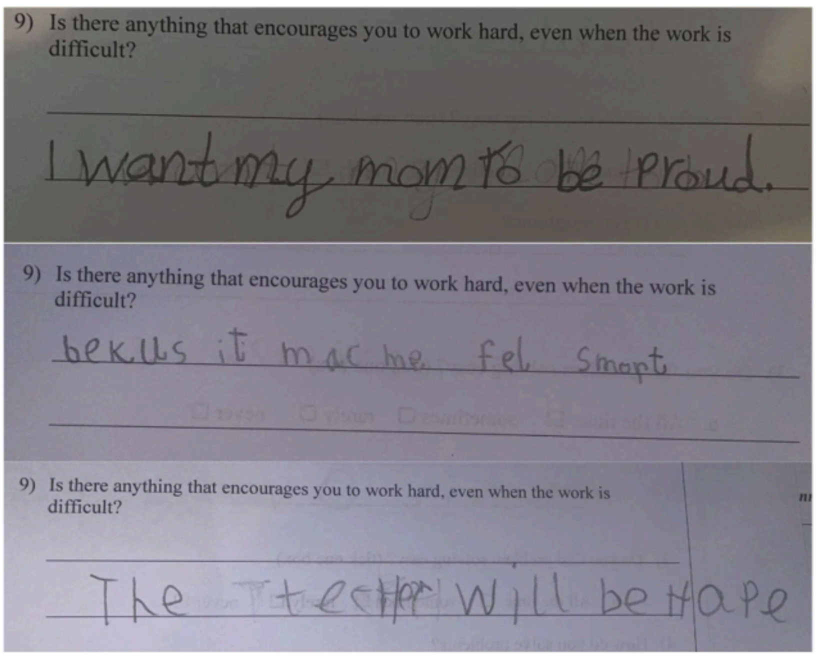


Figure 4.27: *Child 9, Child 14, and Child 17's responses to the question: 'Is there anything that encourages you to work hard, even when the work is difficult?'.*

4.5.4 Tools and supports for participation

Tools and targeted support have played a vital role in promoting student ownership and engagement in mathematics. Mini-whiteboards, used during student-led word problem creation, encouraged active participation and offered all learners a low-pressure way to share ideas. This simple tool helped make thinking visible, fostered peer discussion, and allowed students to feel more in control of their contributions. These small shifts created space for learners to take initiative and feel more confident in navigating mathematical tasks.

For students with additional needs, tailored support further enabled meaningful participation. Strategies such as a support teacher or SNA scribing and reading problems aloud helped ensure all students could engage in the problem-design process. Anticipating challenges before lessons, as noted by Critical Friend 6, enabled more confident and inclusive engagement. The suggestion from Critical Friend 6 of mirrored small-group activities for Special Educational Needs learners provided another layer of support while maintaining their agency. These approaches reflect Florian and Black-Hawkins' (2011) idea of inclusive pedagogy, which focuses on extending what is available to all learners, rather than limiting or separating experiences. Through thoughtful planning and responsive tools, more students are empowered to participate fully and take ownership of their learning.

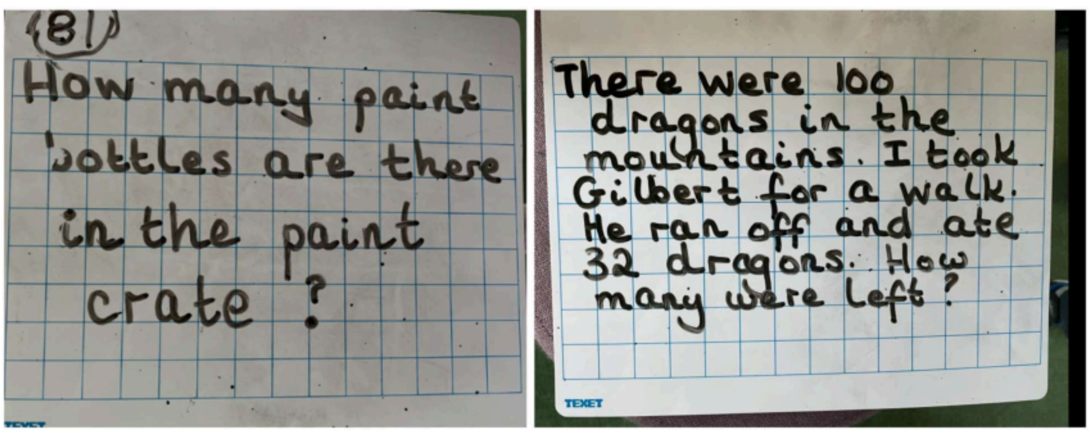


Figure 4.28: *Examples of word problems where an adult has scribed ideas for a student.*

4.6 Conclusion

In conclusion, this analysis demonstrates that student engagement and ownership in mathematics can be meaningfully strengthened through inclusive, creative, and student-centred strategies. A key element was the integration of mathematic picture books, which not only supported the development of mathematical language but also made learning more relatable and enjoyable. As students engaged with stories, they were inspired to design their own problems, deepening their understanding through narrative and self-expression, an approach supported by Burns (2007), who advocates for blending literacy and numeracy to enrich meaning making.

The data also highlighted the value of accessible tools like mini-whiteboards and the importance of tailored adult support in ensuring full participation. These strategies align with Vygotsky's (1978) view of learning as a socially and contextually mediated process, and with Florian and Black-Hawkins' (2011) call for inclusive pedagogies that extend opportunities to all learners. Children's personal motivations, whether to make a parent proud or feel smart, reinforce the emotional dimension of ownership. Together, these findings contribute to a theory of practice that centres the learner as an active agent, capable of engaging deeply with mathematics when their experiences, identities, and voices are genuinely valued.

The next chapter will reflect on the overall learning journey undertaken during this self-study. It will consider the implications of the findings for future classroom practice, highlight key professional learning moments, and explore how this inquiry into my practice has shaped my evolving understanding of inclusive and language-rich mathematics instruction.

Conclusion and Recommendations

5.1 Introduction

This self-study action research explored how I could improve my teaching practice by implementing strategies that foster children's mathematical language, with the goal of enhancing their problem-solving skills. Recognising that language is central to mathematical thinking, I aimed to design lessons that provided opportunities for students to express their ideas, use precise mathematical vocabulary, and explain their reasoning. Through this study, I critically examined my role as a facilitator of language-rich mathematical experiences in a First Class classroom and investigated how my practice could evolve to support young learners in becoming mathematical thinkers.

5.2 Research Summary

A review of literature on mathematical language development, early problem-solving, and literature-based mathematic instruction provided the foundation for this self-study action research. Key themes included the role of mathematical language in conceptual understanding, the connection between language and problem-solving, and the use of mathematic picture books to support vocabulary and engagement. The literature highlighted how an intentional read-aloud can support mathematical thinking and language by embedding abstract concepts in relatable stories (Onesti, Uscianowski, & Mazzocco, 2022).

During my undergraduate teacher training, I was introduced to MathThroughStories.org, a global research-based initiative that promotes the use of storytelling in mathematics teaching. Although I was initially inspired by the concept, I did not meaningfully integrate this approach into my own classroom practice after graduating. It was not until I engaged in deeper reflection on my pedagogical values that I revisited the idea with renewed interest. The disconnect between what I had learned and what I was implementing in my practice prompted the focus of this research: using picture books to support the development of mathematical language and problem-solving in my First Class classroom.

The research question guiding this study was: How can I improve my practice to support the development of mathematical language and problem-solving in my First Class classroom? To address this, I implemented twelve three-part intervention lessons. Each lesson began with Rebecca Robins' First Grade Math Talk slides, which introduced key vocabulary, question stems, and sentence starters to model precise mathematical language. This was followed by a mathematical picture book read-aloud, during which I paused strategically to prompt discussion, clarify new vocabulary, and encourage students to make connections between the story and the mathematical ideas. The lesson concluded with a problem-posing activity, in which students used both new and existing vocabulary to create their own problems or questions. A peer would attempt to solve the problem; if they struggled, the problem-creator would take on the role of teacher, explaining the concept or strategy involved.

The intervention aimed to promote ownership of mathematical language, deepen understanding through dialogue, and embed reasoning within engaging narrative contexts. These routines were repeated over the course of seven weeks with a range of picture books linked to the topics of addition, subtraction, and length.

Data was collected through a variety of sources to gain insight into both student learning and professional growth. These can be seen in Figure 5.1:

Figure 5.1: *Data collection tools used in my self-study action research.*

The analysis followed Kemmis and McTaggart's (1988) action research model of planning, acting, observing, and reflecting. Coding was conducted inductively, and categories were developed through careful review and discussion with critical friends. The process remained grounded in my research question and reflective of the values that shaped the inquiry. Three key themes (Figure 5.2) emerged from the analysis:

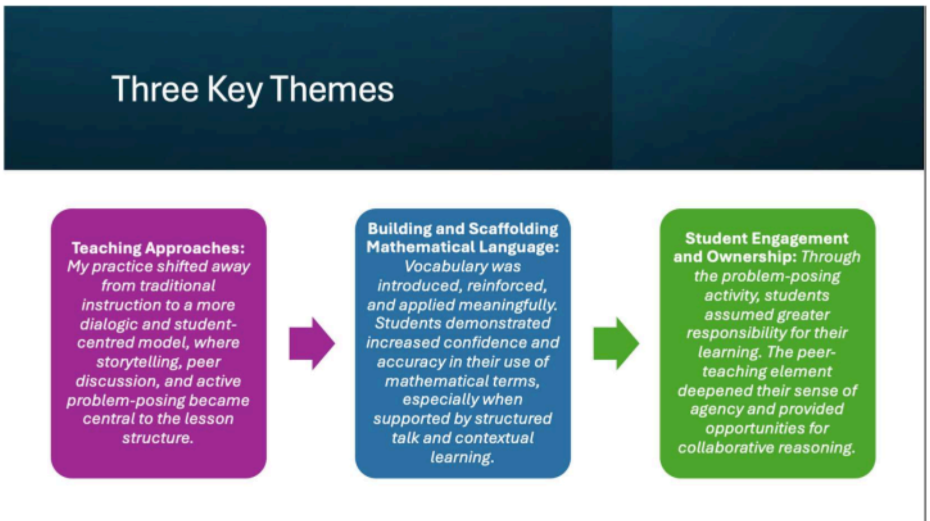


Figure 5.2: *Three key themes identified from my data analysis.*

This research led to the development of a personal living theory grounded in the belief that intentional use of narrative, dialogue, and student-created content can significantly enhance young children's mathematical thinking and engagement. Revisiting previously underused resources like MathsThroughStories.org and applying them critically and reflectively has strengthened both my teaching and professional identity.

5.3 Limitations of the research

This study had valuable insights but also some limitations to consider. The research was conducted with a single class group as part of self-study action research, which offers rich, in-depth understanding but limits broader generalisation to all class levels of a primary school. My class benefited from an in-class support teacher during intervention lessons and Special Needs

Assistant (SNA) support, staffing support that may not be available in all schools, potentially affecting the applicability of findings in different contexts. Their support, particularly in helping children write their word problem, allowed students to focus more effectively on the mathematical aspects of the questions.

One data collection tool asked children to rate their enjoyment of problem-solving on a scale from one to ten at three stages throughout cycle two. Some children struggled to differentiate between rating their enjoyment of the problem-solving component of the lesson and the picture book story. This indicated a need for clearer tools in future research,

Additionally, budget constraints in school may limit the ability to purchase a wide variety of mathematic picture books, leading to repeated use of the same resources. Incorporating cross-curricular books could support more sustainable resource use. While children expressed a desire for a dedicated mathematic picture book library in the classroom, it may not be feasible to have one in every classroom. A communal library shared among a stream, for example the four First Classes in my school, could offer a practical and valuable alternative.

Overall, despite these limitations, the study contributes meaningful insights into using mathematic picture books to develop mathematical language to support problem-solving in primary education and suggest directions for further research.

5.4 Reflections and Recommendations

Engaging in this research has significantly shaped my teaching practice, particularly in recognising the importance of developing mathematical language to support problem-solving. Through the integration of mathematic picture books, children were exposed to rich mathematical vocabulary within meaningful and engaging contexts. Over time, I observed increased confidence in their use of key terms on their mini-whiteboard work, as well as greater clarity in how they explained their reasoning and structured their thinking aloud to their peers.

This shift reinforced the value of embedding mathematical language in narrative and discussion. Picture books provided accessible entry points into problem-solving tasks, allowing children to explore and verbalise mathematical concepts with greater fluency. With the support of in-class teachers and SNA's, all learners, including those with literacy challenges, were able to actively participate and build their mathematical vocabulary through oral language, collaborative thinking, and teacher-guided modelling.

The children's responses throughout the study demonstrated not only a growing enthusiasm for problem-solving, but also a deeper understanding of how language supports mathematical thinking. Their suggestion to create a dedicated mathematic picture book library was a testament to their engagement, and although this may not be possible in every classroom context, a shared resource approach across class levels would promote continued exposure to this valuable learning approach.

As Maxine Greene (1995) explains, imagination allows us to move beyond what is currently known and consider new possibilities for what could be. This research showed how imagination, language, and problem-solving are deeply interconnected. Through story, dialogue, and shared reflection, children engaged more deeply with mathematical content by posing their own problems and exploring them in meaningful ways. In doing so, they developed the tools to think, reason, and solve problems with greater confidence and creativity.

5.5 Future Research

As I transition from teaching First Class to Second Class, I am well-positioned to build on the findings of this research and continue exploring how mathematical language and problem-solving can be supported through literature-based approaches. Future research could include:

- **Implementation with a New Year Group:** Applying the intervention in a 2nd Class setting will offer insights of how slightly older learners engage with mathematical picture books, and whether similar strategies promote further vocabulary development reasoning, and problem-solving confidence at this stage. It may also reveal how pupils' growing cognitive and linguistic abilities influence their ability to extract meaning from mathematical narratives, informing age-appropriate scaffolding across varied educational contexts.
- **Longitudinal Monitoring:** Tracking students who participated in the First Class intervention into Second Class could provide valuable data on the long-term impact of

narrative-based instruction, particularly around language retention and independent reasoning. This type of longitudinal insight would be useful to both researchers and practitioners seeking to design sustainable, evidence based interventions that support progression in mathematical thinking and communication over time.

- **Expansion Across Class Levels:** Extending the intervention to younger and older classes could reveal how mathematical story-based instruction and word problem creation supports learners at different development and curricular stages, informing broader applications. It would allow teachers internationally to consider how such an approach can be differentiated. This provides a scope to aligning with developmental psychology theories and curriculum frameworks that value inquiry, creativity, and language rich problem-solving.
- **Focus on Problem-Posing:** Further investigation into the problem-posing element, where children created and share their own problems, could explore how the activity fosters ownership of mathematical language, supports peer teaching, and deepens conceptual understanding.
- **Cross-Curricular Integration:** Investigating the use of picture books that connect mathematics with other subjects. For instance, books that interlink with SESE, Music, or Literacy topics could increase the sustainability and cross-subject value of this approach. Educators in Ireland working in thematic curriculum models could use this to support a more holistic, engaging learning experience for children.
- **Assessment Tool Development:** Creating simple, classroom-friendly tools to assess children’s use of mathematical language, both orally and in writing, could support teachers in tracking progress more consistently. Especially within problem-posing tasks, as this activity could support ongoing monitoring of progress.
- **Inclusive Practice:** Further research could explore how mathematic picture books support learners with language or literacy difficulties, ensuring all children access and benefit from vocabulary-rich, discussion-based mathematical learning. This resonates not only with the principles of inclusive education in Ireland but also with global movements towards equitable learning experiences, particularly in multilingual and mixed-ability classrooms.

The next phase of my teaching in 2nd Class offers a valuable opportunity to refine and deepen this work, supporting continued professional growth and improved learner outcomes.

5.6 Conclusion

Completing this self-study action research has been a deeply rewarding and transformative experience. It has allowed me to reconnect with approaches I once explored during my initial teacher training, such as picture books to support mathematical understanding, and reimagine how these strategies can be meaningfully embedded in my everyday practice.

This journey has strengthened my professional identity as a reflective practitioner and reminded me of the power of language and dialogue is shaping how young children think mathematically. Watching my students take ownership of mathematical vocabulary and confidently pose and solve their own problems has reaffirmed the importance of creating space for their voices, ideas, and creativity in the classroom.

As I move into a new teaching role in 2nd Class, I feel energised to continue this work, adapting, refining, and expanding the strategies explored in this research. I look forward to deepening my understanding of how language-rich, story-based learning can support all learners and contribute to a more inclusive and engaging mathematics experience.

In closing, I am guided by the words of Kilpatrick (1987), who reminds us:

"The experience of discovering and creating one's own mathematics problems ought to be part of every student's education", (Kilpatrick, 1987, as cited in Zhang, Stylianides, & Stylianides, 2024, p.2).

Reference List

Adelman, C. (1993). *Sadder but wiser: The emergence of educational policy research.* Chicago, IL: University of Chicago Press.

Altrichter, H., Posch, P., & Somekh, B. (1993). *Teachers investigate their work: An introduction to the methods of action research.* London, UK: Routledge.

Arksey, H. & Knight, P. (1999). *Interviewing for social scientists: An introduction to qualitative research interviewing.* London, UK: Sage Publications.

Arneja, C. & Tyagi, S. (2020). The importance of using stories for teaching-learning of mathematical concepts. *International Journal of Advanced Academic Studies*, *2*(4), pp.499-503. Available from: https://doi.org/10.33545/27068919.2020.v2.i4h.445.

Australian Curriculum, Assessment and Reporting Authority (ACARA). (n.d.). *Australian Curriculum, Mathematics.* Retrieved April 14th 2025, from: https://www.acara.edu.au/curriculum/foundation-year-10/learning-areas-subjects/mathematics.

Bahar, A., & Maker, C.J. (2015). Cognitive Backgrounds of Problem Solving: A Comparison of Open-ended vs. Closed Mathematics Problems. *Eurasia Journal of Mathematics, Science and Technology Education, 11*(6), 1531-1546.

Barnaby, D. (2015). *The Use of Children's Literature to Teach Mathematics to Improve Confidence and Reduce Math Anxiety.* Toronto, Canada: University of Toronto.

Barnes, E. M., & Stephens, S. J. (2019). Supporting mathematics vocabulary instruction through mathematics curricula. *Curriculum Journal, 30*(3), pp.322-341. Available from: https://doi.org/10.1080/09585176.2019.1614470.

Bassey, M. (2002). *Case study research in educational settings.* Buckingham, UK: Open University Press.

Bassey, M. (1990). Three Paradigms of Educational Research. In A. Pollard (Ed.), *Readings for Reflective Teaching*, 37-39. London, UK: Continuum.

Bennett, J., Lubben, F., & Hogarth, S. (2007). Bringing Science to Life: A Synthesis of the Research Evidence on the Effects of Context-Based and STS Approaches to Science Teaching. *Science Education, 91*(3), pp.347–370.

Bilewicz-Kuźnia, B. (2021). Inspiring Children's Mathematical Activity Through Contact with a Picture Book. *Edukacja Elementarna w Teorii i Praktyce, 16*, pp.27-41. Available from: https://doi.org/10.35765/eetp.2021.1661.02.

Blankman, R. (2023). Low Floor, High Ceiling Math Tasks, *HMH*, July 23rd 2023. Retrieved 10th November 2024 from: http://bit.ly/3C7oCCO.

Boaler, J. (2019). *Our Teaching Approach.* Retrieved 9th November 2024, from: https://www.youcubed.org/evidence/our-teaching-approach/

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*. San Francisco, CA: Jossey-Bass.

Boaler, J. (2016). *Mistakes "Grow" Your Brain.* Retrieved 16th November, from: https://pdst.ie/sites/default/files/Mistakes-Grow-Your-Brain-Revised.pdf.

British Educational Research Association (BERA). (2012). *Ethical guidelines for educational research* (4th ed.). London, UK: British Educational Research Association.

Brookfield, S. (2017). *Becoming a critically reflective teacher* (2nd ed.). San Francisco, CA: Jossey-Bass.

Bruner, J. S. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Brydon-Miller, M. (2019). *The handbook of action research* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Brydon-Miller, M., Greenwood, D., & Maguire, P. (2003). Why Action Research? *Action Research 1* (1), 9-23.

Burmeister, N., Elliot, R., Weber, L., Whalen, N., Sprader, C. & White, K. (2018). Empowering Teachers through Problem Solving. *Teaching Children Mathematics, 24*(4), pp.1-7.

Burnes, B. (2004). Kurt Lewin and the planned approach to change: A re-appraisal. *Journal of Management Studies*, *41*(6), pp.977-1002. Available from: https://doi.org/10.1111/j.1467-6486.2004.00463.x.

Burns, M. (2007). *About teaching mathematics: A K–8 resource*. Sausalito, CA: Math Solutions.

Căprioară, D. (2015). Problem Solving - Purpose And Means Of Learning Mathematics In School. *Procedia – Social and Behavioral Sciences, 191,* pp.1859-1864. Available from: https://doi.org/10.1016/j.sbspro.2015.04.332.

Chamberlin, M. T. (2018). Enhancing prospective teachers' views of doing mathematics: Documenting and reflecting on mathematical investigations. *Investigations in Mathematics Learning, 11*(2), 103–119. Available from: https://doi.org/10.1080/19477503.2017.1400937.

Cheeseman, J., Downton, A., & Livy, S. (2017). Investigating teachers' perceptions of enabling and extending prompts. In A. Downton, S. Livy, & J. Hall (Eds.). *40 years on: We are still learning! Proceedings of the 40th annual conference of the Mathematics Education Research Group of Australasia,* 144–148. Adelaide, Australia: MERGA

Chinn, S. (2014). Dyslexia, Dyscalculia and Maths Learning Difficulties, *Dyslexia Association of Singapore Handbook 2014*, pp.211-221. Retrieved 12th November 2024, from: https://das.org.sg/wp-content/uploads/2023/10/DASHB2014-international.pdf.

Cleary, B. P. (2005). *The Mission of Addition.* Minneapolis, MN: Millbrook Press.

Cleary, B. P. (2004). *The Action of Subtraction.* Minneapolis, MN: Millbrook Press.

Clements, D. H., & Samara, J. (2004). *Engaging young children in mathematics: Standards for early childhood mathematics education.* Mahwah, NJ: Lawernce Erlbaum.

Coghlan, D., & Brannick, T. (2014). *Doing Action Research In Your Own Organization (*4th ed.). London, UK: Sage Publications.

Cohen, L., Manion, L. & Morrison, K. (2018). *Research Methods in Education* (8th ed.). New York, NY: Routledge.

Cohen, L., Manion. L., & Morrison, K. (2011). *Research methods in education* (7th ed.). London, UK: Routledge.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behaviour*. New York, NY: Plenum Press.

Delaney, S. (2011, November 15th). *How parents can help their child learn maths.* Retrieved April 10th 2025, from: http://seandelaney.com/2011/11/15/how-parents-can-help-their-child-learn-maths/#more-412.

Dekker, B. (n.d.). *Why do some dyslexics struggle with math?* Sydney, Australia: Dyslexia Sydney.

Department of Education and Youth. (2023). *Primary Mathematics Curriculum.* Dublin, Ireland: Government Publications

Department of Education & Science. (1999). *Primary Mathematics Curriculum.* Dublin, Ireland: Government Publications.

Dewey, J. (1933). *How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process.* Boston, MA: D.C. Heath & Co. Publishers.

DiNapoli, J., & Miller, E. K. (2022). Recognizing, supporting, and improving student perseverance in mathematical problem-solving: The role of conceptual thinking scaffolds. *Journal of Mathematical Behavior*, *66*, Article 100965. Available from: https://doi.org/10.1016/j.jmathb.2022.100965.

Doyle, W. (2007). *Structures and strategies for teaching* (2nd ed.). Boston, MA: Pearson Education.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York, NY: Random House.

Dyslexia Association of Ireland. (2020). *Dyslexia and Maths Difficulties.* Dublin, Ireland: Dyslexia Association of Ireland.

Dyslexia Association of Ireland. (n.d.). Dyscalculia and Maths Difficulties. *Info, About Dyslexia.* Retrieved 12th November 2024, from: https://dyslexia.ie/info-hub/about-dyslexia/dyscalculia-and-maths-difficulties/.

Dyslexia Scotland. (2018). *Ideas for supporting maths.* Stirling, UK: Dyslexia Scotland.

English, L. D. & Gainsburg, J. (2016). Problem solving in a 21st-century mathematics curriculum. In L.D. English, & D. Kirshner (Eds.) *Handbook of international research in Mathematics Education* (3rd Ed.). 313-335. New York, NY: Routledge.

English, L. D. (1998). Children's problem posing within formal and informal contexts. *Journal for Research in Mathematics Education, 29*(1), 83-106. Available from: https://doi.org/10.5951/jresematheduc.29.1.0083.

Fathman, A. K., Quinn, M. E., & Kessler, C. (1992). *Teaching science to English learners, grades 4-8* (NCBE program information guide series, No. 11). Washington, DC: National Clearinghouse for Bilingual Education.

Finnish National Board of Education. (2016). *National Core Curriculum for Basic Education 2014.* Helsinki, Finland: Opetushallitus.

Finnish National Board of Education. (2015). The Mathematics Curriculum in Primary and Lower Secondary Grades. *TIMMS 2015 Encyclopaedia.* Retrieved 14th November 2024, from: https://bit.ly/3AmASid.

Florian, L., & Black-Hawkins, K. (2011). Exploring inclusive pedagogy. *British Educational Research Journal, 37*(5), 813–828. Available from: https://doi.org/10.1080/01411926.2010.501096.

Fromental, J.-L. (2006). *365 Penguins.* New York, NY: Abrams Books for Young Readers.

Furner, J. M. (2018). Using children's literature to teach mathematics: An effective vehicle in a STEM World. *European Journal of STEM Education*, *3*(3), 1-12. Available from: https://doi.org/10.20897/ejsteme/3874.

Fuchs, L., Fuchs, D., Seethaler, P. M., & Barnes, M. A. (2020). Addressing the role of working memory in mathematical word-problem solving when designing intervention for struggling learners. *ZDM – Mathematics Education, 52*, 87–96. Available from: https://doi.org/10.1007/s11858-019-01070-8.

Gibbs, G. (1988). *Learning by doing: A guide to teaching and learning methods*. Oxford, UK: Oxford Polytechnic.

Greene, M. (1995). *Releasing the imagination: Essays on education, the arts, and social change.* San Francisco, CA: Jossey-Bass.

Gravemeijer, K. (1994). *Developing realistic mathematics education.* Utrecht, The Netherlands: CD-β Press.

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics education, 34*(1), 37-73.

Hammersley, M. (1993). On the Teacher as a Researcher. *Educational Action Research, 1*(3), 425–445.

Harkrader, L. (2021). *Ruby Makes it Even.* New York, NY: Kane Press.

Have You Got Maths Eyes. (2017). Waikato University Launches New Maths Eyes Trail to Promote Positive Attitudes Towards Mathematics. *Have You Got Maths Eyes.* Retrieved 4th November 2024, from: https://haveyougotmathseyes.com/.

Herbert, S., & Williams, G. (2023). Eliciting mathematical reasoning during early primary problem solving, *Mathematics Education Research Journal, 35*(1), 77-103.

Hooks, B. (1994). *Teaching to Transgress: Education as the Practice of Freedom.* New York, NY: Routledge.

Hooks, B. (2010). *Teaching Critical Thinking: Practical Wisdom.* New York, NY: Routledge.

Ingram, N., Holmes, M., Linsell, C., Livy, S., & Sullivan, P. (2016). Teachers' actions that encourage students to persist in solving challenging mathematical tasks. In B. White, M. Chinnappan, & S. Trenholm (Eds*.). Opening up mathematics education research. Proceedings of the 39th annual conference of the Mathematics Education Research Group of Australasia*, 657–660. Adelaide, Australia: MERGA.

Jenkins, S. (2004). *Actual Size.* New York, NY: Clarion Books.

Jeya, A., & Albina, D. (2019). A Study of Students with Dyscalculia and Their Mathematical Abilities at Primary Schools in Karaikudi. *PEOPLE: International Journal Of Social Sciences, 4*(3), 1533-1542. Available from: https://doi.org/10.20319/pijss.2019.43.15331542.

Jones, S.A. & Seilhamer, M.F. (2019). Teaching the language of mathematics at three levels of an English-medium primary school. *Oxford Review of Education, 45*(5), 639-656.

Jordan, N. C., Glutting, J., Dyson, N., Hassinger-Das, B., & Irwin, C. (2012). Building kindergartners' number sense: A randomized controlled study. *Journal of Educational Psychology, 104*(3), 647–660. Available from: https://doi.org/10.1037/a0029018.

Jordan, N. C., & Hanich, L. B. (2000). Mathematical thinking in second-grade children with different forms of LD. *Journal of Learning Disabilities*, *33*(6), 567–578. Available from: https://doi.org/10.1177/002221940003300605.

Kaitera, S., & Harmoinen, S. (2022). Developing mathematical problem-solving skills in primary school by using visual representations on heuristics. *LUMAT, 10*(2), 111. Available from: https://doi.org/10.31129/LUMAT.10.2.1696

Kemmis, S., McTaggart, R. & Nixon, R. (2014). *The action research planner: Doing critical participatory action research* (1st ed.). Dordrecht, Netherlands: Springer.

Kemmis, S., & McTaggart, R. (1988). *The action research planner* (3rd ed.). Geelong, Australia: Deakin University Press.

Kuhn, J., & Müller, A. (2014). Context-based science education by newspaper story problems: A study on motivation and learning effects. *Perspectives in Science, 2*, 5– 21.

Kuhn, T. (1970). *The Structure of Scientific Revolutions* (2nd ed.). Chicago, IL: University of Chicago Press.

Kwon, H., & Capraro, M. M. (2021). Nurturing problem posing in young children: Using multiple representation within students' real-world interest. *International Electronic*

Journal of Mathematics Education, 16(3). Available from: https://doi.org/10.29333/iejme/11066.

LaRochelle, D. (2023). *100 Mighty Dragons all Named Broccoli.* New York, NY: Dial Books.

Landorf, H., & Wadley, C. (2022). The importance of John Dewey's philosophy for global learning theory and practice. *Social Studies Research & Practice, 17*(1), 6-18. Available from: https://doi.org/10.1108/SSRP-09-2021-0027.

Larson, L.C., & Rumsey, C. (2018). Bringing Stories to Life: Integrating Literature and Math Manipulatives. *The Reading Teacher, 71*(5), 589-596.

Leavy, A. M., & Hourigan, M. (2022). Balancing competing demands: Enhancing the mathematical problem posing skills of prospective teachers through a mathematical letter writing initiative. *Journal of Mathematics Teacher Education, 25*(3), 293-320. Available from: https://doi.org/10.1007/s10857-021-09490-8.

Lee, C. K., & Bailie, P. E. (2020). Nature-based education: Using nature trails as a tool to promote inquiry-based science and math learning in young children. *Science Activities*, *56*(4), pp.147–158. Available from: https://doi-org.may.idm.oclc.org/10.1080/00368121.2020.1742641.

Lewin, K. (1946) Action research and minority problems. *Journal of Social Issues, 2*(4), 34-46.

Li, L., & Disney, L. (2023). Young children’s mathematical problem solving and thinking in a playworld. *Mathematics Education Research Journal, 35*(1), 23-44.

Marulis, L. M., & Neuman, S. B. (2010). The effects of vocabulary intervention on young children’s word learning: A meta-analysis. *Review of Educational Research, 80*(3), 300–335. Available from: https://doi.org/10.3102/0034654310377087.

Maguire, T., O’Sullivan, C., Meehan, C., O’Mahony, J., Ryan, M., Morgan, M. & O’Donnell, C. (2023). *Developing Maths Eyes: A Resource Pack.* Dublin, Ireland: Dublin West Education Centre.

Maguire, T. (2003). *Engendering Numeracy in Adults, Mathematics Education with a Focus on Tutors: A Grounded Approach*, (Unpublished doctoral dissertation). Limerick, Ireland: University of Limerick.

Makar, K., & Fielding-Wells, J. (2018). Shifting more than the goal posts: Developing classroom norms of inquiry-based learning in mathematics. *Mathematics Education Research Journal, 30*(1), 53-63. Available from: https://doi.org/10.1007/s13394-017-0215-5.

McDonagh, C., Roche, M., Sullivan, B., & Glenn, M. (2012). *Enhancing Practice through Classroom Research: A teacher's guide to professional development.* Abingdon, UK: Routledge.

McDonagh, C. (2019). *Enhancing practice through classroom research: A teacher's guide to professional development* (2nd ed.). Abingdon, UK: Routledge. Available from: https://doi.org/10.4324/9780203146200.

McLaughlin, C. (2004). Partners in Research: What's in it for You? *Teacher Development, 8*(2-3), 127–136.

McNamara, M. (2007). *How many seeds in a Pumpkin?* New York, NY: Schwartz & Wade Books.

McNiff, J., & Whitehead, J. (2011). *All you need to know about action research.* London, UK: Sage.

McNiff, J. (2002). *Action research: Principles and practice* (2nd ed.). London, UK: Routledge Falmer.

McNiff, J. (1988). *Action research: Principles and practice.* London, UK: Routledge.

Mercer, N. (1995). *The guided construction of knowledge: Talk amongst teachers and learners.* Clevedon, UK: Multilingual Matters.

Mercer, N., & Sams, C. (2006). Teaching children how to use language to solve maths problems. *Language and Education*, *20*(6), 507–528. Available from: https://doi.org/10.2167/le678.0.

Midgley, C. (2013). *Goals and goal structures in the classroom: Motivation and achievement.* New York, NY: Springer.

Ministry of Education. (2007). *The New Zealand Curriculum.* Wellington, New Zealand: Learning Media.

Morrison, K. (2013). Interviewing children in uncomfortable settings: Ten lessons for effective practice. *Educational Studies, 39*(3), 320–337.

Murphy, C. (2015). Changing teachers' practices through exploratory talk in mathematics: A discursive pedagogical perspective. *The Australian Journal of Teacher Education*, *40*(5). Available from: https://doi.org/10.14221/ajte.2015v40n5.4.

Murphy, S. (2006). *Shark Swimathon.* New York, NY: HarperCollins.

Myhill, D., & Fisher, R. (2005). *Talking, listening, learning: Effective talk in the primary classroom*. Maidenhead, UK: Open University Press.

Myller, R. (1991). *How Big is a Foot?* New York, NY: Dell Publishing.

National Council for Curriculum and Assessment (NCCA). (2023). *Supporting the Development of Maths Eyes at Home and in the Community, Draft Primary Mathematics Curriculum – Support Materials.* Retrieved 20th February 2025, from: https://ncca.ie/media/5468/6-supporting_the_development_maths_eyes_home.pdf.

National Council for Curriculum and Assessment (NCCA). (2016). *Primary language curriculum: English and Gaeilge (junior infants to second class)*. Retrieved 3rd March 2025, from: https://curriculumonline.ie

National Council for Curriculum and Assessment (NCCA). (n.d.). *Senior infants maths: Tipsheet for parents*. Retrieved 14th March 2025, from: https://ncca.ie/media/4892/senior-infants-maths-tipsheet-for-parents.pdf

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics.* Washington, DC: NGA Center & CCSSO.

NRICH. (2019). *Creating a Low Threshold High Ceiling Classroom.* Available from: https://bit.ly/40NP8vp.

Nuraini, N. L. S., Cholifah, P. S., Mahanani, P., & Meidina, A. M. (2020). Critical Thinking and Reflective Thinking Skills in Elementary School Learning. *Advances in Social Science, Education and Humanities Research, 487.*

Oide. (n.d.). *Micro Maths: A classroom-based assessment support resource*. Retrieved 13th March 2025, from: https://pmc.oide.ie/resources/micro-maths/.

Onesti, M., Uscianowski, C., & Mazzocco, M. M. (2022). Extending the Math in Picture Books. *YC Young Children, 77*(3), 42–49. Retrieved April 15th 2025, from: https://www.jstor.org/stable/27185938.

Osman, S., Yang, C. N., Abu, M. S., Ismail, N., Jambari, H., & Kumar, J. A. (2018). Enhancing Students' Mathematical Problem-Solving Skills through Bar Model Visualisation Technique. *International Electronic Journal of Mathematics Education, 13*(3), 273-279. Available from: https://doi.org/10.12973/iejme/3919.

Patterson, E. W. (2016). Exploratory talk in early years: analysing exploratory talk in collaborative group activities involving younger learners. *Education 3-13, 46*(3), 264-276. Available from: https://doi-org.may.idm.oclc.org/10.1080/03004279.2016.1243141.

Piaget, J. (1952). *The origins of intelligence in children.* New York, NY: International Universities Press.

Pinczes, E. J., & MacKain, B. (1993). *One Hundred Hungry Ants.* Boston, MA: Houghton Mifflin.

Professional Development Service for Teachers (PDST). (2024). *Numeracy, Numeracy Link Teacher, Mathematical Language.* Dublin, Ireland: PDST.

Pollard, A. (2011). The Role of Reflection in Teaching and Teacher Development. In *Reflective Teaching in the Primary School: A Handbook for New Teachers* (pp. 32-50). London, UK: Continuum.

Pozas, M., Löffler, P., Schnotz, W., & Kauertz A. (2020). The Effects of Context-based Problem-solving Tasks on Students' Interest and Metacognitive Experiences. *Open Education Studies, 2.* 112-125. Available from: https://doi.org/10.1515/edu-2020-0118.

Pratiwi, S. A., & Widjajanti, D. B. (2020). Contextual problem in mathematical problem solving: Core ability in realistic mathematics education. *Journal of Physics. Conference Series, 1613*(1), 012018. Available from: https://doi.org/10.1088/1742-6596/1613/1/012018.

Purpura, D. J., Napoli, A.R., Wehrspann, E. A., & Gold, Z. S. (2016). Causal Connections Between Mathematical Language and Mathematical Knowledge: A Dialogic Reading Intervention. *Journal of Research on Educational Effectiveness*, *10*(1), 116–137. Available from: https://doi-org.may.idm.oclc.org/10.1080/19345747.2016.1204639.

Riccomini, P. J., Smith, G. W., Hughes, E. M., & Fries, K. M. (2015). The language of mathematics: The importance of teaching and learning mathematical vocabulary. *Reading & Writing Quarterly, 31*(3), 235-252. Available from: https://doi.org/10.1080/10573569.2015.1030995.

Robins, R. (n.d.). *1st grade maths slides*. Unpublished teaching resource. Retrieved 20th January 2025, from: https://docs.google.com/document/d/10_1PIAB86wH0JKrNgX06svdJMjZHdH4BgMpBuKBAjFs/edit?tab=t.0.

Ross, T. (2003). *Centipede's 100 Shoes.* New York, NY: Henry Holt and Company.

Santos, F. H. (2021). Intervention for children with developmental dyscalculia. In D. Lucangeli (Ed.), *Understanding Dyscalculia: A guide to symptoms, management, and treatment*, pp. 65-93. New York, NY: Routledge.

Schoenfeld, A. H. (1985). *Mathematical problem solving.* Orlando, FL: Academic Press.

Shaw, S., Brady, G., & Davey, C. (2011). *Valuing children's participation in research: A UK study.* London, UK: The Children's Society.

Sherman, K., & Gabriel, R. (2017). Math Word Problems: Reading Math Situations From the Start. *The Reading Teacher*, *70*(4), 473–477. Retrieved 10th November 2024, from: http://www.jstor.org/stable/26632490.

Sherman, D., & Gabriel, R. (2017). Mathematics and the body: How sensory experiences influence learning. *Journal of Mathematics Education, 10*(2), 101–115.

Shrum, D. (2019, April 4). *Empower students through individual conferences. ASCD Express, 14*(22). Retrieved 10th April 2025, from: https://www.ascd.org/el/articles/empower-students-through-individual-conferences.

Sianturi, I. A. J. (2024). Teachers' beliefs on integrating children's literature in mathematics teaching and learning in Indonesia. *Educational Studies in Mathematics,* 117, 97–119. Available from: https://doi.org/10.1007/s10649-024-10334-4.

Silver, E. A. (1985). Teaching mathematical problem solving. In T. P. Carpenter, J. M. Moser, & T.A. Romberg (Eds.), *Perspectives on research on effective mathematics teaching,* pp. 251-276. Hillsdale, NJ: Lawrence Erlbaum Associates.

Skelton, J. (2022). Deepening conceptual understanding through story. *Mathematics Teaching*, *280,* 11-15.

Smith, A. (2022). Math Vocabulary Words Are Important: Here's How to Teach Them. *TeachStarter Part of Tes*. Retrieved 1st November 2024, from: https://www.teachstarter.com/gb/blog/math-vocabulary-words-how-teach/.

Stewart, E., & Ball, L. (2024). The Tension Between Allowing Student Struggle and Providing Support When Teaching Problem-Solving in Primary School Mathematics. *Canadian Journal of Science, Mathematics and Technology Education, 23*. Available from: https://doi.org/10.1007/s42330-024-00309-1.

Stites, M. L., & Sonnenschein, S. (2020). Using Storybooks to Support Young Children's Mathematics Learning at School and Home. In Bekir, H., Bayraktar, V., & Karaçelik S. N. (Eds.), *Development, and Education*. Kaunas, Lithuania: Strategic Research Academy.

Sullivan, B., Glenn, M., Roche., M., & McDonagh C. (2016). *Introduction to Critical Reflection and Action Research for Teacher Researchers.* London, UK: Routledge.

Sullivan, P., Borcek, C., Walker, N., & Rennie, M. (2016). Exploring a structure for mathematics lessons that initiate learning by activating cognition on challenging tasks. *Journal of Mathematical Behavior, 41*, 159–170. Available from: https://doi.org/10.1016/j.jmathb.2015.12.002.

Trakulphadetkrai, N. (n.d.). *Maths through stories.* Retrieved 8th November 2024, from: https://www.mathsthroughstories.org/

Tusla. (n.d.). *Guidance for research participants under the age of 18.* Tusla. Retrieved 28th October 2024, from: https://www.tusla.ie/research/tusla-research-office/guidance-for-research-participants-under-the-age-of-18/.

Vanluydt, E., Supply, A., Verschaffel, L., & Van Dooren, W. (2021). The importance of specific mathematical language for early proportional reasoning. *Early Childhood Research Quarterly, 55*, 193-200. Available from: https://doi.org/10.1016/j.ecresq.2020.12.003

Van Oers, B. (2010). The emergence of mathematical thinking in the context of play. *Educational Studies in Mathematics, 74*(1), 23-37. Available from: https://doi.org/10.1007/s10649-009-9225-x.

Viesel-Nordmeyer, N., Ritterfeld, U., & Bos, W. (2021). Acquisition of mathematical and linguistic skills in children with learning difficulties. *Frontiers in Psychology, 12.* Available from: https://doi.org/10.3389/fpsyg.2021.793796.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wallace, N. E. (2024). *Ready, Set, 100th Day.* Seattle, WA: Two Lions Publishers.

Whitehead, J., & McNiff, J. (2006). *Action research: Living theory*. London, UK: SAGE Publications.

Whitehead, J. (2021, November 17th). How might people begin to do Living Educational Theory research? What is a 'living contradiction'? [Video]. YouTube. Retrieved 15th November 2024, from: https://www.youtube.com/watch?v=ef4DYlYN0NA.

Whitehead, J. (1989). *Creating a living educational theory from questions of the kinds, "How do I improve my practice?"* Bath, UK: University of Bath.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem-solving. *Journal of Child Psychology and Psychiatry, 17*(2), 89-100. Available from: https://doi.org/10.1111/j.1469-7610.1976.tb00381.x.

Zhang, L., Stylianides, G. J., & Stylianides, A. J. (2024). Enhancing mathematical problem posing competence: A meta-analysis of intervention studies. *International Journal of STEM Education, 11*(1). Available from: https://doi.org/10.1186/s40594-024-00507-1.

Ziadat, A. H. (2022). Sketchnote and working memory to improve mathematical word problem solving among children with dyscalculia. *International Journal of Instruction, 15*(1), 509-526. Available from: https://doi.org/10.29333/iji.2022.15129a.

Appendices

Appendix A: Ethics Approval Application Form for Master of Education (Research in Practice)

Student name:	Ciaran Michael Sweeney
Student Number:	24253841
Supervisor:	Patsy Stafford
Programme:	Master of Education (Research in Practice)
Thesis title:	Self-Study Action Research
Research Question(s):	How do I refine my practice to improve my approach to fostering mathematical problem-solving in my classroom?/ How can I implement effective strategies to support children's use of mathematical language and their problem-solving skills in my First Class classroom?
Intended start date of data collection:	6th January 2024
Professional Ethical Codes or Guidelines used:	British Educational Research Association (2004) *Revised Ethical Guidelines for Educational Research,* BERA: Notts. Maynooth University (2016) *Research Ethics Policy and Research Integrity Policy,* Maynooth University: Kildare. DCYS Guidance for Developing Ethical Research Projects Involving Children (April 2012).

1(a) Research Participants: Who will be involved in this research:

	TICK ALL THAT APPLY
Early years / pre-school	
Primary school pupils	X
Secondary school students	
Young people (aged 16 – 18 years)	
Adults	X

The individuals directly involved in my research study will be twenty-one First Class children. The children's parents or guardians will be involved in the acquisition of consent and data collection process.

A critical friend and validation group will be involved in the data collection process. Other individuals involved in the permission process will be the school principal, the Board of Management, and Maynooth University.

(250 words max):

1(b) Recruitment and Participation/sampling approach:

I will make a verbal request to conduct the research study to the principal. I will send a letter to the school's Board of Management to seek their permission to carry out my research project with my class.

The children will be active, ongoing participants in the research process. Parents will play a key role in providing consent and will also be involved during the data collection. I will have initial conversations with parents to inform them about the action research project. A letter explaining the details of the action research study will be sent home, accompanied with an information sheet outlining how their children will be involved, and a parent consent form. Children will provide informed assent by signing a child-friendly consent form that explains their participation in the research. Parents and children will have the option to withdraw from the study at any time until the data is anonymized, with an "opt-out" provision available throughout the research process up until the 30th of April 2025.

I plan to avail of a critical friend who will complete reflective templates based on their observations throughout the data collection process.

The research will take place in a co-educational national school with a Catholic Ethos. It is a junior school catering for Junior Infants up to Second Class. There are approximately 350 pupils in the school and fifteen mainstream classes.

The aim of my research is to identify effective supports and strategies that I can implement in the classroom to promote mathematical problem-solving skills. I aim to enhance my own teaching practice and deepen my understanding of how to create a learning environment that fosters the development of children's mathematical problem-solving.

2. Summary of Planned Research

My proposed research question is: "How do I refine my practice to improve my approach to fostering mathematical problem-solving in my classroom?". I plan to use a research-in-practice approach that, specifically self-study, that is guided by a selection of action research models as my chosen methodology. This approach will be guided by my epistemological and ontological values, which include making connections, inclusion, and learning for the real-world.

The data I will collect will be qualitative. My data sources will involve artefacts and information from participants. Additionally, all data will be treated as confidential and stored securely, in accordance with Maynooth University's guidance on General Data Protection Regulation (GDPR).

My data collection tools will consist of:

- A reflective journal
- Observations
- Photographs of children's work samples on whiteboards
- Transcripts of interviews
- Transcripts of conversations
- Analysis of children's drawing/worksheets/activities
- Teacher questionnaires/surveys

I have decided on these data collection tools as I believe they will be most relevant to my research question, and they will allow for the triangulation of data. My data collection will begin on the 6th of January 2025. My final edition of my research project will be submitted on the 12th of September 2025.

3. Ethical Issues:

There are ethical considerations to address while conducting my research. These include reflecting on my professional ethical values, my responsibilities to pupils and parents, my obligations to the university, and any legal requirements should I choose to make my research public. I must ensure to comply with relevant school policies, data protection guidelines, and child safeguarding guidelines.

I must gain permission from the following individuals/bodies:

- The twenty-one children in my class.
- The parents/guardians of the children in my class.
- The school principal.
- The Board of Management.
- The University (Maynooth University).
- The class Special Needs Assistant.
- The critical friends I have chosen (validation group).

It is important to keep the identities of the individual children, teachers, my validation group, and the school anonymous. As I am working with First Class, and the children are still relatively young (six/seven years old), consent may pose an ethical challenge. I look to overcome this by seeking informed and voluntary consent from their respective parents/guardians. I will also ensure that my research ideas are communicated in a manner that is accessible to the children, through child-friendly language supported by visual aids to show them how they will participate. I will explain that the research is not about testing them, but rather about helping me improve my teaching practice. I will keep the children informed about when data collection is taking place, I will use visual cues, such as a “research on” and “research off” sign.

Data will be stored in a secure, encrypted location. Hard copies will be filed in a key protected locked filing cabinet. Soft copies will be kept in a password protected online folder using the OneDrive programme.

Vulnerability

I will make every effort to minimize risks given that children can find aspects of mathematics and problem-solving difficult. I will offer appropriate support to all participants and seek guidance from my colleagues. Where possible, I will try to ensure that data collection is taking place during a time when I have an in-class support teacher present in the room, allowing me to remove a child if necessary and address any issues on a one-to-one basis.

As the researcher, this self-study will impact both my professional development and my relationships with my colleagues. I intend to approach the research with a positive mindset, especially when encountering unforeseen outcomes. I have built a strong rapport with my colleagues and plan to keep them fully informed throughout the research process.

Power dynamics

I will address power dynamics by adopting a democratic approach with both participants and colleagues. Given that I am working with young children, I have created a safe, supportive learning environment to help them feel comfortable during the research. Children will have the option to “opt-out” at any point if they no longer wish to participate, and I will remind them that the research is voluntary and they do not need to share anything that they are uncomfortable with. Throughout the research, I will reflect on my values, assumptions, and actions, while maintaining an open, respectful approach in line with the school’s “open-door” policy.

Informed consent and assent

I will ensure that consent and assent is provided voluntarily and fully informed of the components of my self-study action research project.

I will gain approval from the following individuals and bodies:

- The twenty-one children in my class through a child-friendly language assent form. Children's assent will be ongoing throughout the research through my observation of verbal and non-verbal cues throughout the action research process. Ethical radars are necessary throughout the research process, as the children at this age will have other ways of expressing acceptance and rejection/withdrawal than just verbally.
- The parents/guardians of the children in my class through an explanation letter, an information sheet and a parent consent form.
- The school principal through a verbal request.
- The Board of Management through a letter outlining my action research project and a signature of consent attached.
- Maynooth University through my ethics proposal form.

Sensitivity

Mathematical problem-solving can be a difficult skill for children to develop, and the children have the right to withdraw from the research at any time if they feel uncomfortable or upset. My in-class support teacher will be present during data collection to support me in addressing any issues that may arise in the classroom. I will approach any unexpected outcomes with a positive, solution-focused mindset.

Data storage

All data collected will be directly relevant to my research and used solely for personal analysis and, if necessary, to be reviewed by my research examiner. It will be stored securely in compliance with ethical standards and GDPR guidelines. Online data will be saved in an encrypted OneDrive folder, while physical copies will have personal identifiers removed and stored in a locked filing cabinet. If data needs to be transferred, it will be done via a password-protected USB, stored in a locked drawer. Data will be retained for the required period and destroyed according to Maynooth University guidelines.

Declaration

Ciaran Sweeney 24253841

‘I confirm that to the best of my knowledge this is a full description of the ethical issues that may arise in the course of undertaking this research.’ If any of the conditions of this proposed research change, I confirm that I will re-negotiate ethical clearance with my supervisor.

Signed: Ciaran Sweeney **Date:** 20th November 2024

Attachments: *Please attach information letters, consent forms and other materials that will be used to inform potential participants about this research.*

Appendix B: Checklist for Students

Please complete the checklist below to confirm you have considered all ethical aspects of your research. (Note that the consent form/s, assent form/s and information sheet/s that must accompany this application will be scrutinised and any omission or inadequacy in detail will result in a request for amendments).	**Please tick**
I have attached (an) appropriate consent form/s, assent form/s and/or information sheet/s	●
Each form and sheet is presented to a high standard, as befitting work carried out under the auspices of Maynooth University	●
Each consent form has full contact details to enable prospective participants to make follow-up inquiries	●
Each consent form has full details, in plain non-technical language, of the purpose of the research and the proposed role of the person being invited to participate	●
Each consent form has full details of the purposes to which the data (in all their forms: text, oral, video, imagery etc.) will be put, including for research dissemination purposes	●
Each consent form explains how the privacy of the participants and their data will be protected, including the storage and ultimate destruction of the data as appropriate	●
Each consent form gives assurances that the data collection (questionnaires, interviews, tests etc.) will be carried out in a sensitive and non-stressful manner, and that the participant has the right to cease participation at any time and without the need to provide a reason	●
Please include here any other comments you wish to make about the consent form(s) and/or information sheet/s.	●

Appendix C: Information Letter for Parents/Guardians

Maynooth University Froebel Department of Primary and Early Childhood Education
Roinn Froebel Don Bhun- agus Luath-Oideachas Ollscoil Mhá Nuad.

Dear Parent(s)/Guardian(s),

I am a student on the Master of Education programme at Maynooth University. As part of my degree, I am doing a research project. The focus of my research is based on teaching strategies that support children's mathematical problem-solving and whether this leads to an application of mathematics outside the confines of a mathematical lesson.

In order to do this, I intend to carry out research in the classroom by exploring a variety of teaching strategies that are aimed at developing children's problem-solving, mathematical language, and maths eyes.

The data will be collected using observations, a daily teacher journal, and photographs of the children's work which will remain anonymous. The children will be asked their opinions through discussing how the different teaching strategies have enhanced/hindered their ability to mathematically problem-solve. I will record these anecdotal conversations in my reflective journal and keep the children's anonymity in the process.

The child's name and the name of the school will not be included in the thesis that I will write at the end of the research. Your child will be allowed to withdraw from the research process at any stage up until the data is anonymized. An "opt-out" provision will be available throughout the research process up until the 30th of April 2025.

All information will be confidential, and information will be destroyed in a stated timeframe in accordance with the University guidelines. Findings in the data analysis may be used in journal articles, conferences, and further research papers but the information will keep all children's anonymity. The correct guidelines will be complied with when carrying out this research. The research will not be carried out until approval is granted by the Froebel Department of Primary and Early Childhood Education.

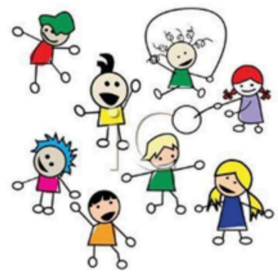
I would like to invite you and your child to give permission for him/her to take part in this project.

If you have any queries on any part of this research project, feel free to contact me by email at: ciaran.sweeney.2025@mumail.ie

Yours faithfully, Ciaran Sweeney.

Appendix D: Information Letter for Child

Maynooth University
National University of Ireland Maynooth



Child's name …………………….

I am trying to find out how children solve maths problems in primary school. I would like to find out activities teachers do in the classroom that help children solve maths problems. I would like to watch you and listen to you when you are in school and to write down some notes about you.

Would you be ok with that? Circle one. YES NO

I have asked your Mam or Dad or Guardian to talk to you about this. If you have any questions, I would be happy to answer them. If you are happy with this, could you sign the form that I have sent home?

If you change your mind after we start, that's ok too.

Appendix E: Information Sheet for Parents/Guardians

Maynooth University
National University
of Ireland Maynooth

Maynooth University Froebel Department of Primary and Early Childhood Education

Roinn Froebel Don Bhun- agus Luath-Oideachas

Ollscoil Mhá Nuad.

Information Sheet
Parents and Guardians

Who is this information sheet for?

This information sheet is for parents and guardians.

What is this Action Research Project about?

A teacher undertaking the Master of Education in the Froebel Department of Primary and Early Childhood Education at Maynooth University, is required to conduct an action research project, examining an area of their own practice as a teacher. This project will involve an analysis of the teacher's own practice. Data will be generated using observation, reflective notes and questionnaires. The teacher is then required to produce a thesis documenting this action research project.

What are the research questions?

"How do I refine my practice to improve my approach to fostering mathematical problem-solving in my classroom?".

What sorts of methods will be used?
Observations, a reflective journal, photographs of children's work on whiteboards, transcripts of interviews, transcripts of conversations, analysis of children's drawing/worksheets/written activity, teacher questionnaires/surveys, photos for spotting maths in the home newsletter etc.

Who else will be involved?

The study will be carried out by myself as part of the Master of Education course in the Froebel Department of Primary and Early Childhood Education. The thesis will be submitted for assessment to the module leaders, Prof. Marie McLoughlin and Dr Suzanne O'Keeffe and will be examined by the Department staff. The external examiners will also access the final thesis.

What are you being asked to do?

You are being asked for your consent to permit me to undertake this study with my class. In all cases the data that is collected will be treated with the utmost confidentiality and the analysis will be reported anonymously. The data captured will be used for the purpose of the research as part of the Master of Education in the Froebel Department, Maynooth University and will be destroyed in accordance with university guidelines. The data may be used in future research journals, articles, and conferences with all data keeping participants anonymous.

Contact details: Student: Ciaran Sweeney *E: ciaran.sweeney.2025@mumail.ie*

Appendix F: Consent Form for Parents/Guardians

Maynooth University Froebel Department of Primary and Early Childhood Education
Roinn Froebel Don Bhun- agus Luath-Oideachas
Ollscoil Mhá Nuad.

Parental/Guardian Consent Form

I have read the information provided in the attached letter and all of my questions have been answered. I voluntarily agree to the participation of my child in this study. I am aware that I will receive a copy of this consent form for my information.

Parent / Guardian Signature: ______________________

Parent / Guardian Signature: ______________________

Date:

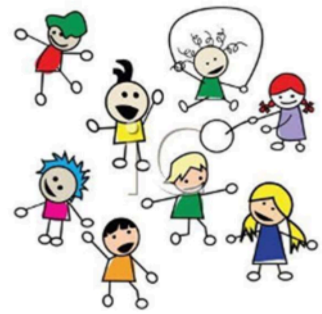
Name of Child: ________________________

Child’s signature: ______________________

Date:

Appendix G: Child's Assent Form

Maynooth University
National University of Ireland Maynooth



Child's assent to participate

My parent/guardian has read the information sheet with me and I agree to take part in this research.

Name of child (in block capitals): ___________________

Signature: ___________________

Date: ___________________

Appendix H: Board of Management Approval Letter

Maynooth University Froebel Department of Primary and Early Childhood Education
Roinn Froebel Don Bhun- agus Luath-Oideachas
Ollscoil Mhá Nuad.

Date: 20/11/2024

Dear Board of Management members,

As some of you are aware I have recently started a Master's in Education (Research in Practice) in Maynooth University. I am writing to request permission to conduct a research study in my First Class classroom.

The research is a self-study action research project where I investigate my own teaching and aim to improve my practice. I will be studying mathematics education in my classroom, with a focus on teacher strategies that enhance/hinder mathematical problem-solving.

I will explain the research to the children in my class and ask for consent from parents and children for data to be collected in the classroom. Data will be collected through a reflective journal, observations, photographs of children's work on whiteboards, transcripts of interviews, transcripts of conversations, analysis of children's drawing/worksheets/activities, teacher questionnaires/surveys, and spotting maths in the home newsletter. All data collected will be anonymised. Children's names and the name of the school will not be mentioned in the research as confidentiality and data protection procedures will be strictly followed.

All children are welcome to participate and can choose whether data will be collected from them. As the research will take part as part of our normal mathematics lessons the children will not be impacted in any way if they choose not to take part.

I hope to share the results of the research with my colleagues on the staff of St. Attracta's Junior National School to help our school develop in relation to teaching mathematics.

Thank you for taking the time to read my letter and feel free to contact me at ciaran.sweeney.2025@mumail.ie if you have any queries about the research.

If you agree, kindly sign below and return a copy of the signed form.

Yours Faithfully,

Ciaran Sweeney.

Approved by:

___________________________	________________________	____________
Print name	Signature	Date

Appendix I: Critical Friend Information Sheet

Maynooth University Froebel Department of Primary and Early Childhood Education
Roinn Froebel Don Bhun- agus Luath-Oideachas Ollscoil Mhá Nuad.

Information Sheet

Who is this information sheet for?
This information sheet is for my critical friends, teaching colleagues, and members of the validation group.

What is this Action Research Project about?
Teachers engaging in the Master of Education (Research in Practice) in the Froebel Department of Primary and Early Childhood Education, Maynooth University are required to conduct a self-study action research project, examining an area of our own teaching practice. Data will be generated using reflective journal, observations, photographs of children's work on whiteboards, transcripts of interviews, transcripts of conversations, analysis of children's drawing/worksheets/activities, teacher questionnaires/surveys, and spotting maths in the home newsletter. The teacher is then required to produce a thesis documenting this action research project.

What is the research question?
How do I refine my practice to improve my approach to fostering mathematical problem-solving in my classroom?

What sorts of methods will be used?
A reflective journal, observations, photographs of children's work on whiteboards, transcripts of interviews, transcripts of conversations, analysis of children's drawing/worksheets/activities, teacher questionnaires/surveys, and spotting maths in the home newsletter.

Who else will be involved?
The study will be carried out by myself, Ciaran Sweeney, as part of the Master of Education (Research in Practice) course in the Froebel Department of Primary and Early Childhood Education, Maynooth University. The thesis will be submitted for assessment to the module leaders, Prof. Marie McLoughlin and Dr Suzanne O'Keeffe and will be examined by the department staff. External examiners will also access the final thesis.

What are you being asked to do?

You are being asked to consent to permit me using the feedback you provide as data on the research. The data will be treated with the utmost confidentiality and the analysis of this data will be reported anonymously on the thesis. The data will be used for the purpose of the research as part of the Master of Education (Research in Practice) in the Froebel Department, Maynooth University and will be destroyed in accordance with Maynooth University's guidelines. The final thesis will be published in accordance with Maynooth University's guidelines and a copy will be available to you upon request. The data may be used in future research journals, articles, and conferences with all data keeping participants anonymous.

Student name: Ciaran Sweeney **email:** ciaran.sweeney.2025@mumail.ie

Appendix J: Critical Friend Consent Form

Maynooth University Froebel Department of Primary and Early Childhood Education
Roinn Froebel Don Bhun- agus Luath-Oideachas
Ollscoil Mhá Nuad.

Consent Form

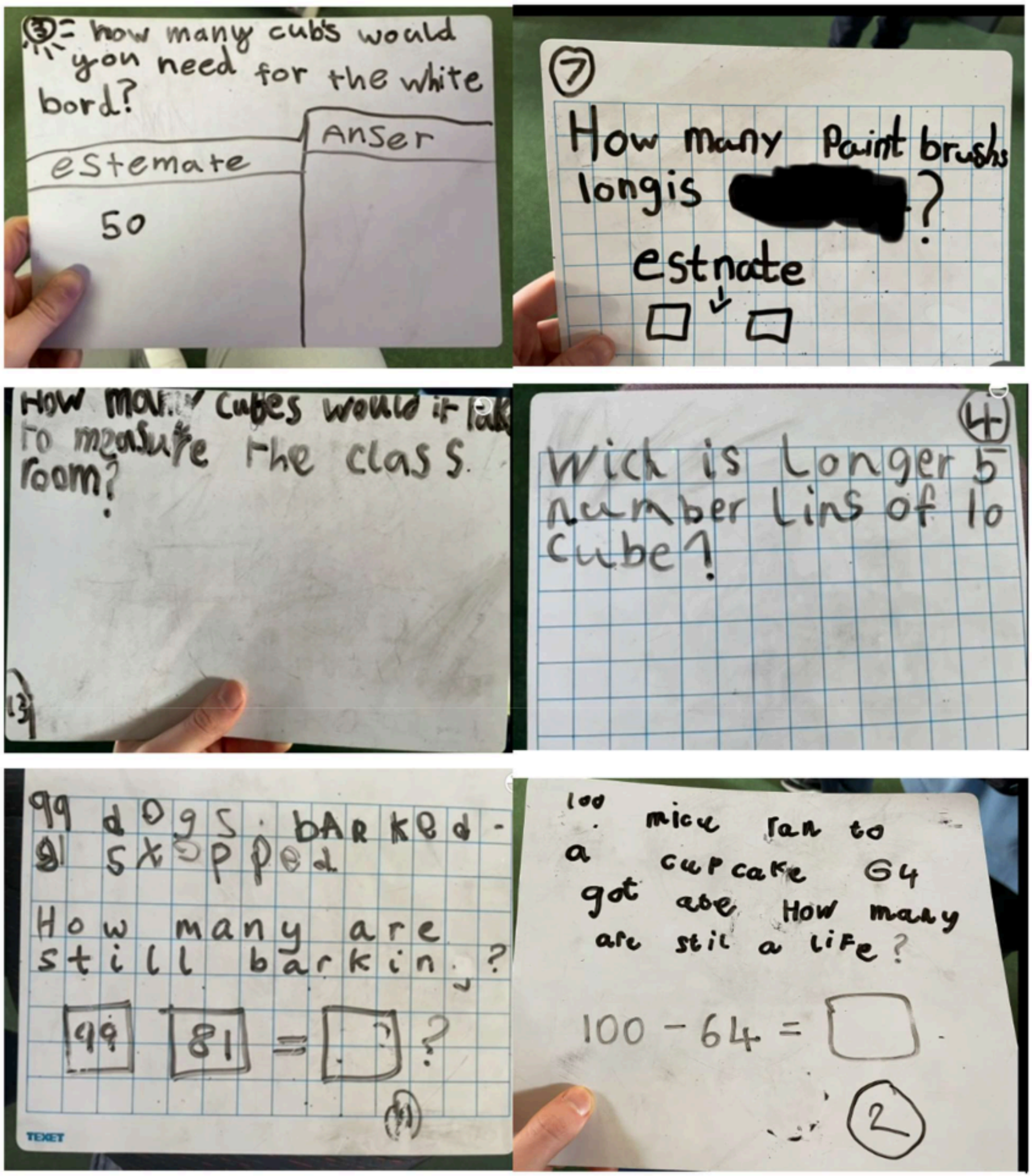
I have read the information provided in the attached letter and the researcher (Ciaran Sweeney) has answered all of my questions. I voluntarily agree that my feedback on the research can be used as a source of data. I am aware that I will receive a copy of this consent form for my own records.

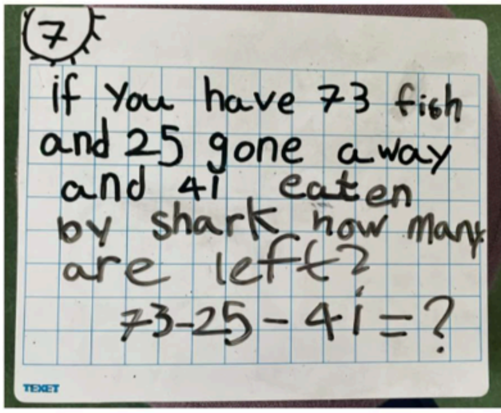
Name: ________________________

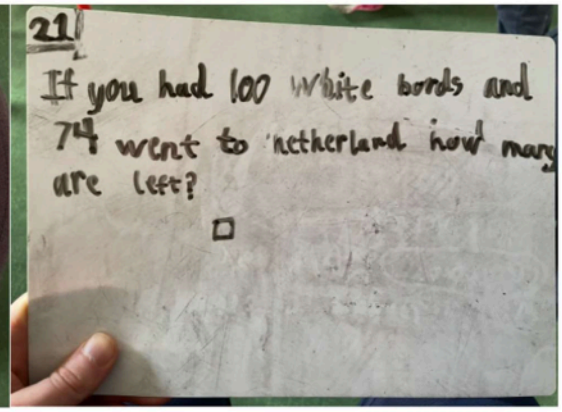
Signature: _____________________

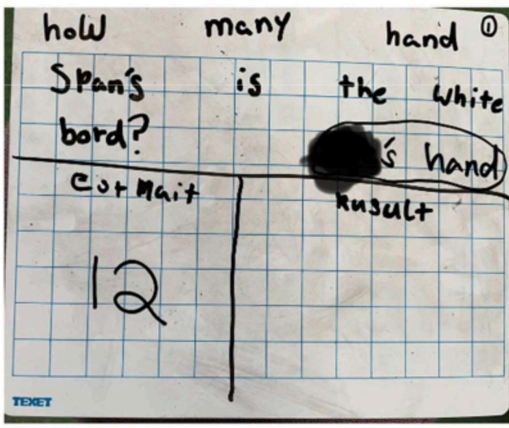
Date: _________________________

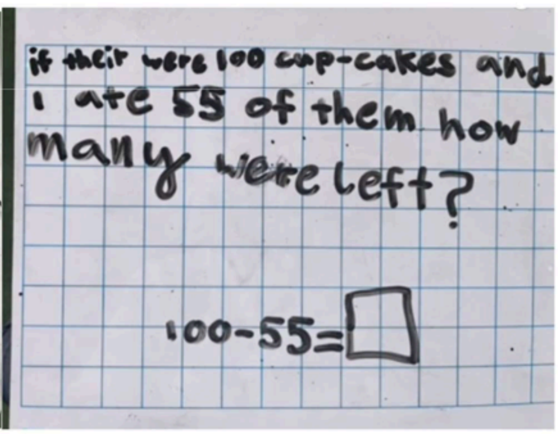
Appendix K: Examples of Children's Word Problems

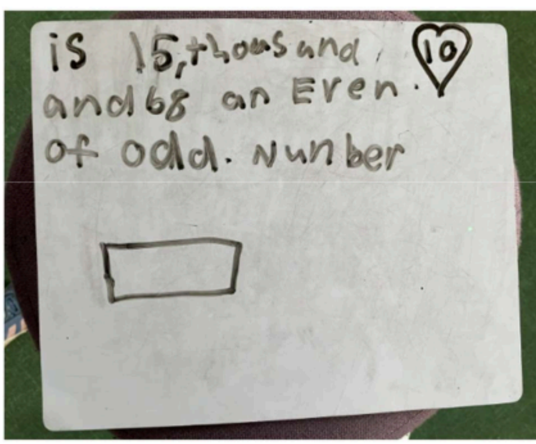


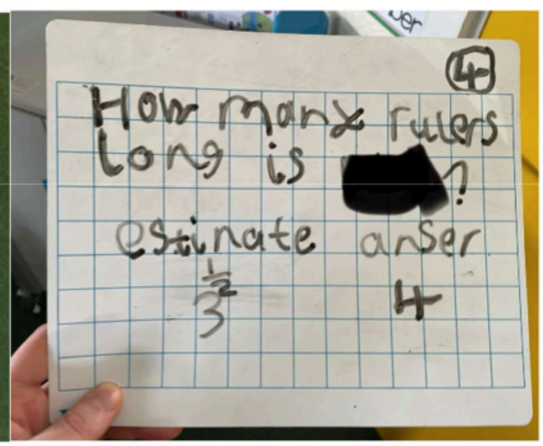

7
if You have 73 fish and 25 gone away and 41 eaten by shark how many are left?
73-25-41=?
TEXET


21
If you had 100 white bords and 74 went to netherland how many are left?


how many hand span's is the white bord?
1
[redacted]'s hand
Rusult
12
TEXET


if their were 100 cup-cakes and I ate 55 of them how many were left?
100-55=


10
is 15,thousand and 68 an Even of odd nunber


4
How many rulers long is [redacted]?
estinate
anser
3½
4

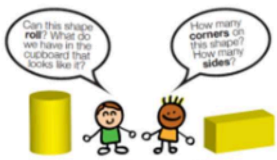
Appendix L: NCCA Maths Talk at Home Information Sheet for Parents

primary developments

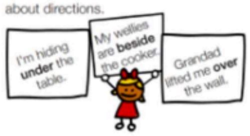
INFORMATION FOR PARENTS

3. Talking about shapes and directions

When we talk about shapes we talk about **edges, corners, straight sides, curved sides, round and flat shapes**. Look at boxes in your cupboard – what shapes are they? What shapes can you see around the house? Out on the street?

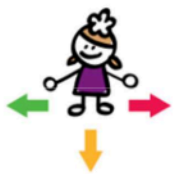


Do you ever find yourself asking your child: *Where are you?* or *Where did you put your lunchbox?* Talking about **directions** is also an important part of maths. Below are some examples of the words children use when learning about directions.



Try hiding an object like a teddy and ask your child to find it by giving directions. Then ask your child to give directions to you so you can find Teddy.

Many children have play mats for their toys – ask your child to tell you how to get from the fire station to the school. Pretend you don't understand unless you get precise directions, for example *first you turn left, then you walk along the street and turn right….*



See **www.ncca.ie/parents** for more information including video clips.

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F +353 1 661 7180
E info@ncca.ie
W www.ncca.ie

NCCA

primary developments

INFORMATION FOR PARENTS

→ Parents → Primary → Junior and senior infants

Helping your child with maths in SENIOR INFANTS

Have you ever thought about how much maths is part of your child's conversations?

Maths is everywhere around us and is part of your child's daily life. You can help your child understand and enjoy maths through simple games and everyday activities.

About this tip sheet

There are three sections in this tip sheet.

1: **What your child is learning in school** tells you about the maths your child will learn in senior infants.

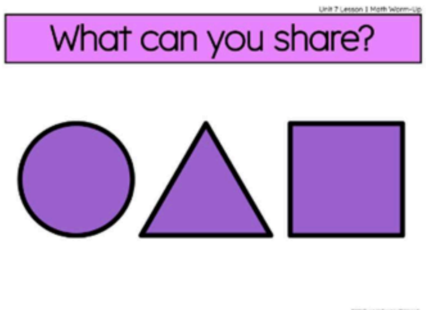
2: **How your child learns at home** gives you tips to help your child with maths. You can watch short video clips with further suggestions by visiting **www.ncca.ie/parents**.

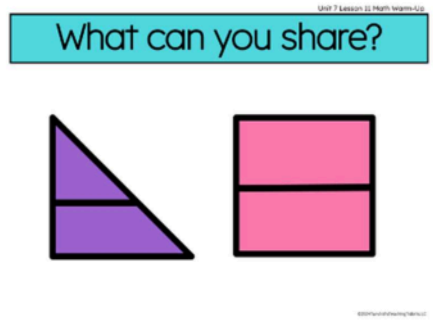
3: **Talking about shapes and directions** gives you examples of the language you can use when helping your child with maths.

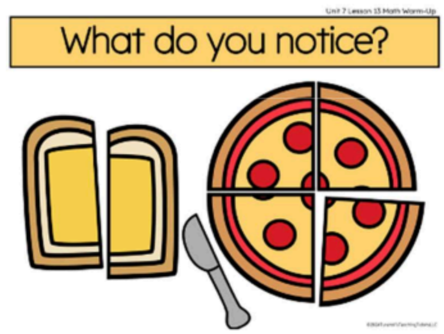
You can look for more ideas in the tip sheets and videos for junior infants and first class.

Appendix M: Maths Talk Homework Sheet for Students

Week of 6th May 2025







Appendix N: Always, Sometimes, Never Oide (n.d.) Activity

Oide

Always, Sometimes, Never

Breakfast is eaten in the morning	A clock has three hands.
Monday is the first day of the week.	There are 5 seasons in the year.
Summer begins on the 1st of June	I always go to bed when it's dark.

Adapted from https://nrich.maths.org/14023

3

Appendix O: Teacher Problem-Solving Questionnaire

Problem-Solving in Mathematics Teacher's Survey

1. **What approaches to teaching mathematics support children developing as problem-solvers in your classroom?**

____

____

____

2. **How do you promote the use of mathematical language in your maths lessons?**

____

____

____

3. **Have you used maths picture books to support the development of mathematical language and mathematical eyes in your classroom before?**

Yes O No O

4. **If you answered yes to the above question, what class level did you use the maths picture books for?**

____

5. **Do you think maths picture books could be a useful resource for children creating their own word problems in 1st class?**

Yes O No O

6. **Could you share a reason why you think it would or would not be a useful resource in supporting the children creating their own word problems?**

____

____

____

7. **What are your thoughts about mathematical language in 1st Class?**

____

____

____

8. **What teaching strategies would you like to see implemented by teachers more to develop children's ability to solve mathematical problems?**

____

____

____

9. **Any final thoughts you would like to share on the topic?**

____

____

____

Thank you for taking the time to fill in this questionnaire, I really appreciate your input 😊

Appendix P: Student Pre-Intervention Problem-Solving Questionnaire

Problem Solving Questionnaire

1) Do you like problem solving in maths? (circle one option)

Yes No Don't Know

2) What are your favourite types of maths problems?

____

3) Do you find maths problem solving easy? (circle one option)

   a. All the time sometimes rarely never

4) How do you solve problems?

____

5) What parts of problem solving, if any, do you find difficult?

____

6) Why is it so difficult?

____

7) What usually helps you when it's a bit of a struggle to problem solve?

____

8) What could teachers do to make it easier for you to learn to problem solve?

____

9) Is there anything that encourages you to work hard, even when the work is difficult?

____

10) Is there anything else you would like to say about problem solving?

____

Thank you for completing this questionnaire 🙂

Appendix Q: Observation Checklist for Critical Friends Observing Lessons

Are the children engaged in the lesson?	
Is the teacher encouraging the students to use their mathematical eyes to guide their input on the lessons actively?	
Are the children engaged in active dialogue using mathematical language?	
Are the children working independently to formulate their own word problems responsibly?	
Is their evidence of the children working responsibly on creating their own word problems?	
What evidence is there that the children are developing as problem-solvers if any at all?	
Were the children given opportunities to spot the mathematics inside the story and discuss new and familiar mathematical language?	
Is the teacher scaffolding sufficiently to support the construction of appropriate word problems?	
Are the children given the opportunity to give feedback on the lesson?	

Would you change anything about the lesson?	

Appendix R: Post Intervention Child Questionnaire

Maths Lessons Feedback

Your Name: ______________________

Date: _____________________________

1. What did you think about the first part of the lesson, when we looked at a picture on the interactive whiteboard?

- **I liked it a lot!**
- **It was okay.**
- **It was not very fun.**

2. When we read the storybook, how easy was it to understand the maths in the story?

- **Very easy!**
- **It was okay, I understood most of it.**
- **It was hard to understand.**

3. Did you like making your own word problems on the mini-whiteboards?

- **Yes, I really liked it!**
- **It was okay.**
- **I didn't like it very much.**

4. How good were you at using maths words when we made word problems?

- **I used lots of maths words!**
- **I used some maths words.**
- **I didn't use many maths words.**

5. How did you feel about the lesson where you got to be a problem solver?

- **I felt like a maths detective!**
- **It was fun to solve problems.**
- **It was a bit hard for me.**

6. Do you think you learned something new today?

- **Yes, I learned a lot of new things!**
- **I learned a few new things.**
- **I didn't really learn anything new.**

7. What was your favourite part of the lesson?
(You can choose more than one!)

- o **Looking at the picture**
- o **Reading the storybook**
- o **Making word problems**
- o **Solving the problems**
- o **Other (Please tell me what you liked the most!)** ________________________

8. What would make the lesson more fun for you?

____
____

9. Do you think you are getting better at solving maths problems now?

- o **Yes, I think I'm getting better!**
- o **I am not sure.**
- o **No, I don't think I'm getting better.**

10. Would you like to keep having maths picture books, 'Maths Eyes' pictures and word problem time as part of Maths lessons? (Feel free to draw a picture too if you want!)

____
____
____

11. Which of the Maths Picture books was your favourite?

____

Thank you for being amazing researchers and helping me learn so much more! 😀

Appendix S: Problem-Solving Enjoyment Scale

Do you find problem-solving in Maths lessons fun?

1	2	3	4	5	6	7	8	9	10

Not Fun! **Lots of Fun!**