Final thesis upload 12.09.25

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OLLSCOIL NA HÉIREANN MÁ NUAD
THE NATIONAL UNIVERSITY OF IRELAND
MAYNOOTH

Froebel Department of Primary and Early Childhood Education
M.Ed. (Research in Practice)
(2024 – 2025)

How Can I Improve Intrinsic Motivation in Third-Class Mathematics Lessons by Promoting a Guided Discovery Approach?

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A Research Dissertation submitted to the Froebel Department of Primary and Early Childhood Education, Maynooth University, in fulfillment of the requirements for the degree of Master of Education (Research in Practice)

Date: 12.09.25

Supervised by: Joni Clarke

Ainm / *Name*: Anne-Marie McGill

Bliain / *Year group*: 2024/2025 Masters in Education (Research in Practice)

Uimhir mhic léinn / *Student number*: 17475464

Ábhar / *Subject*: EDF689

Léachtóir / Teagascóir:

***Lecturer / Tutor*:** Joni Clarke

Sprioclá / *Due date*: 12th September 2025

Teideal an tionscadail / *Assignment title*: A Research Dissertation submitted to the Froebal Department of Primary and Early Childhood Education, Maynooth University, in fulfillment of the requirements for the degree of Naster of Education (Research in Practice).

Líon na bhfocal / *Word Count*: *21986*

Líon leathanach / *Number of pages*: 149

Aon ábhar eile sa tionscadal / *Any other material in the assignment*:

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Page count:	151
Word count:	31,580
Character count:	189,703
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Abstract

Mathematics education in Ireland is shifting towards child-centred, problem-solving approaches under the new Primary Mathematics Curriculum (PMC) (NCCA, 2023). This said, many classrooms remain reliant on traditional, teacher-led instruction, where pupils remain unmotivated. Research highlights strategies such as teacher scaffolding (Kirschner, Sweller & Clarke, 2006) and exploratory talk (Mercer, Wegerif & Dawes, 1999) as effective in promoting motivation and child centred learning. However, Irish studies note barriers such as time pressures and limited training when faced with new curriculums and change (NCCA,2009).

Conducted through a practitioner-led action research (AR) methodology, this study was developed with the goal of improving student motivation in mathematics by employing a Guided discovery (GD) approach. To align with this change, my pedagogy shifted from a didactic role to one which is child centred and links closely with constructivist principles (Bruner, 1961). By aiming to answer the question 'How can I enhance intrinsic motivation during third-class mathematics lessons by promoting a Guided discovery approach?', I sought to gather information from students through a mixed-methods approach.

Many theorists encouraged the development of this study including the work of Bruner (1961) and Vygotsky (1978). However, the main theoretical framework that grounded this study is Self-Determination Theory (SDT) (Ryan & Deci, 2000). This theory explores how intrinsic motivation may be fostered when pupils' needs of autonomy, competence and relatedness are met.

This study's goal was to improve my practice and in turn, live more closely to my values. McNiff and Whitehead (2011) suggest AR as an appropriate methodology for this. These values discussed throughout are care, inclusion, child-centred learning, and enjoyment of learning.

Data analysis revealed that students developed a heightened sense of autonomy, competence, and relatedness throughout the study, all leading to increased motivation levels. While the challenge of frustration arose throughout the study, it ultimately led to more enhanced, productive learning. As a practitioner, I have learnt to live closer to my educational values and now value the importance of reflection in all aspects of life.

Completion of this research has encouraged me to develop a more profound understanding of motivation, guided discovery, and productive struggle. With the aid of SDT, I have become more equipped in promoting intrinsic motivation during mathematics. I am also living more closely to my values through a more constructivist aligned teaching pedagogy.

Acknowledgements

I would like to express sincere thanks to my tutor, Joni Clarke. Her knowledge, guidance, and support throughout the research process have helped me grow both personally and as a practitioner. I am truly grateful to my school's board of management and principal, who facilitated the completion of my research. To my students, thank you for your enthusiasm about my research project. Your excitement and passion about Guided discovery encouraged me to persist even when times were tough. Thank you to my critical friend who remained honest throughout the process and supported me with endless encouragement. Finally, to my mam, thank you for the cups of tea and dinners ready on those Tuesdays and Thursdays of lectures. Your support never goes unnoticed. I hope I have made you proud.

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List of Abbreviations

GD ……………………………………………… Guided Discovery

SDT ……………………………………… Self-Determination Theory

AR ……………………………………….. Action Research

PMC …………………………………….. Primary Maths Curriculum

PDST …………………………………….. Professional Development Service for Teachers

ZPD ……………………………………… Zone of Proximal Development

LTHC ………………………………….... Low Threshold High Ceiling

PMRI …………………………………… Pendidikan Matematika Realistik Indonesia

RME …………………………………… Realistic Mathematics Education

DCYA ………………………………….... Department of Children and Youth Affairs

IMI …………………………………….... Intrinsic Motivation Inventory

ZDD …………………………………… Zone of Distal Development

CPD …………………………………….. Continuous Professional Development

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Chapter One - Introduction

1.1 Introduction

The goal of this thesis is to enhance pupil motivation in mathematics by implementing a Guided discovery (GD) approach. This change in practice encourages a shift from a didactic style of instruction to one that is student-centred. Grounded in Self-Determination Theory (SDT) (Ryan & Deci, 2000), this study explores how intrinsic motivation may be fostered when pupils are given opportunities to explore mathematics concepts through discovery rather than teacher-led instruction. Conducted through a practitioner-led action research (AR) mode, this study examines my teaching and the impact of purposeful change on pupils' motivation.

This first chapter presents an overview and an introduction to the study, where the problem is identified, the background and the goals are discussed, and the methodological approach taken is described. Next, I identify the significance of this study, formulate the research question, and outline the structure of the subsequent chapters.

1.2 Research Question and Aim

As noted, the primary aim of this AR study was to explore how I could improve intrinsic motivation in my mathematics classroom using Guided discovery (GD). The central question that guided my inquiry was the following:

How can I improve intrinsic motivation in third-class mathematics lessons by promoting a Guided discovery approach?

This study was designed to examine the effects of GD on students' motivation and to identify what changes I would need to make in my practice to support intrinsic motivation more effectively.

Using open-ended mathematical tasks, collaborative learning, and scaffolding, children were encouraged to construct their own knowledge in an exploratory way. Through reflection and data analysis, I was able to answer the above questions and, in turn, improve my practice.

1.3 Identification of the Problem

At the beginning of this academic year, I noticed that my third-class students displayed a significant lack of motivation and enthusiasm during mathematics lessons. During the reconnaissance phase, I gathered information that indicated my students had a negative outlook on the subject. Many children expressed that the subject was heavily “book-focused” and discussed their habit of “learning by heart,” which resulted in a lack of enthusiasm, engagement, and motivation. My students were therefore considered passive learners who received knowledge from their teacher rather than constructing it themselves.

After critical reflection, I identified the use of direct teaching approaches as a possible reason for this lack of motivation. I observed that children were heavily dependent on teacher-led explanations and displayed limited confidence or autonomy in their mathematical thinking. This teaching approach, while efficient for covering content and completing textbooks, did not nurture student motivation or independence. This realisation prompted me to examine my professional practices more deeply, especially regarding how well they align with my educational values, which I identify as care, student-centred learning, inclusion, and enjoyment of learning.

I began to identify myself, as Whitehead (1989:42) suggests, as a ‘living contradiction.’ I was upholding child-centred, inclusive values, yet the practice I was implementing contradicted them. With the help of this study, I aimed to enhance my practice by living more closely to my values and improve the overall motivation of the students in my class during mathematics lessons. To achieve this, I planned to examine my own teaching by employing an AR approach. I would make observations, analyse them, and finally record the changes that ultimately led to an increase in my students' intrinsic motivation.

1.4 Background and Context

Traditional methods of instruction, often characterised by direct teaching and rote learning, have influenced mathematical education in Irish primary schools (Hannafin, 2022). While such practices may ensure coverage of curriculum content, they usually struggle to foster deep understanding or motivation within learners. However, over recent years and with the introduction of the new Primary Maths Curriculum (PMC) (NCCA, 2023), teachers are posed with challenging previous pedagogies.

The new PMC (NCCA, 2023) promotes exploration, problem-solving, and learner agency. Due to its introduction, it has become increasingly important within the Irish context to rethink our classroom practices to meet the demands of the curriculum and the needs of the children. By adopting a GD framework, I sought to implement the principles of the PMC in a meaningful way. I aimed to improve motivation by encouraging students to become more active in their learning through the incorporation of exploration, investigation, choice, and independence.

As mentioned above, I had noticed a lack of motivation in my classroom. I was confident that if this problem was occurring within my students, it was happening in other classrooms too. Upon research, I found that the same phenomenon was a problem across Ireland, with authors such as Grehan, Mac an Bhaird, and O'Shea (2016) and Aysel, O'Shea, and Breen (2020) also discussing this issue of poor motivation during mathematics. Understanding that such a situation is a common issue further motivated my study and led me to research the reasons behind this issue.

Mathematics education in Ireland has long grappled with the challenge of low student motivation and underdeveloped problem-solving skills at the primary level (NCCA, 2018). Perkins and Shiel (2016) offer 'maths anxiety' and 'self-efficacy' as reasons for these issues whereas Hourigan, Leavy and Carroll (2016) state that teachers own attitudes on mathematics can heavily effect that of students. Many students have also reported mathematics as difficult, irrelevant, or anxiety-inducing, leading to disengagement and negative attitudes towards the subject from an early age (Fielding-Wells & Makar, 2008; Jeffes et al., 2013). This disengagement is often rooted in traditional teaching methods that emphasise rote learning, textbook dependence, and procedural accuracy, which limit opportunities for student autonomy, exploration, and collaboration (Boaler, 2016; Swan, 2005). As a result, children are often passive recipients of knowledge, lacking the confidence and strategies needed for effective problem-solving (NCCA, 2018), an area central to the rationale of the new PMC discussed on page ten of the curriculum.

This context presents a need for approaches that foster autonomy, competence, and relatedness, three key psychological needs identified in Self-Determination Theory (SDT) (Ryan & Deci, 2000). Aligning with this theory, this study explores how a GD approach can transform the learning environment to support intrinsic motivation and enhance mathematical engagement in a third-class setting.

Next, I will discuss how this theory and the work of other theorists shaped my study, as well as their impact on the intervention.

1.5 Theoretical Framework

This study draws primarily on the SDT, which is the work of Ryan and Deci (2000). This theory suggests that learners' intrinsic motivation increases when their needs for autonomy, competence, and relatedness are satisfied. This theory provided a useful structure for evaluating changes in students' motivation while also informing the design of tasks that promoted these three psychological needs. Chapter Two will provide a detailed discussion of this theory and its impact on my research.

In addition, Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD) played a central role in informing the design and facilitation of GD tasks. The ZPD refers to the space between what a learner can achieve independently and what they can achieve with appropriate support (Vygotsky, 1978). Within this zone, learning is most effective when students are scaffolded to move beyond their current level of understanding (Vygotsky, 1978). Guided by this concept, tasks were intentionally structured to be just beyond the students' independent capabilities, yet accessible with support. This support was implemented through scaffolding (Juhász, 2024). Questioning, peer discussion, and teacher facilitation were carefully implemented to help students engage with the challenge while still maintaining a sense of autonomy. By tailoring support in this way, students were encouraged to take ownership of their learning while being guided towards deeper understanding, thus striking a balance between independence and structured support.

The work of Jerome Bruner (1961) also shaped my study. Bruner was a leading advocate of discovery learning, a constructivist approach that emphasises the importance of learners actively constructing their own understanding through exploration and problem-solving. He argued that when students discover concepts for themselves, they are more likely to retain knowledge and transfer it to new situations (Bruner, 1961). In the context of GD, Bruner's (1961) work underpins the belief that learners gain a deeper understanding when they engage in inquiry and receive appropriate scaffolding, rather than passively absorbing information through direct instruction.

These theoretical perspectives mentioned above helped shape the intervention and analysis of the findings.

1.6 Overview of the Intervention

This intervention was introduced over ten weeks. Participants included twenty-two third class students. The goal was to provide instruction that was no longer didactic but more child-centred, which, in turn, would improve intrinsic motivation. Talbert, Hofkens, and Wang (2019) describe this child-centred approach as one that encourages the construction of knowledge through discussion, problem-solving, and the comparison of strategies.

Studying the SDT provided me with increased knowledge on aspects influencing intrinsic motivation. My students were more likely to feel motivated when I provided an environment that met the psychological needs of autonomy, competence, and relatedness. When researching the best ways to integrate these into my practice, I found GD as a suitable methodology.

The intervention involved implementing GD for the topics of multiplication, division, length, and area. Tasks were designed through a Low Threshold High Ceiling (LTHC) approach to ensure accessibility and challenge for all. Through using open-ended problems, student collaboration, and scaffolding, pupils were encouraged to take ownership over their own learning and engage in challenging mathematical tasks, which led to feelings of autonomy, competence, and relatedness.

Aligning with AR, participant feedback, data collection, and reflections informed the necessary refinements throughout this intervention, which will be discussed in greater detail in Chapter Four.

1.7 Methodological Overview

This study employed an AR methodology. AR is a practitioner-based methodology to improve one's practice (McNiff, 2013). The practitioner-oriented and cyclical nature of AR allowed me to become a researcher and a participant as I studied my practice, intending to improve it. The process involved planning, acting, observing, and reflecting to bring change and improvement to my teaching (Cohen, Manion, & Morrison, 2011)

This form of research also focuses on the practitioner's values. Intending to improve my practice, I was hoping to do so by living more closely to my educational values of care, student-centred learning, inclusion and enjoyment of learning (Whitehead, 1989). When I began to realise that I was not living as closely to my values as I had hoped, I knew that AR would be appropriate methodology.

This study involved two cycles, in which data collection helped inform changes. Data was collected through a mixed-methods approach. Qualitative data included the use of questionnaires, student learning logs, and my own personal reflective journal. Quantitative data was collected through student surveys. The reason for a mixed-methods approach was to allow all students, no matter their literacy ability, to provide data that would inform changes throughout the study.

1.8 Structure of the Thesis

This thesis is organised into six chapters.

Chapter One provides a background of my research and identifies the overall focus and concerns I held, which drove my research. It also discusses the methodology of this study along with the theoretical framework that formed the basis of my learning. This chapter also includes a summary of the intervention.

Chapter Two presents a review of relevant literature, focusing on intrinsic motivation, SDT, and GD. This chapter defines GD and presents an argument for its benefits in education, particularly in mathematics. I also discuss the current policy and curriculum in Ireland, including the new PMC and its focus on child-centred learning, problem-solving, and exploration.

Chapter Three focuses on the research design and rationale for the action plan. This chapter justifies the decision to use AR as the research paradigm. I also explain my reasoning for the chosen data collection tools. Finally, this chapter discusses ethical considerations involved in undertaking this study.

Chapter Four provides an outline of the cycles. It also presents an overview of the intervention used throughout the study. The reflections and changes that came from these are evident throughout this chapter. I also explore relevant literature that guided me to make such changes.

Chapter Five discusses data analysis procedures undertaken and explains how they led to the formulation of my findings. It provides details on data analysis used for qualitative and quantitative data collection. The chapter then presents the findings that arose from the analysis and discusses them in relation to relevant literature. Connections to the original research question are also evident throughout.

Chapter Six concludes the study with key insights, reflections on professional learning, and suggestions for future practice and research.

1.9 Significance of this Study

This study showed positive benefits for my own teaching practice. Overall, I began to live more closely to my educational values, which in turn began to benefit the students in my class. Through critical reflection, iterative planning, and evidence-informed practice, this study has allowed me to evolve from a didactic teaching approach to one that is grounded in constructivist principles. In this way, I began to witness student motivation improve.

This study aligns with the new PMC and its promotion of discovery and exploratory learning in mathematics. The curriculum also places an emphasis on problem-solving, an area that Irish students often find challenging (NCCA, 2018). Using GD, teachers can overcome the barriers that students face concerning problem-solving and low motivation.

Moreover, the study holds relevance for a range of stakeholders. Pupils stand to benefit through increased motivation, deeper understanding, and improved attitudes towards mathematics. Teachers may also observe value in the practical strategies presented for scaffolding, building relationships, fostering autonomy, and supporting competence in mathematics. From a broader perspective, the findings may inform school-wide practices and contribute to the national discourse on effective mathematical pedagogy in line with curriculum reform.

Overall, this study holds significance for not only myself as a practitioner and the students in my classroom but also other practitioners hoping to improve the intrinsic motivation of their students.

1.10 Conclusion

To conclude, this chapter has outlined the rationale, aims, and educational relevance of the current study, which explores how GD can enhance intrinsic motivation in a third-class mathematics classroom. It also explores the methodology used throughout the study and offers information about the data collection tools used.

The following chapters provide details on the structure of this study. The next chapter, the literature review, will offer a critical analysis of relevant academic literature for this study.

Chapter Two - Literature Review

2.1 Introduction

This chapter aims to review literature surrounding the research question, 'How can I improve intrinsic motivation in third-class mathematics lessons by promoting a Guided discovery approach?' The review builds a cumulative argument for Guided discovery (GD) as an effective pedagogical method and one which can enhance intrinsic motivation.

The literature review is organised into five key sections. First, it outlines the current challenges in primary mathematics education, with a focus on the lack of intrinsic motivation among students. Second, it introduces Self-Determination Theory (SDT) as the theoretical lens through which motivation is understood, focusing on its aspects of autonomy, competency, and relatedness. Thirdly, it explores the principles of GD and their alignment with constructivist theories of learning, placing focus on Bruner's (1961) idea of discovery learning. Next, with a section titled 'Policy: The New Primary Maths Curriculum (PMC) (2023)', the review presents an argument for why GD is a pedagogically sound and motivationally supportive approach for mathematics instruction in Irish primary schools, particularly in third class. This section links closely to the new Primary Maths Curriculum (PMC) introduced to Ireland in 2023. Finally, this chapter reviews international literature on the implementation and outcomes of GD, with a particular focus on Indonesia. Relevant theory will be evident and support each section throughout.

By combining theory, research, and policy, this chapter argues that GD not only aligns with the aims of the new PMC but also has the potential to transform classroom practices in ways that meaningfully enhance pupils' motivation.

2.2 The Problem: Lack of Motivation in Mathematics

This section will explore the problems faced by teachers in Irish mathematics classrooms, including a lack of intrinsic motivation amongst students. A growing body of research including international examples such as Velez and Ubuzo (2024) and Irish research such as NEPS (2020) suggest that this problem stems not only from children's own anxieties about the subject but from a failure to meet students basic psychological needs (Ryan & Deci, 2000). When these needs are not met in lessons, intrinsic motivation declines. This section will discuss these issues, identifying reasoning behind them while also focusing on how best to overcome them.

2.2.1 Lack of Motivation

Low motivation in mathematics among primary school children is a well-documented concern. The Professional Development Service for Teachers (PDST) (2018) reported that many primary school students exhibit low levels of confidence and motivation in mathematics, often attributing their difficulties to an inability to understand rather than a lack of effort. Other research indicates that many students perceive mathematics as boring, irrelevant, and difficult, leading to disengagement and reduced interest in the subject (Fielding-Wells & Makar, 2008). In the Irish context, many students develop negative attitudes towards mathematics from an early age, which can hinder both their confidence and long-term achievement in the subject (Jeffes et al., 2013). Such disengagement reflects an issue in how mathematics is taught and experienced by students. Addressing this motivational deficit and the factors contributing to it is therefore essential for improving mathematical understanding and performance (Jeffes et al., 2013).

2.2.2 Contributing Factors to Low Mathematical Motivation

Traditional approaches to mathematics instruction, such as direct teaching and rote learning, frequently contribute to passive learning environments that diminish student motivation, particularly by restricting student choice and independence (Boaler, 2016; Swan, 2005). In such classrooms, mathematical learning is often in the form of procedural memorisation, rather than fostering a coherent and meaningful understanding of underlying concepts (Oudeyer, Gottlieb, and Lopes, 2016). In these contexts, children's choice and freedom are restricted. When students are given limited opportunities to make choices and construct meaning for themselves, they are more likely to experience anxiety, disengagement, and low persistence (Middleton and Spanias, 1999; Turner et al., 2011).

Procedural approaches that place emphasis on correct answers over exploration are seen to reduce opportunities for students to make personal connections with content, a key driver of motivation (Turner at al., 2011). Closed ended tasks where solution is priority is often commonly observed during teacher – led pedagogies. When students are repeatedly exposed to such closed-ended tasks, with one correct answer, they may begin to perceive mathematics as a subject focused solely on following rules and achieving solutions, rather than as a meaningful, creative, and personally relevant discipline (Boaler, 2016b). Along with these factors, the absence of choice and open dialogue often leads to disengagement, as learners are not encouraged to make connections to their own experiences or to explore multiple strategies for problem-solving (Sullivan & Mornane, 2014). When students are forced to complete problems independently, they often feel unsupported and isolated (Middleton & Spanias, 1999). Turner et al. (2011) presents research that suggests that environments supporting collaboration and discussion foster a sense of belonging leading to increased motivation levels. A lack of literature identifying belonging as important for promoting motivation can be identified. Wang et al. (2019) discuss a sense of belonging as often missing from literature but advocate for its benefits in promoting motivation levels amongst students.

High-stakes assessment environments, commonly seen throughout primary schools in Ireland as Drumcondra tests, prioritise performance over learning goals (Smyth & Banks, 2012). Such environments often discourage risk-taking and creative problem-solving, both of which are crucial for developing a sense of independence and success amongst students (Middleton & Soanias, 1999: Ryan & Deci, 2000). Additionally, pressures placed on educators to cover content for these assessments can lead to strategies often based on promoting extrinsic motivation like rewards which undermine a sense of intrinsic engagement (Niemiec & Ryan, 2009).

In addition to limited choice, independence and feelings of support and belonging, traditional approaches often fail to promote a sense of success. When success in maths is promoted to students who have speed and accuracy rather than understanding and strategic thinking it can often hinder student confidence and motivation to succeed (Shiel, Kavanagh & Millar, 2016). As a result, students who struggle are more likely to attribute their difficulties to a lack of ability (Sheil et al., 2016). This can be linked to the research carried out by the PDST (2018) who link a lack of motivation in mathematics to the environments surrounding students and not one's ability.

The factors mentioned above often lead to a feeling of anxiety around mathematics, commonly referred to as 'maths anxiety (Luttenberger et al., 2018). This term is often assigned to feelings of stress and apprehension during mathematical activities (Luttenberger et al., 2018). Students who have previously experienced failure, embarrassment, or confusion in mathematics often develop a fear of the subject, which can lead to a self-protective disengagement from mathematical tasks (Dowker, Sarkar & Looi, 2016). This avoidance behaviour can often undermine students' sense of ability reinforcing negative belief about their mathematical ability.

Adding to these feelings, many students view mathematical ability as fixed and reserved for a select few, further exacerbating feelings of anxiety and low confidence (Prast et al., 2018). Boaler (2016b) contradicts this perceived thinking and explains that mathematical ability is malleable, and everyone can achieve it through effort, struggle, and the right kinds of learning experiences.

Ultimately, the lack of choice, independence, feelings of success and belonging within classrooms helps to explain this problem of low motivation amongst students. As educators, it is important to face these issues on how a lack of motivation is influencing areas of the curriculum like that of problem-solving and student understanding. This motivational deficit evident amongst students is not just a matter of attitude, it directly affects students' ability to solve problems, which is central to mathematical proficiency (Middleton & Spanias, 1999).

2.3 Motivation

2.3.1 General Perspectives on Motivation

Motivation is a foundational concept in psychology, broadly defined as the internal drive that energises, directs, and sustains human behaviour (Ryan & Deci, 2000). In the context of child development and learning, motivation refers to a child's "willingness, need, desire, and compulsion to participate in, and be successful in the learning process" (Bomia et al., 1997: 1).

Two major types of motivation are recognised: intrinsic and extrinsic. Intrinsic motivation refers to a person exploring and engaging in activities for the fun, challenge, and excitement of doing so (Niemiec & Ryan, 2009). These factors are usually accompanied by feelings of curiosity and interest (Deci & Ryan, 1985; Niemiec & Ryan, 2009). In comparison, extrinsic motivation involves performing a task to obtain a separable outcome, such as a reward, or to avoid punishment (Ryan & Deci, 2000). Under controlling conditions that external factors enforce, feelings of enthusiasm, interest, and joy are often undermined and instead replaced with those of anxiety, boredom, or alienation (Niemiec & Ryan, 2009).

Although both forms are present in educational contexts, intrinsic motivation has been associated with deeper engagement and longer-lasting learning (Deci et al., 1991) and for this reason, will be the focus of this study.

Given the challenges discussed in the above section, a framework that directly addresses and supports students' needs for choice and independence, feelings of belongings and feelings of success is crucial. Self -Determination Theory (SDT) offers such a lens through its discussion of autonomy, competence and relatedness as key psychological needs for promoting intrinsic motivation.

2.4 Theoretical Framework: Self-Determination Theory (SDT)

SDT, developed by Ryan and Deci (2000), explains that intrinsic motivation thrives when learners' basic psychological needs for autonomy, competence, and relatedness are met. Autonomy refers to a feeling of ownership over one's learning in the form of choice and independence (Niemiec & Ryan, 2009). Competence involves feeling effective and capable and relatedness is a sense of connection with others (Ryan & Deci, 2000). These three terms align closely with the terms choice, independence, belonging and success used throughout literature above. Traditional mathematics methodologies, like direct instruction, can undermine these needs by limiting student choice, reducing opportunities to experience success, and minimising social interaction (Middleton & Spanias, 1999; Turner et al., 2011).

Niemiec and Ryan (2009) offer a comprehensive explanation of how one can include these three psychological needs in education. The authors share that autonomy can be maximised in the classroom by encouraging students' voice and choice in activities. They also note that when children understand the rationale for why an activity is useful, they often feel more autonomous. Competence can be supported by ensuring activities are optimally challenging, aligning with their Zone of Proximal Development (ZPD), which will be discussed in the following sections. In addition to this, it is important that the feedback and tools provided by teachers promote a sense of success and feelings of efficacy (Niemiec & Ryan, 2009). Finally, relatedness can be promoted by allowing students to feel respected and valued. Ryan and Deci (2000) support this by stating that learners feel seen, heard, and valued through collaborative group work and positive teacher-student interactions. Building strong relationships and showing genuine interest in students' lives fosters a sense of belonging (Wang et al., 2019).

The next section will discuss GD as a possible solution to the problems discussed above and emphasise how GD links to the SDT, showing its effectiveness for promoting intrinsic motivation.

2.5 Solving the Problem - Guided Discovery

2.5.1 Guided Discovery Learning in Education

GD in mathematics was strongly influenced by the work of Tamás Varga, who led a major mathematics education reform in Hungary during the 1970s (Juhász et al., 2024). His work emphasised problem-solving, discovery learning, and active student participation (Juhász et al., 2024). This approach promotes learner agency, exploration, and conceptual understanding through structured activities that are facilitated by teachers. Unlike traditional direct instruction, where knowledge is transmitted from teacher to student, GD enables learners to construct knowledge through active investigation and problem-solving (Lubis, Myraz & Putri, 2019).

This type of learning links closely to the constructivist theory. Bruner (1961), a key advocate of constructivism, argued that learning is most effective when students construct and discover ideas themselves through guided exploration, rather than being passive recipients of information. In this model, the teacher does not hand over full responsibility to students but rather takes on the role of facilitator, posing purposeful questions, scaffolding tasks, and encouraging reflection, therefore allowing children to explore (Kadir Permana & Saputra, 2023).

The main aim of GD is not to transmit fixed knowledge but to develop problem-solving and critical thinking skills that can be readapted in various future situations (Juhász et al., 2024). For this reason, it typically occurs in problem-solving contexts. GD involves learners working toward solutions through structured inquiry and teacher facilitation. The teacher's role is essential, not to dictate knowledge, but to guide, prompt, and support learners toward achieving curricular goals. This aligns with Bruner's (1961) view that teachers should equip students with the tools to think and discover for themselves rather than rely solely on memory.

2.5.2 Guided Discovery in Mathematics Education

Mathematics education offers a particularly effective context for GD due to its emphasis on problem-solving and conceptual understanding (Simamora & Saragih, 2019). The core principle of the GD approach concerning mathematics is to provide students with scaffolding to enable them to discover mathematical concepts and knowledge with their own creative power (Juhász, 2024). This model enables learners to take ownership over problem-solving instead of providing them with direct teaching pedagogies like ready-made definitions and strategies (Juhász, 2024).

Problem-solving, a central component of mathematics and one prominent in the new PMC has been documented as well-suited to a discovery-based approach (Lubis et al., 2019). Rather than being passive recipients of information, during GD, students are encouraged to interact meaningfully with mathematical concepts, often using manipulatives, real-life contexts, and collaboration to uncover underlying patterns and relationships central to problem-solving (Simamora & Saragih, 2019).

Recent studies have demonstrated the benefits of GD in developing mathematical understanding and motivation. Rodríguez et al. (2021) found that conceptually rich and personally meaningful tasks increased student engagement and performance. Similarly, Brandenberger, Hagenauer, and Hascher (2018) found that linking mathematical problems to students' lives heightened intrinsic motivation, as children perceived the content as valuable and relevant. Turner et al. (2011) also note that students are more motivated when they can relate personally to mathematical tasks. Showing children the purpose behind the content allows children to see how they can use these concepts independently in everyday life therefore encouraging a sense of autonomy, a component of the SDT (Ryan and Deci, 2000).

It is also important to note that this study focuses on third-class children. Van de Walle, Karp and Bay-Williams (2022) acknowledge that at this age, children are transitioning toward more abstract thinking and are cognitively capable of engaging in multi-step problem-solving. They are increasingly capable of metacognition and strategic planning, which makes them more receptive to tasks that require reflection and justification. GD leverages this developmental readiness by creating a learning environment that both challenges and supports, motivating students to engage deeply and take pride in their mathematical growth (Rush, 2024).

Based on this evidence one must question if GD is an appropriate methodology for promoting intrinsic motivation. The next section will discuss the link between GD and the relevant theory.

2.5.3 The Link Between Guided Discovery and Self-Determination Theory

GD aligns strongly with the three psychological needs presented by the SDT for improving intrinsic motivation.

GD fosters autonomy by allowing learners to make decisions, explore strategies and direct aspects of the problem-solving process. Reeve (2012) states that when students perceive that they have meaningful control, they become more intrinsically motivated.

Throughout implementing GD, competence is supported when tasks are appropriately challenging (Vygotsky, 1978). For this to be successful, the Zone of Proximal Development (ZPD) is important to consider. By ensuring content is within this zone, students with appropriate scaffolding can succeed.

Relatedness is incorporated throughout GD by ensuring collaborative problem-solving takes place. These interactions allow children to feel this sense of belonging described by the SDT (Ryan & Deci, 2000). From a socio-constructivist perspective, learning is inherently social (Vygotsky, 1978). By incorporating this sense of collaborative learning, GD not only aligns with SDT principles but also those of constructivist. Also, the use of feedback from teachers as a form of scaffolding, allows for relationships to form between teacher and student and so, develops a sense of relatedness (Niemiec and Ryan, 2009)

By meeting psychological needs central to SDT, GD creates a learning environment that fosters intrinsic motivation in mathematics. Thus, SDT offers a valuable theoretical framework explaining why GD is effective in motivating learners and supporting meaningful mathematical learning. This study aims to promote intrinsic motivation by adapting the three components of SDT throughout learning.

The teacher plays a vital role in developing appropriate practice that leads to motivated learning. The next section will discuss the change in a teacher's role from instructor to facilitator.

2.6 The Teacher's Role During Guided Discovery

In a GD learning environment, the role of the teacher undergoes a fundamental transformation from that of a direct instructor to a facilitator of learning. Unlike traditional approaches where the teacher transmits information and procedures, in GD the teacher carefully designs open-ended, thought-provoking tasks and guides students through exploration, prompting them to make their own connections and construct understanding (Kadir et al., 2023).

This shift requires the teacher to encourage children to discover concepts rather than simply demonstrating methods. This approach transforms the teacher into a co-learner and guide, fostering a classroom culture that embraces curiosity, discussion, and mistakes. Teachers should promote that mistakes are not only accepted but valued as opportunities for growth and reflection (Boaler, 2016a). The 2023 PMC explicitly supports this pedagogical stance, stating that “mistakes and errors are normalised as part of the learning process” (NCCA, 2023: 30). By creating this safe environment where students feel they belong yet are successful, the basic needs of competency and relatedness are evident.

Hmelo-Silver, Duncan and Chinn (2007) suggest that another important role of the teacher when implementing GD is to ask questions and offer students guidance, encouragement, and timely feedback. This aligns with the work of Vygotsky (1978), who argued that learning occurs most effectively within the ZPD, with the teacher offering timely prompts and scaffolds. Throughout lessons, the children rely on the teacher as a resource to guide their learning before becoming more independent in their discoveries. Importantly, teachers must be adept at recognising when to intervene and when to step back, allowing students to take ownership of the learning process by not giving too much guidance (Yang et al., 2010; Simamora & Saragih, 2019). Kirschner et al. (2006) caution that if the scaffolding provided by teachers is insufficient, there could be misconceptions formed among students, leading to negative effects. Therefore, finding a correct balance is crucial to productive implementation.

Barbara Rogoff extended Vygotsky’s theory of the ZPD by emphasising a child’s active role in scaffolded learning experiences. Through her concept of *guided participation*, Rogoff (2003) highlights the collaborative nature of learning, where both adult and child co-construct meaning through shared activities involving observation, listening, and choice. This approach aligns closely with the principles of GD, where the teacher does not merely deliver knowledge but supports students’ exploration in a structured, responsive manner. Such scaffolding, as described by Wood, Bruner and Ross (1976) and consistent with Rogoff’s framework, is flexible rather than fixed, helping learners within their ZPD through timely prompts, questioning, and feedback. As Laff and Ruiz (2019) note, Rogoff's framework encourages educators to prioritise student interests, provide opportunities for peer interaction, and tailor support to learner readiness all of which are central to effective GD in the mathematics classroom and show strong connections to SDT’s component of relatedness.

While the motivational benefits of GD are clear, its success depends heavily on effective facilitation and task design. Teachers must balance guidance with student independence, ensuring that prompts and scaffolds are used to steer learning without diminishing exploration (Simamora & Saragih, 2019). Moreover, tasks must be appropriately challenging and relevant, aligning with students’ experiences and developmental stages (Rodríguez et al., 2021). This requirement demands careful planning and a deep understanding of mathematical content and pedagogy. The next section will discuss how educators can plan these tasks appropriately to best implement GD in the classroom as well as aligning closely to the new Primary Maths Curriculum (PMC) in Ireland.

2.6.1 Choosing Appropriate Tasks

The teacher has the responsibility to plan tasks and lessons that will encourage discovery in the classroom. In GD lessons, the selection and design of appropriate mathematical tasks are central to promoting deep understanding while still encouraging intrinsic motivation. Rodríguez et al. (2021) argue that tasks such as those evident through GD, should be moderately challenging yet achievable, aligning with Vygotsky’s Zone of Proximal Development (ZPD), where learners engage with material they cannot yet master independently but can succeed with support. Incorporating challenging tasks also promotes problem-solving skills by demanding a combination of conceptual understanding and strategic thinking, both of which are essential components of effective problem-solving (Sullivan et al., 2014). While the word ‘challenge’ can often be seen in a negative light, studies have shown that students often embrace struggle and thrive on challenge, thereby increasing learning and skills (Russo & Hopkins, 2019).

Research demonstrates that engaging with such challenging mathematical tasks fosters the core components of intrinsic motivation: autonomy, competence, and relatedness (Russo & Minas, 2020). Firstly, such tasks support autonomy by offering students flexibility in how they approach problem-solving. Secondly, challenging tasks promote a sense of competence. Students tend to view these tasks as more demanding but also more meaningful and authentic, often leading to heightened feelings of accomplishment and pride (Russo & Hopkins, 2019). Finally, the social aspect of challenging tasks contributes to relatedness. Collaborative problem-solving is frequently embedded and encouraged in the structure of these lessons, with students typically beginning independently and later engaging in shared dialogue with peers (Russo, 2020). This balance of independent effort and collective exploration enhances both engagement and motivation.

Rodríguez et al. (2021) agree with incorporating a sense of challenge but add that tasks should also be both conceptually rich and personally meaningful. The authors state that when students can see the real-world application of mathematical concepts, their engagement and motivation tend to increase. Turner et al. (2011) agree and add that students are more motivated and engaged when they can relate personally to mathematical tasks. Conversely, when students are unable to relate to mathematical content and tasks appear abstract and disconnected from students lived experiences, it leads to diminished motivation (Brandenberger, Hagenauer, & Hascher, 2018). In summary, designing learning experiences that are relevant and personally meaningful is essential for nurturing intrinsic motivation in mathematics classrooms.

A specific type of task well-suited to GD, which incorporates a sense of challenge to children, is the Low Threshold, High Ceiling (LTHC) task. These tasks are accessible to all learners but allow for extended exploration by those ready for greater complexity (McClure, 2011). LTHC tasks enable differentiation and promote equity while maintaining cognitive challenge, making them ideal for mixed-ability classrooms (Boaler, 2016b). Research by Sullivan et al. (2014) supports the effectiveness of LTHC tasks in promoting mathematical thinking and engagement, noting that such tasks help all learners feel successful while also challenging more advanced students, creating an inclusive environment where all learners feel that they belong, and fuelling the sense of relatedness.

As mentioned above, a sense of challenge should be evident when choosing tasks that will promote GD, however, for this challenge to be met accordingly, a sense of mathematical resilience is also needed amongst students.

2.7 Mathematical Resilience

Martin (2002) recognises that motivation and resilience are complimentary of each other. Mathematical resilience, the capacity to persist and adapt when faced with challenges, is actively developed through GD (Johnston-Wilder & Lee, 2010). Such challenges are often seen in LTHC tasks. Without a level of resistance to these challenges, student motivation may be lost (Martin, 2002). By promoting self-belief amongst students, naturally cemented in LTHC tasks (McClure, 2011), students experience small success therefore enriching their resilience (Martin, 2002).

The act of supporting students to find answers independently, a main component of GD, often improves low student resilience therefore improving motivation (Johnston Wilder & Lee, 2010). When appropriately supported by a More Knowledgeable Other (MKO), LTHC tasks promote confidence, a growth mindset, and deeper engagement (Vygotsky, 1978). It is important that such support aligns with Vygotsky's ZPD (1978), which stresses the importance of providing support just beyond the learner's current level to promote cognitive development. Lee & Johnston Wilder (2013) acknowledge that if tasks are not well-calibrated to students' readiness, offering too much challenge without sufficient scaffolding, students may become frustrated, experience a sense of failure, and begin to disengage.

Such cases of frustration often undermine mathematical resilience, leading learners to lose motivation and curiosity (Johnston Wilder & Lee, 2010). This highlights the crucial role of the teacher in designing tasks that strike a balance between challenge and support, ensuring that learners are stretched but not overwhelmed. Environments that encourage exploration, value mistakes, and offer appropriate scaffolding are essential for maintaining both resilience and motivation in discovery-based mathematics classrooms.

The next section will discuss the implementation of the new PMC in Ireland. Links between content discussed so far will acknowledge the strong connection between GD and this new curriculum.

2.8 Policy: The New Primary Maths Curriculum (PMC) (2023)

The new PMC (NCCA, 2023) represents an enhanced shift in emphasis within mathematics in Irish primary schools. While the previous 1999 curriculum also embedded such constructivist principals, the new PMC places stronger focus on mathematics as a creative, connected, and purposeful subject, emphasising reasoning, conceptual understanding, and real-world application (NCCA, 2023). This curriculum further prioritises student agency, active participation, and meaningful engagement, principles that align closely with GD.

2.8.1 How GD Aligns with the New Curriculum

One of the main aims of the curriculum is to highlight the importance of conceptual understanding (NCCA, 2023). Through its promotion, it encourages students to understand why procedures work rather than simply applying them without reasoning. The development of conceptual understanding is an element aligned with GD due to its exploratory nature (Amiyani & Widjajanti, 2018). When children feel this sense of accomplishment of understanding content, they will feel a sense of competence, a concept noted in the SDT for promoting motivation (Ryan & Deci, 2000).

The new curriculum prominently uses the word "explore" sixteen times, emphasising the importance of investigation, open-ended tasks, and mathematical sensemaking. GD enhances this curriculum by allowing students to work together to build their understanding, following ideas from constructivist theory and Vygotsky's (1978) ZPD, where teachers help students learn through thoughtful questions and support that match the child's current level.

The curriculum introduces learning outcomes and progression continua, which move away from fixed content goals and allow for more flexible, differentiated learning (NCCA, 2023). This flexibility supports GD's use of open-ended LTHC tasks that promote exploration and strategic thinking at different levels of readiness. The next section will further discuss GD's alignment with the new PMC and some challenges that may be faced when opting to implement such change.

As mentioned previously, GD has been noted as a successful approach for developing problem- solving skills (Lubis et al., 2019). The new PMC places strong emphasis on problem-solving throughout, describing it as one of its four elements (how children learn) (NCCA, 2023: 13). O'Shea and Leavy (2013) have previously discussed low motivation levels in mathematics as associated with underdeveloped problem-solving skills but say that constructivist teaching methodologies are encouraging change. By tackling the issue of low problem-solving skills and therefore aligning more closely with the values of the PMC, constructivist principles and SDT, it is hoped that motivation levels amongst students will improve.

Following on from the above statement, it is important to consider the alignment between SDT, and the principles embedded in the PMC. The new PMC explicitly reflects SDT principles, advocating for learner-centred approaches that promote agency, confidence, and collaboration. By integrating structured exploration with purposeful guidance, GD addresses SDT's call for environments that nurture intrinsic motivation while avoiding the pitfalls of unstructured discovery (Kirschner et al., 2006). However, the extent to which GD can meet all three needs depends on the skill of the teacher in balancing openness with support, ensuring that learners are neither overwhelmed by excessive freedom nor constrained by overly prescriptive instruction. A discussion of some of these challenges is now discussed in section 2.8.2.

2.8.2 Challenges Faced When Implementing GD

While GD shows evidence of positivity, especially around improving motivation, there are various challenges arising from its implementation. Irish research shows that many teachers feel unsure about guiding open-ended or inquiry-based learning and often go back to teaching step-by-step instructions, especially when they are pressed for time trying to complete a curriculum (Ní Shúilleabháin & Neururer, 2022).

Critics highlight that some learners, especially those with poor prior knowledge, may not benefit from the style of open- ended tasks promoted by GD without sufficient scaffolding (Kirschner et al., 2006). In such cases, where teachers face pressures to scaffold all children, often a challenge in classrooms of large sizes, the use of explicit instruction may be more beneficial.

Increased training to successfully implement GD in classrooms is necessary. Without appropriate training in such practices, teachers are often seen reverting to procedural pedagogies (Marshall & Smart, 2013). Internationally, evidence has shown that for a shift in practice to be successful, professional development should be continuous and practice orientated, enabling educators to reflect on and adapt their approaches (Jaworski & Potari, 2021). Such evidence is relevant to Ireland as the NCCA (2023) also suggest professional learning opportunities as essential for successful enactment of the PMC.

The next section will discuss a successful international example of implementing GD in mathematics classrooms.

2.9 International Best Practice: Indonesia and Guided Discovery

When examining international best practice for the implementation of GD, Indonesia has provided many studies of success. Over the past two decades, parts of Indonesia have made significant efforts to shift its mathematical pedagogy from traditional rote methods to more student-centred approaches. One of the most noticeable successes has been the introduction of the PMRI (Pendidikan Matematika Realistik Indonesia). PMRI is Indonesia's adaptation of the Dutch Realistic Mathematics Education (RME) approach. It focuses on making mathematics meaningful and relevant by grounding learning in real-life contexts familiar to students (Zubainur, Veloo and Khalid, 2015). The links to Turner et al.'s (2011) discussion about relatable content in promoting intrinsic motivation. Central to PMRI is GD where students are encouraged to explore problems, discuss ideas, and construct mathematical understanding through active participation and collaboration (Zubainur et al., 2015). Rather than memorising procedures, learners instead model and reinvent mathematical concepts with the teacher acting as a facilitator. PMRI promotes problem-solving, critical thinking, and reflection and has been widely supported in Indonesia through teacher training, lesson study, and curriculum integration (Zubainur et al., 2015).

Numerous Indonesian studies have documented the positive effects of GD on motivation, conceptual understanding, and classroom engagement. Studies such as those performed by Yurniwati and Hanum (2017) and Amiyani and Widjajanti (2019) advocate for GD. These studies focus on how GD influences students' interests and attitudes towards mathematics. The results consistently show that learners involved in GD showed signs of increased engagement, enjoyment, and improved mathematical performance. These outcomes suggest that when students are active participants in constructing knowledge, they develop a more positive relationship with the subject, therefore enhancing motivation.

2.10 Conclusion

The literature reviewed indicates that low intrinsic motivation in mathematics is linked to pedagogical approaches that fail to meet pupils' needs for autonomy, competence and relatedness. SDT offers a framework for addressing these needs and GD can be seen as an appropriate methodology to support this framework and improve student motivation.

International evidence, notably from Indonesian educational settings, demonstrates the effectiveness of GD in enhancing students' motivation. In the Irish context, the recent Irish PMC (2023) advocates for child centred, exploratory learning and so, provides increased opportunities for implementing GD methods. Finally, the curriculum aims to promote conceptual understanding, which teachers can encourage using carefully chosen tasks and scaffolding.

Overall, GD is a strong teaching method backed by evidence that shows great potential for developing student motivation in third-class students, who are ready for more independence and active participation. Chapter Three will discuss the methodology demonstrated throughout this study, an action research approach.

Chapter Three - Methodology

3.1 Introduction

This chapter outlines the methodological framework adopted for this study. The purpose of this study was to explore how a Guided discovery (GD) approach could be employed in my classroom to enhance motivation in mathematics among third-class students. The chapter begins by outlining the purpose of this study. It also details ethical considerations, the rationale for action research (AR), data collection tools, and data analysis used to address the following research question:

How can I improve intrinsic motivation in third-class mathematic lessons by promoting a Guided discovery approach?

Throughout the chapter, I will emphasise my values, which I have named as care, student-centred learning, enjoyment of learning, and inclusion. A key aim of my research was to ensure that these values were meaningfully embedded into my mathematics teaching, thereby avoiding what Whitehead (1989: 42) would refer to as a "living contradiction", a practitioner whose actions undermine their educational values.

In the next section, I will discuss the methodology used for this project, action research.

3.2 What is Action Research?

Action research (AR) is a practitioner-led methodology aimed at systematically investigating and improving one's professional practice (McNiff, 2013). This form of research allows a "coherent approach to the everyday practice and problems of teachers in ordinary classrooms who are trying to understand, make sense of, and improve their professional lives" (McNiff, 2013: 19). AR allowed me to become a researcher and a participant as I studied my practice, intending to improve it. This dual role enabled a critical examination of my teaching to bring about meaningful change in my practice. Noffke and Zeichner (1987) suggest that by engaging in research to improve practice, practitioners become more confident, develop awareness of issues, change their values and beliefs, and broaden their views on teaching, schooling, and society.

AR is seen as a collaborative study. Kemmis & McTaggart (2014) emphasise the importance of working with others to co-construct professional knowledge, a view supported by Putnam and Borko's (2000) argument that learning is situated and enhanced through social interaction. Throughout my research, collaboration took the form of 'critical friends,' colleagues who were familiar with the context of the study. These critical friends provided both constructive challenge and supportive feedback. Critical friends challenged my assumptions and asked important questions allowing me to develop a deeper understanding of the implication of my practice on students learning (Pine, 2009; Noor & Shafee, 2021). Their constructive questioning and feedback also promoted rigour and helped minimise personal bias. As Hodgkinson (1957) cautions, practitioner-researchers can become so immersed in their practice that it becomes difficult to maintain critical. Therefore, the participation of trusted critical friends enhanced the validity and credibility of the research process. This reflective collaboration was further supported by the cyclical nature of AR, which encourages ongoing adaptation and learning throughout the research process.

The cyclical nature of AR allows for continuous refinement and improvement based on insights gathered from each stage. It begins with small cycles, which include planning, acting, observing, and reflecting. Cohen et al. (2011) suggest that these stages encourage practitioners to identify key issues within their practice. The iterative nature of this approach facilitates the progressive clarification of assumptions and the development of more informed strategies (Cohen et al., 2011). As cycles are repeated, they contribute to a growing body of reflective evidence that demonstrates change over time. These include 'changes in activities and practices, changes in language and discourse, and changes in forms of organisation that may constrain or characterise one's practice' (Cohen et al., 2011: 347). Through critical reflection, each cycle informs both the research process and the practitioner's growth. Throughout this study, repeating cycles of analysis enabled the iterative refinement of emerging themes, enhancing the accuracy and credibility of the findings.

To support reflection throughout each cycle, the 'What model' (Rolfe, Freshwater & Jasper, 2001) was used. This model is explained in greater detail in Figure 3.1 below. Using this model allowed me to engage more deeply with classroom experiences and encouraged me to move from surface-level reflection and instead, engage in meaningful analysis of my practice. Reflecting on experiences allowed me to identify patterns, evaluate the impact of the implementation of GD, and plan necessary changes. Using this model worked well with the cyclical nature of AR, as each reflection informed subsequent planning and cycles (McNiff, 2013).

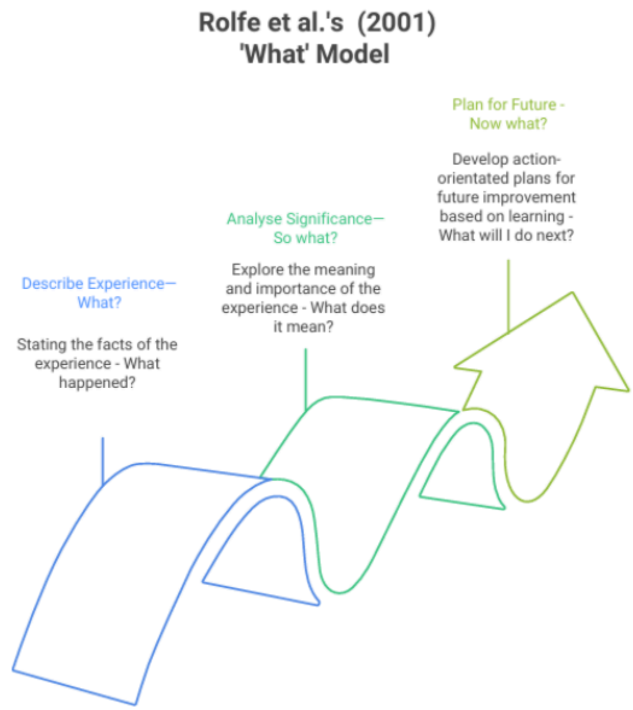


Figure 3.1: Rolfe et al.'s (2001) 'What' Model

3.3 Why I Chose Action Research

Action research (AR) was chosen as the methodology for this study because it offered a reflective and structured approach to addressing a real and recurring issue in my classroom, low motivation in mathematics. As a teacher committed to fostering child-centred, engaging learning environments, AR provided the tools to systematically explore and improve my practice. McNiff and Whitehead (2011) argue that AR enables educators to align their teaching with their values, and this process helped me do just that. By engaging in the iterative cycles of planning, acting, observing, and reflecting, I was able to challenge my assumptions, refine my strategies, and better support my students. As Cohen et al. (2011) emphasise, those who are closest to a problem are best positioned to develop meaningful solutions. Through AR, I was able to take ownership of my professional learning while making responsive, evidence-based changes that benefited both my pupils and my practice.

3.4 The Action Research Cycles

Action researchers need to plan an investigation timeline using cycles. This allows the researcher to act on findings based on the knowledge gained from the previous cycle (Cohen et al., 2011). I was continuously acting on information I had gathered and aiming to make changes to better my knowledge. See Figure 3.2 below for a detailed outline of the cyclical timeline used.

Cycle 1: January 2025 **Topics:** Multiplication and Division	• The request for ethical permission has been granted. • Gain consent and assent from BOM, parents, and pupils. • I engage in discussions with my critical friend. • I take part in mathematical discussions with the class. • Gather information about children's thoughts on mathematics and what they like/dislike about it. • Introduce guided discovery activities. • Use of reflective journal • Introduce children's learning logs • Initial survey and questionnaire
Cycle 2: February 2025 **Topics:** Length and Area	• Analyse data from children's questionnaires, learning logs, and surveys. • Decide on any necessary changes for cycle 2 • Continued use of reflective journal • I engage in discussions with my critical friend. • Second questionnaire. • My journal reflects on my continued observation and conversations with children. • Reflect and discuss activities and findings with my critical friend and supervisor. • Drafting the findings and discussions chapter.

Figure 3.2: Timeline of Research

A comprehensive insight into both cycles will be provided in Chapter Four, titled 'The Project: Preparation and Research Cycles.'

3.4.1 AR Plan and Implementation of Guided Discovery

I set out to create a plan based on the AR model to prepare both the students and I for the research and activities. It was broken into five phases. Phase 1: Planning, Phase 2: Implementation, Phase 3: Data collection, Phase 4: Data analysis, and Phase 5: Reflection and reporting. This model is closely linked to the work of Kemmis and McTaggart (1988), who explain that this process is iterative, meaning it continues to evolve as new understandings emerge. I will discuss Phases 4 and 5 in greater detail in the following chapters.

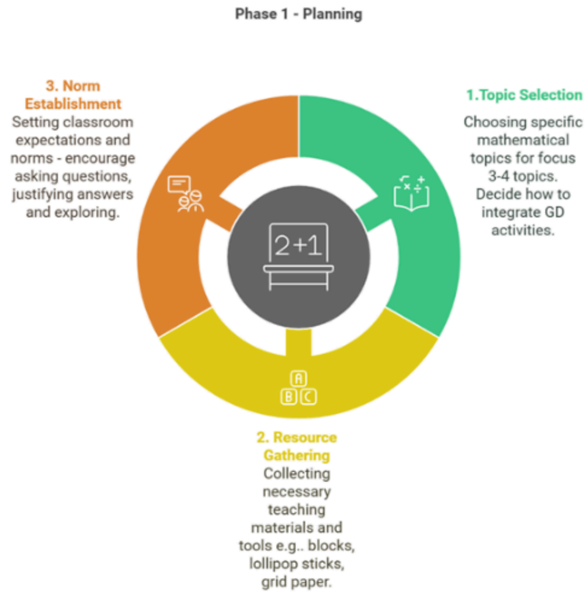


Figure 3.3 Phase 1 of the Plan

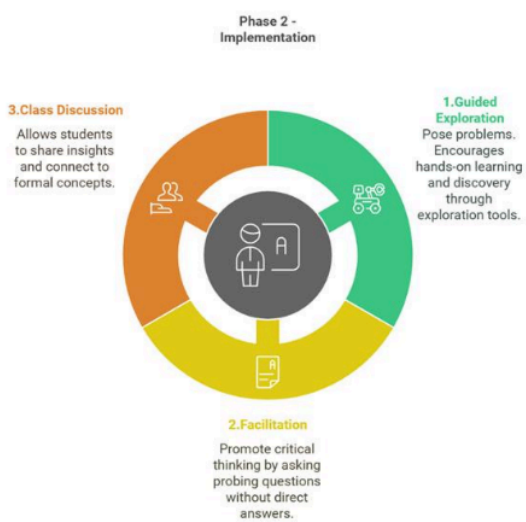


Figure 3.4: Phase 2 of the Plan.

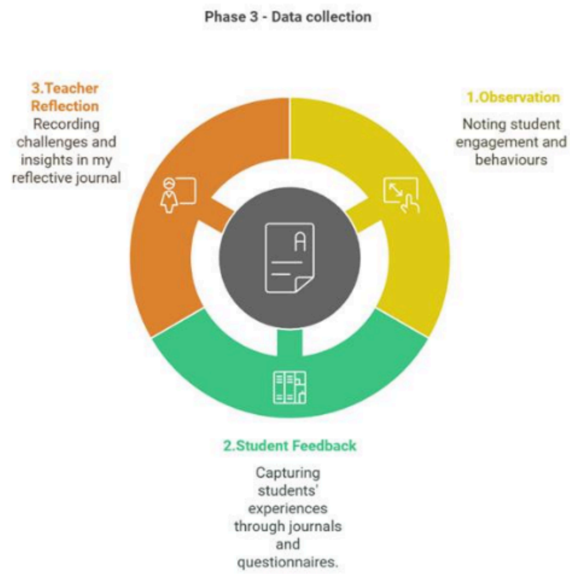


Figure 3.5: Phase 3 of the Plan

Having outlined the cyclical nature of the study, it is essential to consider the ethical responsibilities underpinning each phase. The following section details the ethical protocols that were implemented to protect and respect all participants involved.

3.5 Ethics

Ethical considerations were central to the design and implementation of this research to ensure the protection, dignity, and rights of all participants. This section outlines the ethical procedures followed, including informed consent, confidentiality, and adherence to institutional guidelines.

3.5.1 Vulnerability

Due to the research involving children, ethical sensitivity to their vulnerability was essential. Biggam (2017) highlights the importance of taking specific precautions in such contexts. The first protocol followed was to receive ethical approval from Maynooth University. Following that, risk management procedures were implemented, as outlined below.

3.5.2 Informed Consent and Assent

Permission to conduct this AR project was obtained from the school's Board of Management, the principal, and all participants. Following the principles outlined by Howe and Moses (1999), informed consent was secured through clearly written letters of assent for children and consent for adults, Child assent forms were presented in a developmentally appropriate manner, while adult letters included detailed information about the study's purpose, procedures, and its alignment with the PMC. Following the Department of Children and Youth Affairs (DCYA) (2012) guidelines, I ensured participants fully understood their role. I verbally explained to the children that this project aimed to improve my teaching, not to assess them.

Participants were reminded of their right to withdraw at any stage, with their data excluded accordingly (Cohen et al., 2011; Fine & Sandstrom, 1988). While children could not opt out of participating in mathematic lessons, they could choose not to contribute to data collection. Once relevant consent and assent was gathered, data collection could begin.

3.5.3 Trustworthiness

To ensure the trustworthiness of this AR project, I addressed validity, credibility, dependability, and transferability. I avoided bias by using triangulation, which included multiple data collection tools, participant perspectives, and a critical friend. These measures align with Rolfe's (2006) view that rigour is essential for producing high-quality, credible research.

3.5.4 Confidentiality and Anonymity

Confidentiality can be described as 'not disclosing information from a participant in any way that may identify that individual or that might enable the individual to be traced' (Cohen et al., 2011: 92). To adhere to my promise of confidentiality, participants were given the right to anonymity. Anonymity is explained as information provided by participants that should in no way reveal their identity (Cohen et al., 2011). Protecting participant information helped me to build trust with those involved and ensured that all participants felt comfortable sharing their experiences and insights. Clear protocols for handling data were ensured, such as anonymising names and any identifiable details to protect children's privacy. I protected the school's identity by not mentioning the area or any details that may disclose its identity. These steps ensured further protection of anonymity of data.

3.5.5 Data Storage

Data including observation notes, and consent forms was securely stored. Digital data was encrypted and kept on password-protected devices, while physical data was locked in secure storage. All records were anonymised to ensure confidentiality.

3.5.6 Sensitivity

The study involved continuing regular mathematics lessons with the addition of a GD approach, which did not raise inherently sensitive issues. However, the shift in pedagogy required careful consideration for students with additional needs. Drawing on research by Thibodeau and Rappaport (2020), I introduced the changes using child-friendly explanations, focused on consistency, highlighted students' strengths, and validated their concerns. These practices helped foster a stable, supportive learning environment.

With the ethical considerations carefully addressed to ensure the privacy, dignity, and rights of all participants, the research progressed to the data collection phase. The following section outlines the mixed-methods approach adopted to gather rich, reliable data on the impact of GD on student motivation in mathematics.

3.6 Data Collection—A Mixed-Methods Approach

This study employs a mixed-methods approach where both qualitative and quantitative tools were used. This approach helped to better understand how GD affects student motivation in mathematics and allowed for checking the data from different angles, which made the findings more reliable (Creswell & Plano Clark, 2018).

Qualitative research integrates the methods and techniques for observing, documenting, analysing, and interpreting the characteristics, patterns, attributes, and meanings of the human phenomena under study (Gillis & Jackson, 2002; Leininger, 1985). Using qualitative research allowed me to collect words, statements, and expressions, also known as 'soft data,' which gave an overview of real-world circumstances and avoided any sign of generalisation (Kennedy & Montgomery, 2018).

Quantitative data is a number-based methodology. This data was collected through student surveys using a Likert-scale. My main reason for introducing quantitative data collection was to ensure an inclusive approach in my study where all children, despite their literacy ability, could share their opinions.

The next section will explore the qualitative and quantitative collection tools used in more detail.

3.7 Data Collection Tools

Collecting data plays a vital role in identifying the changes implemented in practice, evaluating their effectiveness, and informing future improvements. Reflecting on this data also supports critical thinking about whether one is acting in alignment with their stated educational values (Zuckermann & Rajaun, 2008).

As previously explained, this study employed a mixed-methods approach, incorporating both qualitative and quantitative data collection tools. A mixed-methods approach provides a more comprehensive picture by drawing on the strengths of both quantitative and qualitative research, particularly in educational settings where understanding both outcomes and experiences is essential (Creswell & Plano Clark, 2018). The use of qualitative data collection allowed me to see statistical based evidence pointing directly to the outcomes of my research including how often and how much aspects of my research were happening. Through this method, I was able to identify how much and how often students showed signs of curiosity, frustration and engagement. However, the use of qualitative data collection pointed to the reasons behind these feelings and therefore gave an insight into experiences and possible reason behind these emotions.

The goal of this research was to obtain a well-rounded perspective on students' motivation during mathematics. To achieve this, a range of data collection tools were employed, including a teacher's reflective journal, student learning logs, pupil questionnaires, and surveys. The next section will discuss these in greater detail.

3.7.1 Reflective Journals

A reflective journal was kept to document observations, thoughts, and insights about classroom practices, student behaviours, and emerging patterns over time. 'A reflective journal aims to help teachers organise their thoughts based on their research, develop awareness, and make conscious decisions regarding ongoing teaching and learning situations' (Zuckermann & Rajaun, 2008: 1). The journal became an important part of my research as I could see developments in my practice and factors impacting motivation from observations that I noted. All personal reflections I made in my journal were guided by my values, the implementation of the new practice, and my honest feelings and thoughts at the time. These reflections enhanced my practice and elevated my skills to a higher level.

Informal conversations with students were documented in my reflective journal and provided valuable insights into their experiences with mathematics. These child-led dialogues helped uncover their preferences, challenges, and emotional responses to GD. As Lundy (2007) asserts, enabling children to express their views meaningfully is central to authentic participation, while Hill (2006) highlights how informal interactions can reveal perspectives that formal tools may miss. This approach ensured all students could contribute, regardless of learning needs aligning closely to my value of inclusion. Additionally, I recorded observational data, in the form of notes, during lessons. These focused on non-verbal cues such as facial expressions and body language, which often indicated engagement or discomfort (Denham & Onwuegbuzie, 2013). These observations supported a holistic view of student motivation and aligned with practitioner inquiry by enabling reflection on pedagogical impact (McNiff, 2013).

3.7.2 Learning Logs

Based on the success of my own reflective journal, I decided to encourage the children to reflect on mathematics lessons. I began to incorporate student learning logs. Branigan & Donaldson (2019) support the use of learning logs due to the rich data that can be gathered. After lessons, the children answered three questions based on the lesson. These were as follows: *What* did I learn? *How* did I learn it? And *how* did I feel? Using learning logs served as another valuable source of data, offering insights into how students approached problem-solving, expressed their views on GD as a methodology, and reflected on feelings such as pride, frustration and enjoyment. I placed great importance on giving the children a voice in conducting the research, as it offered a comprehensive perspective on my research while also enhancing their role as co-researchers (Lundy, McEvoy & Byrne, 2011).

3.7.3 Student Questionnaires

Questionnaires were a key data collection tool, enabling efficient and structured insights from all participants. Following Cohen et al.'s (2011) eight-step guide, described in figure 3.6, I clarified the objective, to explore motivation during mathematics and students' views on GD, and selected my third-class students as the sample. I designed questions appropriate to their language level, guided by Munn and Drever (1990), ensuring clarity and avoiding leading questions. Both closed and open-ended questions were included. Closed questions facilitated quantitative analysis, while open-ended questions captured deeper, personal insights and unexpected perspectives (Munn & Drever, 1990; Oppenheim, 1992).

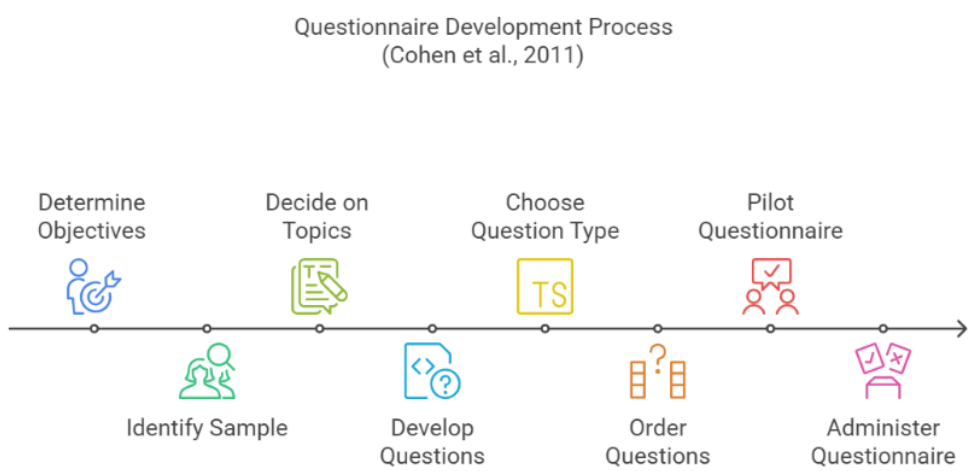


Figure 3.6: Questionnaire Development Process

Munn and Drever (1990) also state that the design and layout of a questionnaire hold great importance. To ensure the questionnaires were engaging, clear, and quick to complete, I followed guidelines by Munn and Drever (1990), using ample spacing and avoiding the compressed layout cautioned by Cohen et al. (2011). Questions were ordered from simple to more complex, ending with an open-ended item to capture student perspectives. Clear instructions were provided orally and in writing to ensure full understanding for all (Cohen et al., 2011). This careful design enhanced the study's ability to comprehensively assess student motivation and the effects of GD.

3.7.4 Student Surveys

Surveys served as the quantitative data collection method in this study, aimed at exploring students' intrinsic motivation during mathematics lessons. Surveys were planned carefully to investigate the intrinsic motivation of children in my class, aligning with the research question. Surveys are widely used in educational research due to their 'efficiency in collecting standardised data, ease of administration, and potential for statistical analysis' (Cohen et al., 2011: 256). A rating scale in the form of a Likert scale was employed as a response method. These scales provide a range of responses to a given question or statement (Likert, 1932; Cohen et al., 2011).

I used the Intrinsic Motivation Inventory (IMI), grounded in Self-Determination Theory (SDT), to inform the survey statements. The IMI addresses autonomy, competence, and relatedness throughout, key factors influencing intrinsic motivation (Ryan & Deci, 2000). Questions from the 'Activity Perception' and 'Task Evaluation' questionnaires were selected for their focus on intrinsic motivation and relevance to student perspectives. To suit third-class students' cognitive development, the original 7-point Likert scale was simplified to a 5-point scale with added visual support, in the form of emojis. This enhanced comprehension and accessibility (Hox et al., 2003). Visual aids also improve motivation and reduce cognitive load, helping children to express feelings more accurately (Borgers et al., 2000). This adaptation made the tool clearer and more appropriate for young learners.

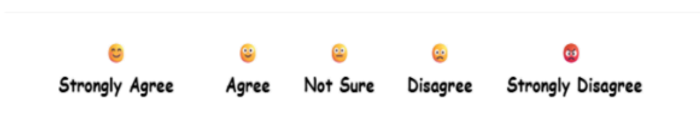


Figure 3.7: Final Rating Scale Used

The combination of the tools mentioned above ensured a rich, multi-dimensional dataset that captured the interplay between teaching strategies and students' motivation. By gathering and reflecting on all data it contributed to a deeper understanding of what drove or hindered motivation in mathematics. Once the data was collected, it was time to analyse it in the form of a thematic analysis.

3.8 Data Analysis

Data analysis is a critical component of the research process, as it allows the researcher to make sense of the data collected and to identify patterns, meanings, and insights relevant to the study's aims (Creswell, 2003). In AR, the analysis process must be systematic, reflective, and closely aligned with the practitioner's evolving understanding of their practice (McNiff, 2017). By engaging in rigorous analysis, I moved beyond surface-level descriptions to generate evidence-based conclusions that informed my practice. The following sections outline the approach taken to analyse both qualitative and quantitative data gathered throughout this study.

3.8.1 Analysing Qualitative Data

Qualitative data was collected and analysed using thematic analysis, a method that encourages identifying, analysing, and reporting patterns or themes within the data (Braun & Clarke, 2012). This analytical approach was selected because it was suitable to capture participants lived experiences, perspectives, and behaviours concerning motivation and GD in mathematics. It allows for a rich, detailed, yet complex account of data, especially when exploring under-researched topics or areas requiring interpretive depth (Nowell et al., 2017).

Figure 3.8 displays each phase of the process. Each phase was iteratively conducted to refine themes and ensure that they authentically reflected the data. As Dawadi (2020) explains, this process enables researchers to construct more complex and meaningful insights of participants responses. The cyclical nature of thematic analysis also aligned with the broader AR framework, allowing for continuous reflection and refinement.

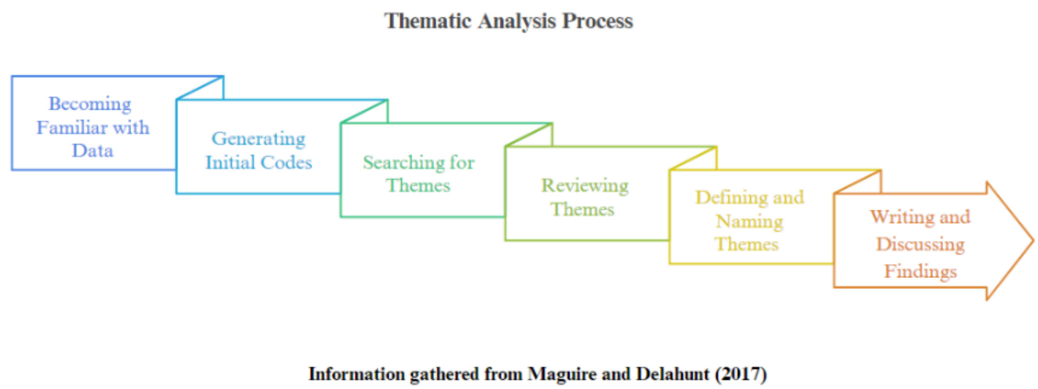


Figure 3.8: Process of Thematic Analysis

Initial codes were developed by examining the data collected, focusing on recurring expressions, behaviours, and attitudes that indicated levels of motivation. These codes were refined and grouped into broader themes.

Thematic analysis provided a clear and organised way to combine information from different sources, helping to better understand how certain classroom methods, like GD, affected students motivation levels. This approach ensured that nuanced patterns within the data were captured and meaningfully interpreted (Braun & Clarke, 2006; Nowell et al., 2017).

3.8.2 Analysing Quantitative Data

Survey responses were analysed quantitatively by assigning numerical values to Likert-scale answers and calculating the mean score for each statement. This allowed for the identification of patterns in student motivation (Cohen et al., 2011). These patterns were then compared with qualitative data to enhance the analysis and confirm the main ideas, making the findings more trustworthy within a mixed-methods approach. Examples of quantitative data analysis can be seen in Chapter Five.

3.9 Conclusion

In conclusion, this chapter has outlined the methodological approach undertaken in this study, detailing the AR design, ethical considerations, data collection and analysis methods, and procedures used to ensure trustworthiness and rigour. The chosen methodology aligned closely with the research aims and allowed for a meaningful exploration of classroom practice within a real-world context. By adhering to ethical guidelines and implementing robust data management protocols, the study maintained integrity and protected the rights of all participants. The next chapter will show and discuss both cycles of the study, emphasising important changes that occurred in my practice which led to increased student motivation.

Chapter Four - The Project: Preparation and Research Cycles

4.1 Introduction

In the previous chapter, I discussed the cyclical approach that action research (AR) takes. By employing a cyclical approach, researchers can reflect on the intervention and their practice and make changes. In this chapter, I will discuss the Reconnaissance Phase of my study, the Guided discovery (GD) intervention, the first cycle's process and reflections, and how I changed my approach for the second cycle. Additionally, I will share the data that helped me to make these changes, which were appropriate for the aim of improving students' intrinsic motivation.

4.2 Reconnaissance Phase

Before the introduction of GD, I sought to understand students' feelings towards mathematics to identify areas where motivation was lacking and what aspects they enjoyed. This was called the 'Reconnaissance Phase.' Dillon (2008) promotes the use of reconnaissance in AR, as it allows the author to truly acknowledge the starting point and encourage future reflection on the changes that occurred throughout the study. This phase involved two forms of data collection. First, the class brainstormed words associated with mathematics on the Interactive Whiteboard, revealing a mix of responses such as "fun," "boring," "workbooks," and "problems."

Next, students wrote their feelings about mathematics on post-its. Of the twenty responses, six students expressed strong positivity, often linking their enjoyment to problem-solving, games, or ease of the subject. Three others described a general liking. However, eight students found the subject difficult, one described it as "ok," and another said it was "boring."

Reflecting on these responses, I began to identify my own teaching habits as a reason for low motivation in mathematics. Regarding comments received from the students, lessons appeared to be controlled by me, limiting any sense of a student-centred classroom. These findings confirmed my conviction that a change in my practice was necessary. GD, which focuses on exploration, independence, and active participation, was introduced to enhance student motivation and create a more inclusive, meaningful, and engaging way to learn mathematics.

These baseline attitudes provided a valuable reference point for assessing the impact of the intervention throughout the AR cycles and allowed me to identify my starting point and future motivations for this research (Dillon, 2008).

The next section will explain the process of implementing GD in my classroom.

4.3 An Overview of the Intervention: Guided Discovery

In this section, I will discuss the intervention that is at the heart of this research, GD. I will give an insight into how I implemented this intervention throughout Cycle One. Methods and resources mentioned will include Low Threshold, High Ceiling (LTHC) tasks, the use of concrete materials, and scaffolding. I will also mention collaboration and discussions throughout. The linkage between GD and the Self-Determination Theory (SDT), the framework used to promote students' intrinsic motivation, will also be evident.

Throughout this discussion, I aim to show the changes that were made in my practice. These changes are evident in Figure 5.1, which details features of my practice pre-intervention and features that were evident throughout Cycle One.

Teaching Style Compared

	Pre-intervention	Post-Cycle One
Teaching style	Directive, teacher-led	Inquiry-based, student-centred
Role of materials	Minimal or textbook-based	Concrete materials central to learning
Student engagement	Passive, recall-focused	Active, exploratory
Assessment	Product-based (correct answers)	Process-based (thinking, reasoning)
Teacher's role	Instructor	Facilitator and co-learner
Tasks	Closed - right or wrong	Open - multiple correct answers and methods
Use of reflection	Rare	Central to the study. Allowed for changes to be made on the intervention and my practice

Figure 4.1: Comparison of my Practice Pre-intervention and Throughout Cycle One

4.3.1 Low Threshold, High Ceiling (LTHC) Tasks

Low-Threshold High-Ceiling (LTHC) tasks were integral to the GD approach implemented in this study. These open-ended mathematical tasks are designed to be accessible to all learners while offering opportunities for deeper exploration and higher-order thinking (Van de Walle et al., 2022). Unlike closed tasks, LTHC tasks promote multiple strategies and solutions, fostering inclusion, cognitive engagement, and differentiation by depth rather than task (Sullivan et al., 2009; NRICH, 2014). Their open structure also supports key aspects of Self-Determination Theory (Ryan & Deci, 2000) as students collaborate, make choices, and engage meaningfully with content. This approach aligns with the new PMC's emphasis on reasoning, problem-solving, and conceptual understanding (NCCA, 2023).

LTHC tasks were central during multiplication and division lessons in the first cycle. These tasks enabled all students, regardless of ability, to engage meaningfully. Some used concrete materials like cubes to model groupings, while others progressed to drawing arrays or forming number sentences. This variety highlighted the inclusive and differentiated nature of the tasks and approach. Group work further enhanced peer learning and reflective discussion. One notable moment occurred when students, through exploration, discovered the commutative property of multiplication—an insight that would previously have been delivered through direct instruction. This shift underscored the effectiveness of LTHC tasks in facilitating conceptual understanding and increasing learner motivation.

4.3.2 Concrete Materials

Influential thinkers like Piaget (1952), Bruner (1960), Skemp (1987), and Dienes (1969) advocate for the use of concrete experiences and multiple representations as essential for students' cognitive development and long-term retention. These ideas underpin the belief that children must understand what they are learning, not just memorise procedures.

Throughout my study, concrete materials played an important role in motivating students, promoting reasoning, enhancing collaboration, and increasing problem-solving skills. Students had the opportunity to use concrete materials to solve LTHC tasks. To incorporate choice as promoted by Sullivan and Mornan (2014), multiple options were available to them. See figure 4.2 for an example of materials. Concrete materials proved successful, as they allowed students to bridge the gap between abstract concepts and their existing knowledge (Van de Walle et al. 2022).

Figure 4.2: Example of Concrete Materials Available

Throughout the topics of multiplication and division, students used cubes, buttons, and blocks to model arrays and groupings, which supported their reasoning and promoted mathematical discussion with peers. Their use encouraged autonomy and competence, two key components of SDT (Ryan & Deci, 2000), by allowing students to take ownership of their learning through choice and experience success through hands-on problem-solving. The use of collaboration allowed children to see problems represented in different ways and encouraged them to try different representations to extend their thinking. This level of discussion and cooperation in pairs ensured relatedness, therefore meeting all three psychological needs to promote intrinsic motivation.

The materials also served as a powerful scaffold for learners with additional needs, making mathematical concepts more accessible and promoting inclusion within the classroom. This aligns with research by Moyer (2001) and Clements and Sarama (2011), who highlight that manipulatives, when used meaningfully, can support deeper learning and mathematical reasoning for all learners in a constructivist environment.

4.3.3 Scaffolding

Scaffolding was presented in various ways during this research, but I found it particularly challenging during Cycle One. Through reflections, I noticed that I was becoming wary of falling into old habits of direct instruction and limited scaffolding. Upon research, I found the importance of scaffolding through GD and found appropriate ways to integrate it successfully in lessons.

As discussed throughout Chapter Two, scaffolding is essential when implementing GD. It was important when children were answering LTHC tasks, as children could explore mathematical concepts independently but with specific guidance when needed. This shift was crucial for me, as previously, I undertook an instructor's role and provided direct answers. However, by using scaffolding, I employed probing questions and prompts to help children discover concepts independently. Probing questions included: "What do you notice about this?" "Can you guess what comes next?" or "Is there another way to represent this?" These questions allowed children to extend their thinking independently and fostered a feeling of competence, crucial for intrinsic motivation (Ryan & Deci, 2000). Moreover, providing appropriate scaffolding provides autonomy, as students are not told what to do but instead encouraged to think critically and make decisions based on their reasoning. Scaffolding proved particularly important in my classroom due to the range of abilities. Some students often needed more guidance than others. This aligns closely with Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD), as described in Chapter Two, where learning is optimised when students receive guidance to progress just beyond their current understanding. This current understanding varied for each student and so, the level of scaffolding also varied.

4.4 Cycle One

Throughout this section, I will discuss Cycle One's initial findings including both challenges and positive outcomes. I will also explain my strategies for overcoming these challenges during the reflection phase, utilising relevant literature. Figure 5.3 shows the positive outcomes and challenges faced throughout Cycle One.

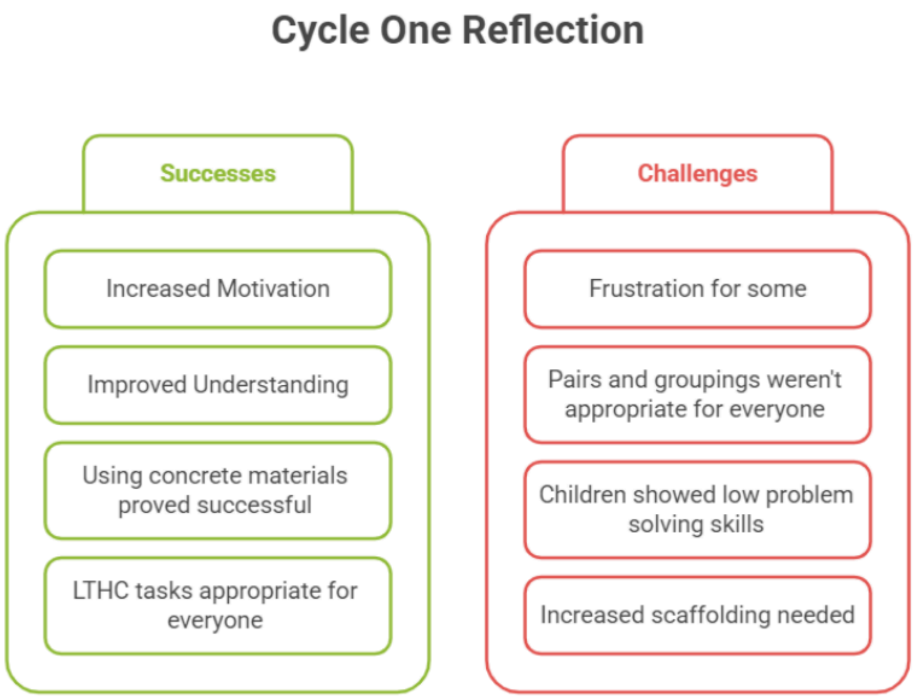


Figure 4.3: Successes and Challenges Identified Following Cycle One

4.4.1 Positive Outcomes of Cycle One

Cycle One marked a meaningful shift in pedagogical practice. My teaching transformed from a didactic style to one more focused on my students. A key positive outcome was the noticeable increase in student motivation, central to my research question. Many children showed greater enthusiasm and willingness to engage with mathematics, frequently expressing enjoyment of the open-ended nature of the tasks. Comments captured in my reflection journal, such as "I like working this out myself," "I like that I can try to answer in different ways," and "This is fun maths" demonstrated a shift in mindset, where students began to see mathematics as something exploratory rather than procedural, a clear shift from their previous views in the reconnaissance phase.

The use of LTHC tasks proved highly effective, as they enabled all learners to access the task while also offering meaningful extension opportunities for higher-ability students. This confirmed the value of these tasks in a mixed-ability classroom, supporting Sullivan et al.'s (2009) view that LTHC tasks allow differentiation by depth rather than by task design. Students were able to choose strategies and representations that suited them, which further promoted autonomy and mathematical reasoning. Relating these tasks to the lives of the students also promoted increased interest as recommended by Turner et al. (2011). Throughout questionnaires and learning logs, children discussed how they could use these tasks in real life, for example, sharing sweets with their friends. These results showed the connections that my students were making.

Another significant success was the use of concrete materials. Despite initial reservations that they might be distracting, students used them with purpose and focus. Manipulatives such as cubes, number lines, and counters helped students visualise problems and test ideas, making abstract concepts more accessible. Use of materials was particularly beneficial for students with additional needs, reinforcing Bruner's (1961) and Clements and Sarama's (2011) research on the importance of hands-on learning in mathematical development.

The study began to show positive outcomes on my students' motivation as evident through multiple sources of data collection. Nevertheless, challenges became apparent, and writing personal reflections and reviewing literature was necessary in helping to make changes in my practice in Cycle Two. The next section will discuss the challenges I faced throughout the intervention.

4.4.2 Challenges Faced

Challenges faced, as outlined in Figure 5.3, included student frustration, mixed responses to pairs and grouping, low problem-solving skills, and increased scaffolding needed. These challenges were apparent throughout the data collection tools I used. Figure 5.4 illustrates the various tools used to identify these challenges. I aim to discuss these challenges throughout this section.

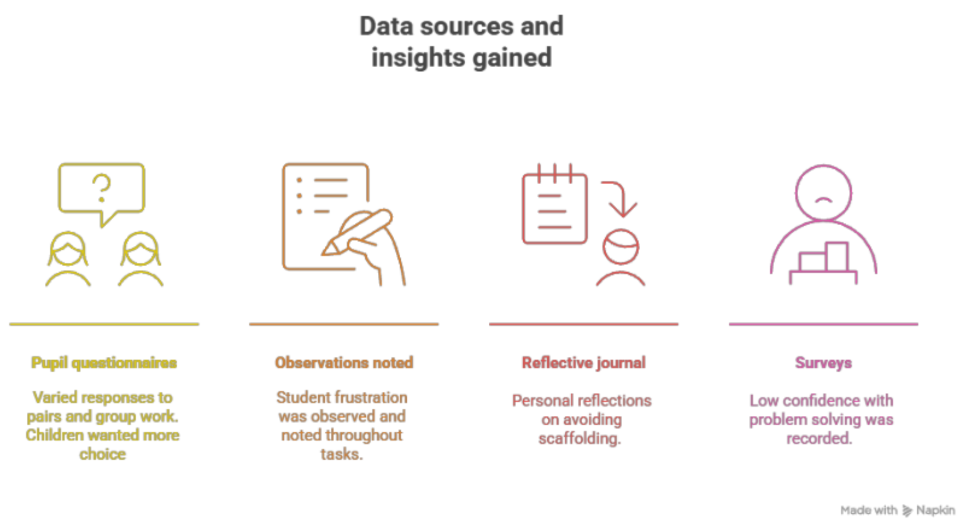


Figure 4.4: Data Source and Insights Gained

4.4.3 Frustration and Scaffolding

While the first cycle yielded many successes, it also highlighted several areas that required refinement and change. One of the most prominent challenges was the need for increased scaffolding. Despite their motivation, many students lacked the necessary strategies or confidence to initiate open-ended tasks independently. These factors led to frustration. My journal reflected on student's comments such as "This is too hard" and "I can't do this." I also noticed children's dependence on me to provide them with answers or tell them how to solve problems. A child's question, "Why can't you just tell us what to do?" brought this observation to my attention. I found myself questioning how much direction I had previously provided them with.

Conversely, during this cycle I often hesitated to intervene, worried that doing so might revert lessons to a didactic approach. However, reminded by relevant literature, it became evident that strategic scaffolding was essential to support students' progress while maintaining the exploratory nature of Guided discovery (Wood, Bruner & Ross, 1976).

4.4.4 Co-operation

Group pairings also presented difficulties. Some students did not work well together, either due to mismatched confidence levels or dominant group dynamics, limiting the effectiveness of collaboration. These findings highlighted the need for more intentional pairing based on learning needs, social compatibility, and support for equitable participation. Questionnaire responses indicated that children preferred to collaborate with friends. I was initially cautious about permitting such pairings, concerned that they might cause misbehaviour. However, I recognised the need to challenge this assumption, as limiting opportunities for effective collaboration could restrict the development of relatedness, a key psychological need identified in Self-Determination Theory (Ryan & Deci, 2000).

4.4.5 Low Problem-Solving Skills

Additionally, my observations and reflections pointed to generally low problem-solving skills. Many students expected direct instruction or quick answers, a reflection emphasising the previous exposure to more traditional, procedural teaching methods. Children also showed little evidence of having a toolkit to develop problem-solving skills and gave up easily. Developing persistence, resilience, and flexible thinking emerged as priorities moving forward.

These challenges informed the changes introduced in Cycle Two, which aimed to strengthen scaffolding and model problem-solving strategies more explicitly, promote a sense of resilience, and refine group structures to better support collaboration and inclusion. These factors were reflected on before moving forward to Cycle Two.

4.5 Reflection Phase

Before Cycle Two, I took time to reflect on the previous cycle and its challenges. I engaged in a period of reflection by investigating data collected so far. I began to read increased literature around the challenges I was facing to inform necessary changes. Figure 4.5 shows the challenges faced, the literature consulted, the insights gained, and finally, the changes that were made for Cycle Two.

CYCLE ONE CHALLENGE	LITERATURE CONSULTED	LEARNING FROM LITERATURE	CHANGE MADE FOR CYCLE TWO
Student frustration	Boaler (2016) – Mathematical Mindsets Biccard (2021)- Productive Struggle in Mathematical Modelling	Productive struggle and growth mindset help reframe mistakes as essential to learning therefore reducing frustration	Introduced growth mindset posters and language; normalised mistakes and encouraged persistence
Students relied heavily on teacher direction; lacked independence	Wood, Bruner & Ross (1976) – The Role of Tutoring in Problem Solving	Strategic questioning supports learner autonomy without removing challenge	Used open-ended prompts (e.g., "What do we know?") Avoided direct answers while supporting thinking
Students lacked a bank of problem-solving strategies	Polya (1945) – How To Solve It	The toolkit gives students the confidence and independance when completing problem solving tasks	Created a co-constructed problem-solving "toolkit" accessible to all students
Scaffolding was withheld from the teacher and not very child centred	Mercer et al. (1999) - Children's talk and the development of reasoning in the classroom.	Exploratory talk helps make reasoning visible and promotes co-construction of knowledge. Also a form of scaffolding	Embedded structured peer discussions to support scaffolding, reasoning, justification, and collaborative thinking

Figure 4.5: Literature Consulted, and the Learning Gained

4.6 Discussion of Changes to Practice in Cycle Two

This section will discuss the changes that occurred throughout Cycle Two based on the challenges faced in Cycle One. After studying literature, discussing concerns with my critical friend and reflecting on data gathered, I became confident in addressing these changes and implementing GD to a higher standard in my classroom.

To address the lack of resilience and increased frustration evident in some students, I turned to the work of Jo Boaler (2016a; 2016b) and Biccard (2021). Their work on mathematical growth mindsets and the value of productive struggle provided significant information for me throughout this study. I introduced Boaler's reflections on neuroscience research discussing the role of mistakes and brain growth. Her positive mindset messages were used throughout lessons and displayed on our walls. These additions encouraged children to shift their mindsets about mistakes. The work of Boaler (2016b) also promoted a change in the praise and feedback I provided to children. In the past, I had prioritised praising children who arrived at correct solutions, however, Boaler (2016a) influenced me to instead praise the efforts and persistence of children. My practice began to shift from praising correct answers to praising students' mathematical thinking. This improved students' resilience and supported their sense of competence.

As mentioned previously, I often noticed that students lacked confidence when approaching problem-solving questions and seemed to have no toolkit or strategies readily available to guide their thinking. As a response, I started reading increased problem-solving literature and found inspiration in Polya's (1945) four-step problem-solving model. This model encourages learners to understand a problem, devise a plan, carry it out, and look back at the solution. Having this resource readily accessible enabled learners to develop greater independence and confidence when engaging with open-ended problems, as it provided them with a scaffold to navigate complex tasks and evaluate their approaches more effectively. Additionally, children now had personal toolkits containing strategies that they found helpful for problem-solving. See figure 5.6 an example of a student's toolkit.

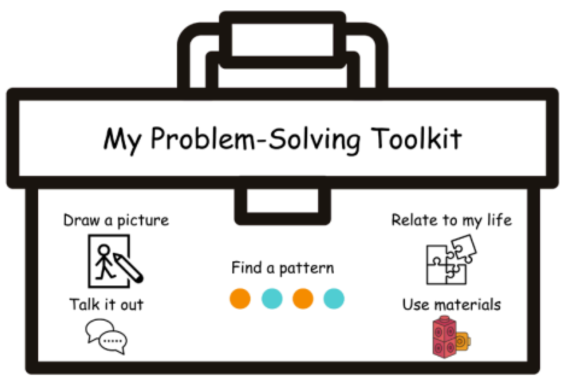


Figure 4.6: A Problem-Solving Toolkit

After noticing the lack of scaffolding I had provided in Cycle One and recognising its value, I began to read the literature about productive scaffolding. I discovered the research conducted by Wood et al. (1976), which emphasised the significance of scaffolding through questioning. I began to restructure my feedback to include open-ended prompts such as "I wonder if we could try that another way?" or "What do you already know about that?" This shift allowed for scaffolding without directly giving instruction, which encouraged learners to think for themselves and preserved the exploratory spirit of GD.

Scaffolding was also introduced through the concept of "exploratory talk" as explained by Mercer et al. (1999). The authors describe this as learners engaging in critical yet constructive dialogue, where ideas are shared, examined, and built upon collaboratively. This approach allowed scaffolding to occur not only through teacher facilitation but also through peer-to-peer interaction, aligning with Vygotsky's (1978) notion of the Zone of Proximal Development (ZPD), where learning is supported through social collaboration. Given that GD is a child-centred approach, it was crucial to provide students with as much autonomy as possible. Rather than relying solely on adult input, learners became active co-constructors of knowledge, drawing on and contributing to a shared understanding of mathematical ideas. Mid-task and lesson pauses were used strategically, and children began to borrow ideas from each other, provide reasoning for their efforts, and engage more effectively with tasks. This form of communication between students promoted the sense of relatedness that may have been missing from Cycle One. See Appendix 10 for further examples of sentences and prompts used.

By promoting exploratory talk in Cycle Two, students were able to build on each other's thinking, clarify misconceptions collaboratively, and engage more meaningfully with the tasks. This addition also aligns with the PMC where one of the four elements is communication which promotes children "discussing and conveying their thinking, ideas, relationships and logical arguments" in the form of maths talk (NCCA, 2023: 15). The second cycle marked a distinct shift from the first, where limited peer interaction and over-reliance on teacher guidance had constrained both autonomy and collaborative learning.

To allow children to become more confident and comfortable with peer interactions, I gave them the option to choose their partners or groups. While I initially approached this strategy cautiously, concerned that it might lead to off-task behaviours, the outcome was notably positive. Students showed high levels of engagement and focus, likely due to their investment in both the task and the collaborative process. This decision also aligned with the integration of exploratory talk, which supported structured peer dialogue and allowed me to monitor learning more effectively through shared discussions. Furthermore, giving students autonomy in choosing their working groups contributed to a more student-centred learning environment, supporting one of the key principles of self-determination theory: autonomy as a driver of intrinsic motivation (Ryan & Deci, 2000). By embedding opportunities for choice within the structure of GD, students not only took greater ownership of their learning but also demonstrated increased motivation and accountability during collaborative tasks.

4.7 My Practice Pre- and Post-Intervention

In this section, changes in my overall practice will be evident. Having implemented informed changes in response to the challenges identified during the initial cycle, I observed further refinements in my approach. These adjustments brought my practice closer to alignment with my core professional values, including care, child-centred learning, inclusion and fostering enjoyment in learning. Also, I noticed a significant boost in students' motivation during mathematics lessons, which I believe is due to intentionally including the three psychological needs of the Self-Determination Theory (Ryan & Deci, 2000), autonomy, competence, and relatedness, within the GD approach. Figure 5.5 diagrammatically shows the stages of improvement in my practice from pre-intervention to Cycle Two

Teaching Style Compared

	Pre-intervention	Post-Cycle One	Cycle Two
Teaching Style	Directive, teacher-led	Inquiry-based, student-centred	Increase in student-centred learning with the addition of exploratory talk Increasred scaffolding
Role of Materials	Minimal or textbook-based	Concrete materials central to learning	Continued use of concrete materials
Student Engagement	Passive, recall-focused	active, exploratory	Increased due to the choice of pairs and groups Less frustration
Assessment	Product-Based (correct answers)	Process-Based (thinking, reasoning)	Process-Based with additional growth mindset feedback
Teacher's Role	Instructor	Facilitator and co-learner	Facilitator and co-learner Using prompts and statements to extend thinking
Tasks	Closed - right or wrong	Open - multiple correct answers and methods	Open - multiple correct answers and methods
Use of Reflection	Rare	Central to the study. Allowed for changes to be made on the intervention and my practice	Part of my daily routine More natural approach

Figure 4.7: Overview of Changes in my Practice

4.8 Conclusion

This chapter provided a comprehensive account of the implementation of GD in my classroom. It outlined the initial pedagogical shift, the processes and outcomes of Cycle One, and the reflective considerations that informed changes for Cycle Two.

Cycle One highlighted both the strengths and challenges of this approach. While many students demonstrated increased engagement and enthusiasm, particularly using LTHC tasks and concrete materials, several areas required refinement.

Difficulties such as student frustration, over-reliance on the teacher, limited problem-solving strategies, and ineffective group dynamics became evident. These findings, informed by relevant literature, helped me to adjust my practice further for Cycle Two. These changes included providing improved scaffolding, adding a problem-solving toolkit, grouping students by choice, and placing greater emphasis on encouraging independence and resilience.

Reflecting on these developments, it is evident that my practice began to shift more closely toward my professional values. The evolution of my role from instructor to facilitator allowed for a deeper understanding of my students' needs and strengthened my capacity to create a motivating mathematical learning environment.

The next chapter will explore the impact of these changes by examining the findings from my study and evaluating the overall effectiveness of the GD intervention in enhancing student motivation in mathematics.

Chapter Five - Data Analysis and Findings

5.1 Introduction

This chapter presents a comprehensive analysis of the data collected in response to the overarching research question:

How can I promote intrinsic motivation in third-class mathematics lessons using a Guided discovery approach?

The study adopts a mixed-methods approach, incorporating both quantitative and qualitative data to provide a robust and multi-dimensional understanding of the outcomes. Quantitative data was gathered through Likert-scale surveys and analysed to identify trends in the students' responses. Qualitative data was analysed using thematic analysis. This methodological triangulation enhances the credibility and depth of the findings (Clark & Creswell, 2008).

As a practitioner-led action research (AR) study, this process allowed me not only to gather and analyse data but also to reflect on and improve my teaching practice in real-time. By systematically analysing the outcomes of my pedagogical choices, I was able to identify areas of success and development, an essential aspect of reflective practice in education (Schön, 1983).

This chapter is organised around three major themes that emerged from the data and closely align with the research question. These themes are:

1. Increased Student Engagement
2. Student Frustration
3. Change in Teachers Role

Collectively, these themes illustrate the complex yet positive experiences of implementing a Guided discovery (GD) approach in a primary mathematics classroom. In addition, these themes also shed light on the factors that can contribute to the promotion of intrinsic motivation among learners.

5.2 Data analysis

Data analysis was a critical stage in the research process, as it allowed me to make sense of the information collected and draw meaningful conclusions regarding the research question. Using systematic analysis identified patterns, relationships, and themes, transforming raw data into evidence-based insights (Cohen et al., 2011).

In AR, data analysis is important as it not only informs findings but also supports the practitioner in evaluating the impact of their interventions and refining their professional practice (Blodgett, 2010). Analysing both forms of data ensures that the research is rigorously reflective, providing a balanced and credible foundation for decision-making and further investigation. Without careful analysis, the data remains disorganised and disconnected, which limits its usefulness for answering the research question or contributing to educational improvement. As McNiff and Whitehead (2011) emphasise, AR analysis is integral to the reflective cycle, enabling educators to make informed judgements and adapt their practices in response to emerging evidence.

5.2.1 Analysing Quantitative Data

As discussed throughout Chapter Three, quantitative data took the form of Likert scale surveys. These scales are commonly used to measure attitudes, opinions, and perceptions (Likert, 1932). These surveys asked children to rate their responses to statements using a scale of agreement (supported by emojis for clear delivery).

Statements included the following: ‘I enjoy being challenged in maths lessons,’ ‘Lessons are fun,’ ‘I enjoy Guided discovery,’ and ‘I keep trying even when a problem is difficult.’ These statements arose from reflecting upon the children’s learning logs, my observations that I recorded in my reflective journal, and conversations during lessons. Responses varied from ‘strongly disagree,’ ‘disagree,’ ‘not sure,’ ‘agree,’ and ‘strongly agree.’

To facilitate analysis, each response was assigned a numerical value on an ordinal scale, with *Strongly Disagree* scored as one and *Strongly Agree* scored as five. This transformation of qualitative sentiments into quantifiable data enabled the calculation of descriptive statistics, including response frequencies and mean scores. Likert (1932) explains that averaging responses across several items results in a more accurate measure of an individual’s overall attitude. Figure 5.1 shows the calculation of a mean score from one of the statements. This analytical approach allowed for the identification of trends and shifts in student attitudes across the duration of the intervention and gave more information about how GD influenced intrinsic motivation in the mathematics classroom (Lim, 2025). A sample of the survey is included below as Figure 5.2 for reference.

Responses to the statement, "I would like to continue Guided discovery in math lessons."

Response Option	Assigned Value	Number of Responses	Total Score (Value × Responses)
Strongly Agree	5	19	95
Agree	4	1	4
Not Sure	3	1	3
Disagree	2	0	0
Strongly Disagree	1	0	0
Total	—	**21**	**102**

$$\text{Mean} = \frac{\text{Total Score}}{\text{Number of Responses}} = \frac{102}{21} \approx 4.86$$

Figure 5.1: Shows the Process of Finding the Mean Score when Using. Quantitative Data

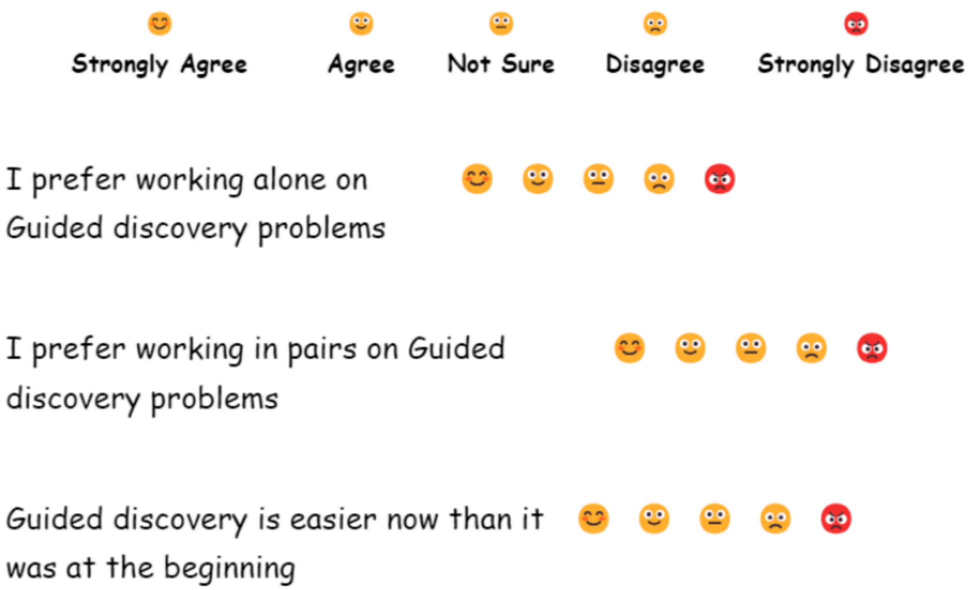


Figure 5.2: Sample of a Student Survey

5.2.2 Analysing Qualitative Data

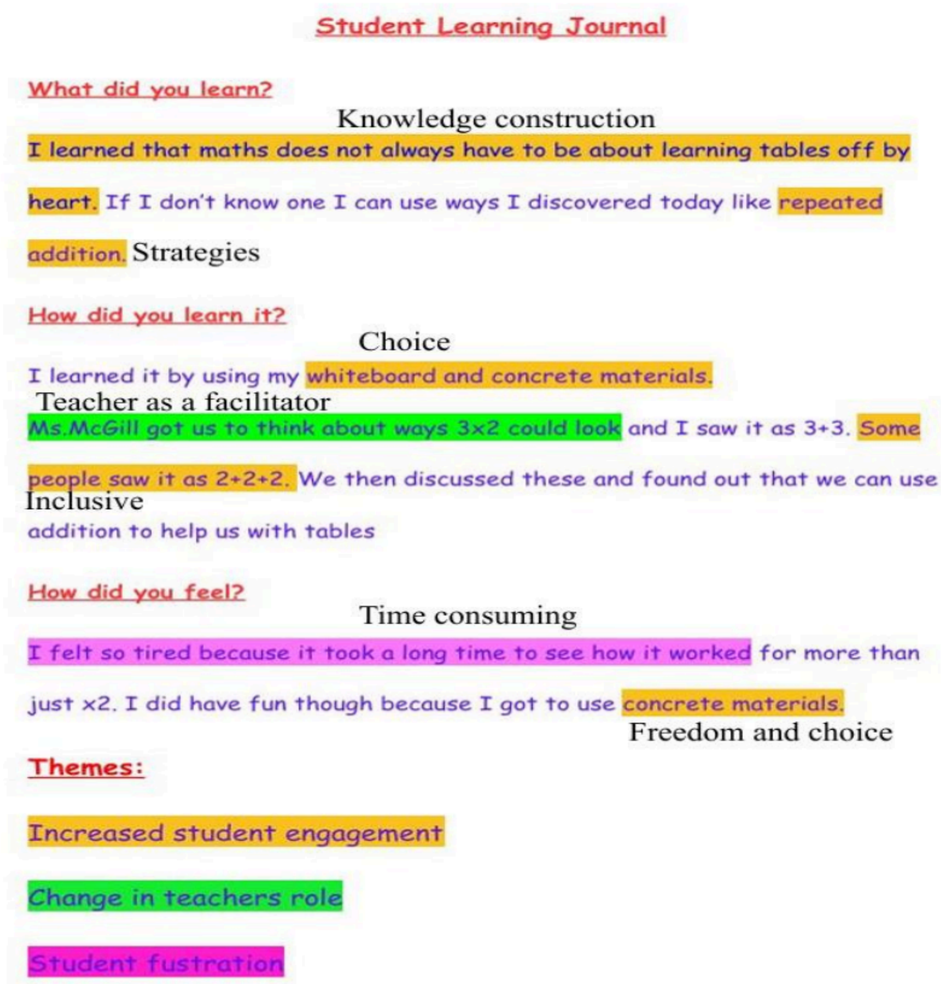
Qualitative data was analysed thematically using Braun and Clarke's (2006) six- phase model. This model contains the following stages: familiarisation with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and producing the report. Please see below a more detailed description of each stage.

Figure 5.3: Braun and Clarke's (2001) Six-Phase Thematic Analysis Model

As seen above, stage two, coding is an integral and important part of the thematic analysis process. In the next section, the use of coding will be discussed, including its importance for identifying relevant themes.

5.2.3 Coding

The process of analysing the qualitative data involved a systematic coding approach, in line with Braun and Clarke's (2006) six-phase framework for thematic analysis. As I engaged with the data numerous initial codes began to emerge. These codes captured recurring patterns in behaviour, language, and emotional responses observed during the intervention. Figure 5.4 details a coded section from a student's learning journal.


Student Learning Journal

What did you learn?

Knowledge construction

I learned that maths does not always have to be about learning tables off by heart. If I don't know one I can use ways I discovered today like repeated addition. Strategies

How did you learn it?

Choice

I learned it by using my whiteboard and concrete materials.

Teacher as a facilitator

Ms.McGill got us to think about ways 3x2 could look and I saw it as 3+3. Some people saw it as 2+2+2. We then discussed these and found out that we can use addition to help us with tables

Inclusive

How did you feel?

Time consuming

I felt so tired because it took a long time to see how it worked for more than just x2. I did have fun though because I got to use concrete materials.

Freedom and choice

Themes:

Increased student engagement

Change in teachers role

Student fustration

Figure 5.4: Coded Student's Learning Journal

Through an iterative process of reviewing, refining, and grouping similar codes, broader categories began to form. These refined codes were then organised into overarching themes that reflected key dimensions of the student's experience with GD. Figures 5.5, 5.6, and 5.7 illustrate this process. Figure 5.5 displays the initial and refined codes that contributed to the development of the theme *'Increased Engagement,'*, while Figure 5.6 outlines the codes that led to the theme *'Frustration'*. Figure 5.7 presents those that formed the basis of the theme *'A Change in the Teacher's Role'*.

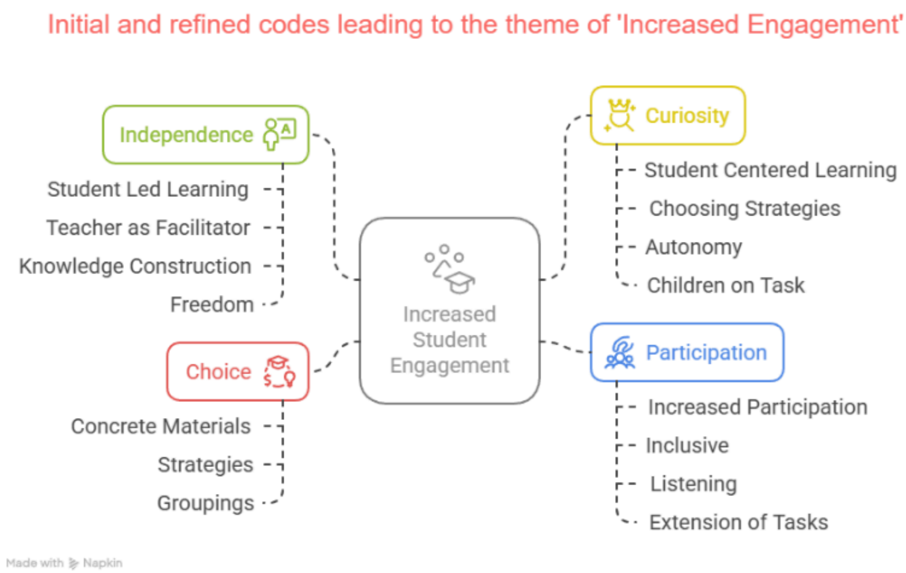


Figure 5.5: Coding Leading to the Theme of Increased Engagement

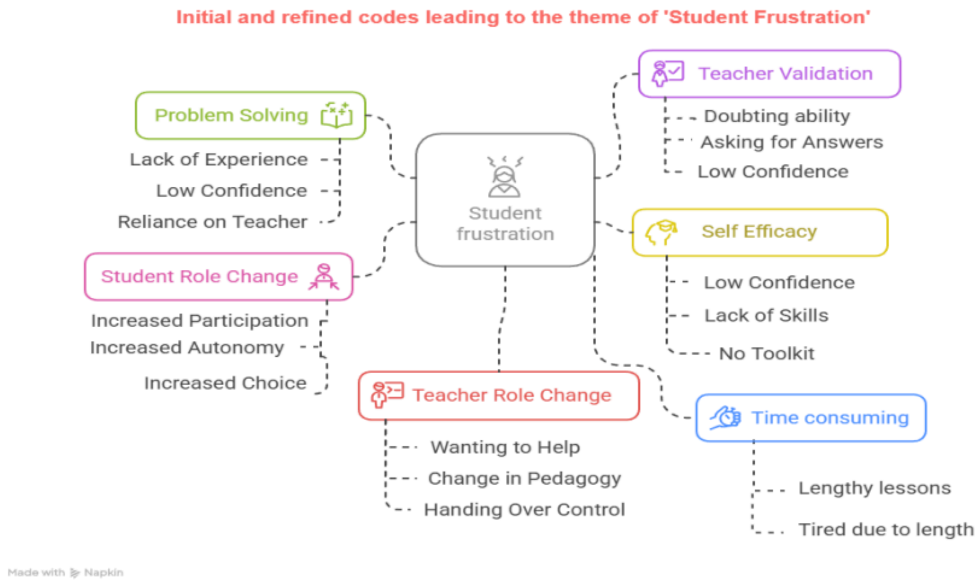


Figure 5.6: Coding Leading to the Theme of Student Frustration

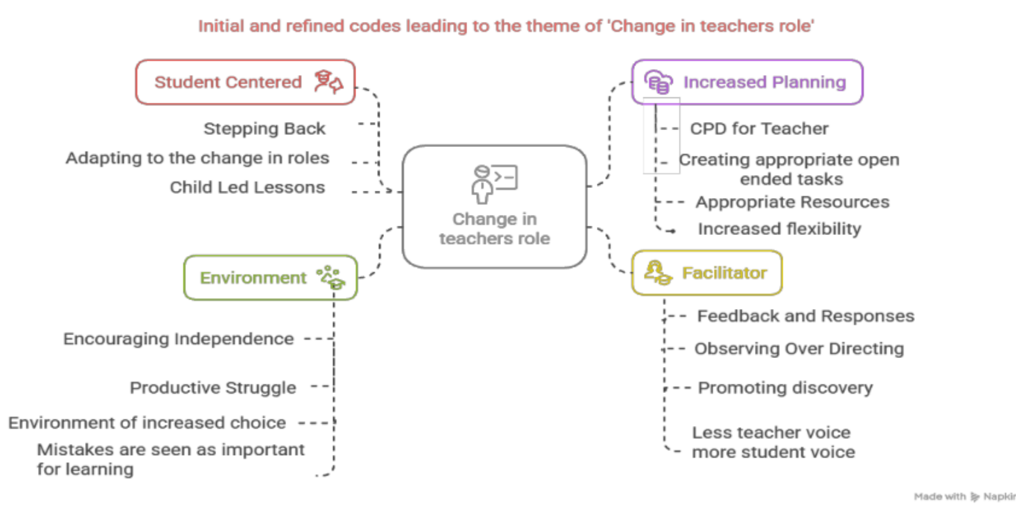


Figure 5.7: Coding Leading to the Theme of Change in Teachers' Role

By integrating the findings from student surveys with the themes that emerged from qualitative data sources, I developed three coherent and interrelated themes that consistently appeared across the dataset. This process of using two types of data enhanced the credibility and validity of the analysis by allowing multiple forms of evidence to support the thematic conclusions (Cohen et al., 2011). The following section presents a detailed discussion of each theme, supported by illustrative examples drawn from across the study.

5.3 Theme 1: Increased Student Engagement

The implementation of GD approaches markedly increased student engagement, one of the most prominent findings from this research. This theme emerged from a combination of qualitative data sources, including student questionnaires, a teacher's reflective journal that noted personal reflections on lessons and observations made, and student learning logs. This data was further supported by the quantitative data collected from surveys.

The initial codes that emerged when analysing qualitative data included: *hands-on activities*, *student-centred learning*, *concrete materials*, *autonomy*, *extending tasks*, and *increased participation,* which were refined into broader thematic categories including *independence*, *choice, curiosity,* and *participation*, all converging into the final theme of increased engagement.

Children demonstrated high levels of enthusiasm for GD lessons. Reflective journal entries noted that students frequently asked, "Are we doing Guided discovery today?" This highlights not only their eagerness to take part but also their growing emotional connection to this form of learning. This shift in attitude was further supported by questionnaire responses, where students indicated they found maths "more fun" and said they enjoyed "working it out without the teacher telling us." These statements signified a departure from passive learning and pointed to a deepening engagement driven by active participation.

Concrete materials have proven to be particularly effective in fostering engagement through hands-on experiences. Activities involving manipulatives encouraged students to explore mathematical concepts in a fun, child-friendly way. I began to note these moments in my reflective journal:

"When using concrete materials, including cubes, buttons, and lollipop sticks, the children were visibly more engaged, as they found it easier to work things out when they could visualise it in front of them."

(McGill, Reflective Journal, 2025).

This observation aligns with research that supports the use of physical tools to enhance conceptual understanding and motivation (Carbonneau, Marley & Selig, 2013).

A further factor in increased engagement was the observed rise in student autonomy. I had previously noticed students, particularly higher achievers, sitting around once completing mathematical questions and waiting for me to come and verify their answers. However, due to the addition of GD, children were frequently seen extending tasks without prompting, an outcome that indicated not only understanding but also a desire to persist and explore further. In my reflective journal, I recorded my thoughts on these task extensions.

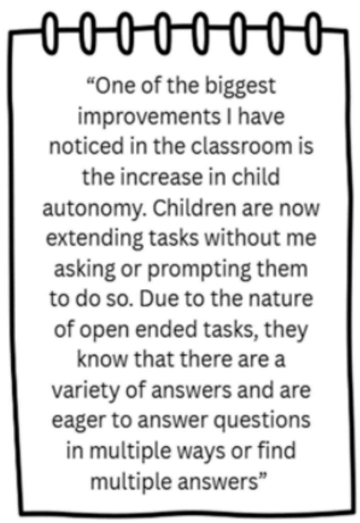


Figure 5.8: Reflective Journal Entry Discussing Changes in Child Autonomy

Such behaviour reflects intrinsic motivation, where learners engage out of personal interest and internalised goals, a key factor of the SDT (Deci & Ryan, 2000).

Moreover, collaborative groupings and freedom of strategy choice gave learners a stronger sense of autonomy, competence and relatedness. This autonomy appeared to drive engagement, particularly for students who previously displayed lower confidence or disengagement during the previous style of direct teaching. Answering the question 'What do you enjoy about Guided discovery?' One child shared:

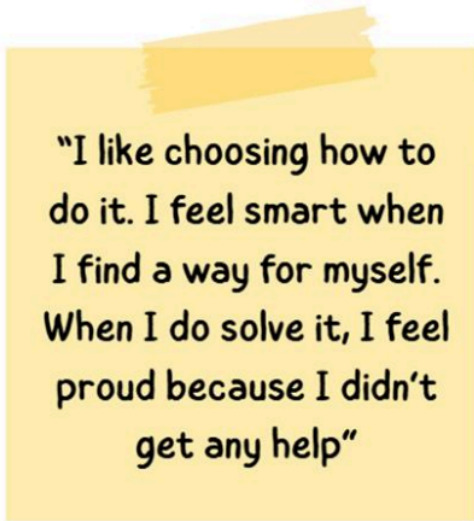


Figure 5.9: Child's Response

This finding links heavily to research conducted by Russo and Hopkins (2019), who suggest that when children make progress with challenging tasks, such as LTHC tasks, they experience a sense of accomplishment and pride, key indicators of increased competence throughout.

Quantitative results further validated the elevated levels of student engagement. When asked to respond to the statement *"Maths lessons are fun,"* all twenty-one students either strongly agreed or agreed, producing a mean score of 4.81 out of 5. Similarly, the statement *"I enjoy Guided discovery"* received positive responses, with eighty-six percent strongly agreeing. These responses reflect an increased positive attitude towards mathematics and an emotional connection to the lessons, key indicators of engagement (Cunningham, Wang & Bishop, 2006). As Robinson and Aronica (2015) argue, when students find learning enjoyable and meaningful, they are more likely to actively participate and persist through challenges. To see children enjoying lessons affirmed that I was now living more closely to my value of enjoyment of learning indicating that my practice was aligning more with my stated values.

Figure 5.10: Results to Survey Statement 'Lessons are fun.'

A standout moment from this study was when Child J was filling in his end of year memory book. When questioned 'What is your favourite memory from this year?', he wrote 'Guided discovery'. This child did not place much importance on school and often expressed P.E as his favourite subject. This child choosing Guided discovery, part of an academic subject, was a huge moment for me as his teacher. Clearly, GD engaged him in ways previous mathematic teaching had not.

Across all data sources, the triangulation of findings strongly supports the conclusion that student engagement increased significantly when learners were provided with opportunities to lead their learning through discovery, collaborate with others, use concrete materials, and operate in an environment that valued their autonomy and voice.

Although the finding above shows that this implementation has proven successful in engaging children during mathematics lessons, it is important to remember that teacher development plays an important role in AR studies. Whitehead (1989:41) encourages action researchers to tackle the question, "How can I improve my current practice?" The codes, themes, and responses from the children have shown a shift from a traditional style of teaching, where I was an instructor, to a more child-centred approach, where I can be seen as a facilitator. The strategies implemented show the extensive research carried out by me as an educator to introduce a way of teaching that would promote intrinsic motivation in a child-friendly manner.

5.3.1 Discussion and the Link between Engagement and Intrinsic Motivation

Through the implementation of GD, the psychological needs of autonomy, competence, and relatedness, central to SDT, were supported in the classroom. Children identified opportunities for meaningful choice, challenge, and collaborative learning. These conditions align with the findings of Collie and Martin (2019), who argue that when students perceive their environment as satisfying these core needs, they are more likely to exhibit both higher engagement and increased motivation.

In this study, engagement was observable through students' persistence with tasks, curiosity during lessons, and enthusiasm for learning. While motivation is inherently difficult to measure directly, such observable behaviours are commonly accepted as key indicators of intrinsic motivation (Guay, Vallerand & Blanchard, 2000). As Collie and Martin (2019: 4) note, "engaged students are more likely to feel motivated to learn because they are experiencing success and meaning in their learning." In this context, engagement acted both as a visible outcome of the teaching approach and as evidence for deeper motivational shifts. Therefore, the findings suggest that GD extended past short-term interest and instead, it fostered the kind of sustained engagement that is associated with the development of intrinsic motivation over time.

The next section will discuss Theme 2: Frustration, a challenge I encountered and overcame throughout this study.

5.4 Theme 2: Frustration

Early stages of the intervention revealed the presence of frustration among students. Although it was initially identified as a challenge, this frustration became one of the most significant findings of my research and has led to important learning and development. I initially became aware of the frustration among students due to the increased independence that GD expected from them. They were transitioning from the comforts of direct teaching approaches to a more independent problem-solving environment where, instead of being told what to do and how to solve problems, they were discovering for themselves. In my reflective journal, I recorded instances where children expressed dissatisfaction, asking, *"Why won't you just tell us the answer?"* or showing visible signs of impatience when they couldn't quickly arrive at a solution.

Further signs of frustration became evident throughout the student's learning journals. Due to the open-ended nature of tasks, students felt a sense of uncertainty. One student noted, "I was very mad at first" after a multiplication lesson, while another student wrote, "It was hard and long." These responses showed an apparent shift in students' comfort zones due to the exploratory nature of this intervention. Boaler (2016b), however, acknowledges that a shift in comfort zone can often lead to more meaningful learning, encouraging further investigation.

I also began to acknowledge that student mistakes in the process of discovery were leading to frustration. In my reflective journal, I recorded the following observation:

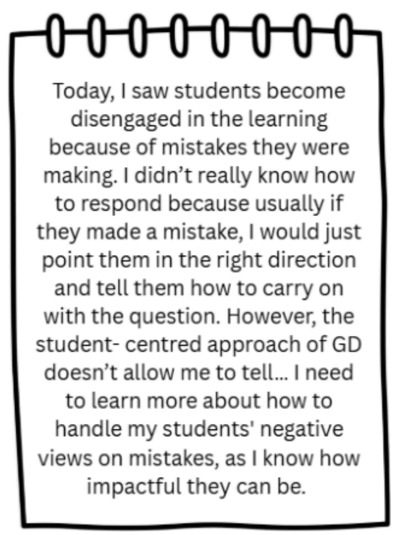


Figure 5.11 Reflection on Children Making Mistakes in Class

These behaviours revealed how unfamiliar and uncomfortable the struggle process was for many of them. They were not yet open to making mistakes or to viewing difficulty as a sign of growth.

Quantitative data collected also suggested a sense of frustration amongst students. When asked to respond to the statement 'I sometimes become frustrated during GD lessons,' children shared intriguing results. These results are seen in Figure 5.12 below. Results showed a mean total of 3.75, which indicates a general agreement to the statement and highlights that frustration was a common experience among students in the class.

Response to 'I sometimes become frustrated during GD lessons.'

Response	Number of Children	Point Value
Strongly Agree	2	5
Agree	13	4
Not Sure	4	3
Disagree	0	2
Strongly Disagree	1	1

N= 20 Mean = 3.75

Figure 5.12: Survey Results Responding to the Statement 'I sometimes become frustrated during GD lessons.'

Importantly, not all frustration was detrimental. Child S, an exception to previous comments, noted that although she became frustrated during some lessons, it motivated her to keep trying to discover the answer or concept on her own. This experience marked a significant shift in my perception of frustration, transforming it from a negative reaction to a potential avenue for deeper learning, provided it receives appropriate support.

Reflecting on literature and my notes, I gradually began to realise that this shift away from teacher-led instruction towards a more learner-driven approach challenged some students' sense of competence, one of the three basic psychological needs described in Self-Determination Theory (Ryan & Deci, 2000). Their frustration appeared to stem from a sudden decrease in external support, which they had previously relied on and so, challenged their motivation. Similarly, drawing from Vygotsky's ZPD (1978), I realised that some of the tasks initially exceeded the students' capacity to work independently, placing them in what Taber (2018) describes as the Zone of Distal Development (ZDD), where learning becomes ineffective without sufficient support. These theories suggest that the frustration that was evident in my classroom could be avoided with better scaffolding.

Instead of resorting to direct instruction methods, I initiated research on productive ways to address this frustration. I came upon the term 'productive struggle,' defined by Biccard (2024). This concept can be seen as essential for mathematical learning and intrinsic motivation when challenge, as commonly seen in LTHC tasks, is met with the correct balance of support.

In Cycle Two, I adjusted my approach to the intervention, as explained in Chapter Four. The scaffolds that I implemented, such as toolkits, prompts, and peer support, acted as support for children yet still preserved the open-ended nature of tasks. These changes allowed students to feel more supported and capable, therefore improving their intrinsic motivation (Ryan & Deci, 2000). Implementing these changes led to an increase in resilience and persistence. In particular, the promotion of a growth mindset environment, based on Boaler's (2016a) work, helped students view mistakes as evidence of learning and growth. Over time, I noticed children overcoming challenges by making comments such as "Maybe if I try another way" or "I think I'll use another strategy to work this out." Through these comments, increased autonomy is evident as children make their own decisions rather than relying on their teacher.

5.4.1 Problem-solving

As mentioned in section 4.4.5 (Chapter Four), problem-solving skills were identified as an area that students struggled with throughout this study. As an important part of the new PMC (NCCA, 2023), encouraging development in this area was important. Along with trying to promote increased problem-solving skills came added frustration from students. Overall, many children found problem- solving challenging, confusing and had negative perceptions of what problem-solving really entailed. To overcome this challenge, I had to shift my own assumption of what problem-solving meant. I reflected on my own thoughts towards problem-solving and came to the realisation that I had previously seen problem-solving as a method only taught through word problems. With the help of CPD (Continuous Professional Development), particularly the work of Van De Walle et al. (2022), my own thoughts on problem-solving began to change. I realised that problem-solving was not just a secluded aspect of maths but a 'fundamental feature of mathematics curricula' (Foster, 2023: 594).

With the addition of the work of Polya (1945) and problem-solving toolkits throughout Cycle Two, came increased confidence and positive attitudes for my students and I. Along with this, the GD approach lends itself well to problem-solving and so, creates an overall environment of problem-solving in a child-centred way (Simamora & Saragih, 2019). The students who took part in this study now have an increased level of problem-solving skills evident in their work and conversations. With the aid of LTHC tasks, students now see problem-solving as self-directed missions in which they want to find multiple solutions and pathways.

5.4.2 Discussion and Link to my Research Question

In the initial stages of the intervention, I assumed that intrinsic motivation would naturally emerge if students found mathematical content enjoyable, easy to understand, and relevant. However, through the lens of Self-Determination Theory (Ryan & Deci, 2000) and my observations across both cycles, I came to a deeper understanding: 'intrinsic motivation is not simply the result of ease or immediate success. Rather, it is often cultivated through 'meaningful challenge, persistence, and the eventual sense of accomplishment that follows struggle' (Bullmaster-Day, 2016: 3).

Frustration, as it emerged early in the study, challenged my beliefs and practice. While initially considered a setback, it became clear, through reflection and research, that this emotional response could serve as a positive to my study, provided it was met with the right pedagogical support. This aligns with Biccard's (2024) assertion that productive struggle, when appropriately scaffolded, fosters deeper understanding and resilience. By shifting the learning environment to support struggle instead of removing it, I observed that students developed a stronger sense of agency and competence.

In this way, the experience of frustration became directly linked to my research question: 'How can I improve intrinsic motivation in third-class mathematics lessons by promoting a Guided discovery approach?' The answer lies not in removing challenge but in creating the conditions where challenge can lead to growth. By transforming unproductive struggle into productive struggle, all three basic psychological needs, autonomy, competence, and relatedness, were more fully supported, allowing intrinsic motivation to emerge and thrive for my students.

The next section will discuss the final theme, which shows how this study has shifted my practice.

5.5 Theme 3: Change in Teachers' Role

Brown (c.2015) shares that when students become the centre of the learning, it is usually assumed that the teacher takes a lesser role; however, the opposite has been true throughout the implementation of GD in my classroom. In this section, I will examine how my role as a teacher developed further due to enhanced planning, changes in responses, and modifications to the learning environment, as well as how becoming a facilitator led to more meaningful lessons.

The transformation in my practice was evident through both qualitative and quantitative data. When examining student questionnaires, learning logs and my reflective journal, Initial codes such as *student-centred learning*, *stepping back*, *adapting to change in roles*, *child-led learning*, and *facilitator* were refined into broader codes which can be seen in figure 4.9. Students commented on a change in my behaviours throughout questionnaires, with statements such as:

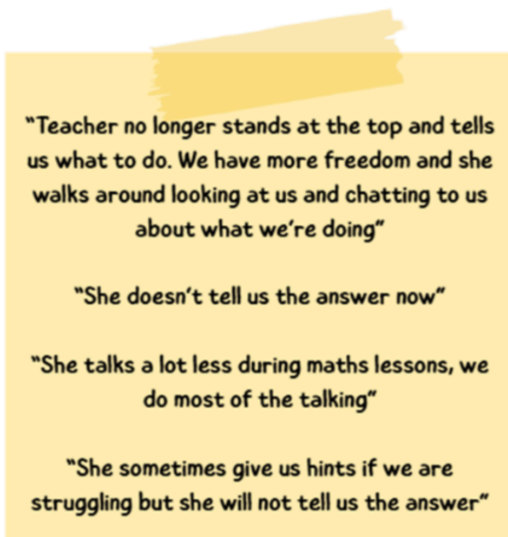


Figure 5.13: Children's Questionnaire Responses Discussing Change in Teacher Role

This change, acknowledged by my students, reflects an alignment with constructivist principles, where the teacher's role is to support, scaffold, and extend learning based on students' active engagement (Vygotsky, 1978).

Quantitative results also highlighted the change in my role. Children shared a strong disagreement to the statement 'I prefer when the teacher stood at the top of the room, and we listened'. This statement reflected my previous role in the classroom as a lecturer over my new role as a facilitator. Seventeen children voted 'strongly disagree' (1), two children voted disagree (2) and two children voted 'not sure' (3). This resulted in a mean total of 1.29, suggesting a strong disagreement. When combining this data along with their comments above, children not only enjoyed the change in my role but also their new roles as explorers rather than passive listeners.

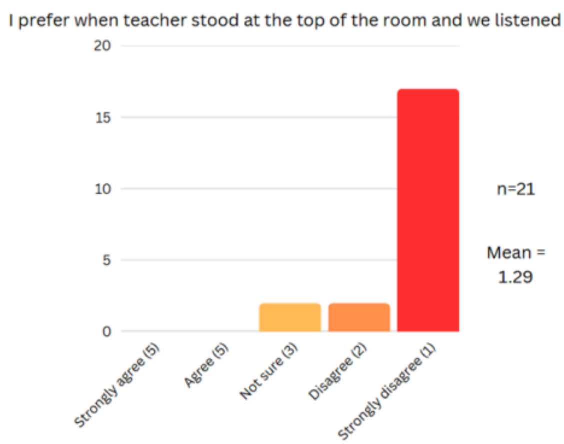


Figure 5.14: Results from Survey Statement 'I prefer when teacher stood at the top of the room and we listened.'

5.5.1 Increase in Planning

Through reflective journal entries, I noted a significant increase in planning workload. Planning took different forms, including identifying appropriate concrete materials, designing discovery-based tasks tailored to pupils' interests, and becoming flexible and ready for discoveries that may happen the following day. Yuliani & Saragih (2015) highlight the importance of flexibility during GD, noting that teachers must be prepared to adjust based on student responses and unanticipated learning outcomes. In a journal entry made on 30th April I reflected on planning and wrote the following:

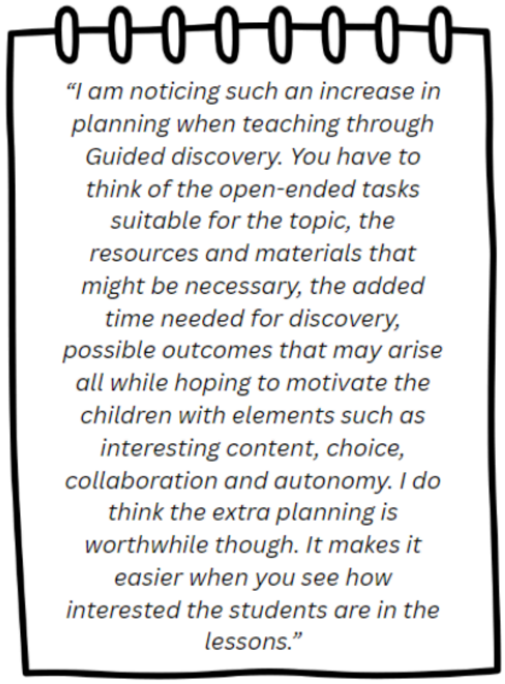


Figure 5.15: Teacher Reflective Journal Entry Discussing Increase in Planning

As outlined in the reflection above, the implementation of GD had a significant impact on the planning process. I began to acknowledge that often two plans were needed for each lesson, one for the intended path and one for the possible discoveries that could be made. However, planning was not just needed for the lesson content but also for the scaffolding and easing of frustration throughout the lessons. To ensure that students' struggles remained productive rather than discouraging, deliberate and thoughtful planning was essential. Biccard (2021) emphasises that productive struggle is most effective when key elements, such as the classroom environment, task design, teacher orientation, and student orientation, are intentionally considered. In line with these recommendations, planning ensured coherence, progression, and appropriate levels of challenge. Tasks were carefully selected and designed to promote student discovery, stimulate curiosity, activate prior knowledge, and match the learners' developmental levels (Biccard, 2024).

By embedding these principles into open-ended tasks and providing timely scaffolding, students engaged meaningfully with the content, encountering manageable challenges that encouraged persistence and deeper understanding.

A detailed lesson plan which shows intensive planning can be seen in Appendix 9.

5.5.2 From Instructor to Facilitator

During lessons, my role shifted from being instructional to being a facilitator. I became aware of putting a greater emphasis on observation, feedback, and open-ended questioning, rather than direct instruction. The reduction of teacher voice and amplification of student voice were central to this shift. This repositioning aligns with the role of a facilitator in discovery learning, as described by Bruner (1961), who advocated for teachers to act as guides that promote inquiry and support learners in constructing meaning independently, thereby encouraging their sense of autonomy.

Students, too, acknowledged this shift, expressing appreciation for the freedom to choose strategies, make mistakes, and receive responsive support rather than fixed instructions. Students responded to the question "How did you complete this task?" in their learning journals and many noted the freedom to choose strategies and materials, trying different ways, talking to their friends, and using previous learning as ways that were helpful to them.

5.5.3 Ongoing Continuous Professional Development (CPD)

To adapt accordingly to this change in role, I engaged in intensive personal professional development throughout the intervention. Initially, I felt underprepared for the demands of GD. To shift from direct instruction to GD, I not only needed to engage with new strategies but also needed to change my mindset. I dedicated time outside of school hours to better my understanding of discovery learning and scaffolding and reflect on relevant theories. This learning took the form of academic reading, consultations with my critical friend and supervisor, and continuous self-reflection.

Overall, although time consuming, I could notice the benefits of this extra CPD. It allowed me to adapt my role effectively and transform as a practitioner, which was also reflected among students as their learning transformed, and ultimately, they became more motivated. As Ivanova (2017:205) states, “CPD is beneficial for both teachers themselves and their students, as it increases and maintains the quality of tuition and improves learners’ results.”

5.5.4 Discussion

This theme directly links to the core aim of my research: to improve intrinsic motivation in mathematics through the implementation of GD. By adjusting my practice, including planning, responses, and interactions, I helped shape a learning environment that promoted autonomy, competence, and relatedness, key components of intrinsic motivation (Ryan & Deci, 2000).

In this way, my changing role functioned not only as a response to student needs but also as a catalyst for personal and professional development. Whitehead (1989:41) encourages practitioners undergoing AR to reflect on the following question: ‘How can I improve what I am doing?’ Through this lens, my evolving role enhanced learning for my students but also developed my commitment to ongoing professional learning. This study highlights the power of AR, which drives learner-centred transformation (Oranga & Gisore, 2023).

5.6 Conclusion

This chapter has presented the analysis from both quantitative and qualitative data collected through the intervention. The collected data helped shape the findings from this study.

The findings highlight the positive impact that GD can have on pupil engagement and motivation in the primary mathematics classroom. Drawing on the framework of SDT (Ryan & Deci, 2000), the data suggest that GD supported the development of the core psychological needs of autonomy, competence, and relatedness, each of which is essential for fostering intrinsic motivation.

While the intervention revealed clear benefits, the findings also highlighted challenges, particularly regarding the increased demands on teacher planning and the need to create a classroom environment that contributes to productive struggle. The need for well-organised tasks, helpful support, and meaningful questions became key factors for allowing effective discovery while still giving learners control.

Despite these challenges, the overall impact of this study is positive. The findings provide strong support for the use of GD as a pedagogical strategy in the classroom. GD as a methodology, not only promotes mathematical understanding but also meets the motivational needs of learners.

The next chapter will summarise the research and provide recommendations for the future of GD in classrooms.

Chapter Six - Implications and Conclusion

6.1 Introduction

This study examined the potential benefits of introducing Guided discovery (GD) as a child-centred approach to tackling poor motivation during mathematics lessons in the primary school classroom. I employed action research (AR) methods of data collection and analysis to identify and capture the changes made in my practice. This study had several aims, including motivating my students and aligning more closely with my identified values of care, child-centred learning, enjoyment of learning, and inclusion. The children in my class became more motivated, and I am now living more closely to these values, which provides evidence of the study's overall success in meeting its aims. This final chapter presents a summary of the key findings from the study, outlines its limitations, discusses the implications for educational practice, reflects on the challenges faced, and concludes with recommendations for future teaching and research.

6.2 Summary of Findings

This research has revealed both the benefits and challenges of implementing GD in the classroom. The three main findings that emerged were increased engagement, frustration, and a change in the teacher's role. As mentioned in Chapter Five, I saw an increase in students' engagement and motivation throughout this study. The shift from a passive, didactic approach to a more child-centred pedagogy marked a significant transformation in the learning environment. Children now construct their own knowledge through open-ended tasks with the support of carefully designed scaffolding. This contrasts with the previous didactic teaching approach, in which I told students how and what to do. Using GD in the classroom, the children's psychological needs of autonomy, competence, and relatedness were being met throughout each lesson, therefore improving intrinsic motivation levels. Children felt autonomous when choosing strategies or materials to solve problems. They sensed relatedness through collaboration associated with GD, and they felt pride and success in their learning, which relates closely to competence. In addition, the presence of challenge, when appropriately scaffolded, converted initial frustration into productive struggle, which further enhanced student motivation and progress in mathematics.

One of the main challenges I faced throughout this research was understanding and exploring the sense of frustration evident among many students. Through the study of productive struggle (Biccard, 2024), I became aware of how to adapt my role to support this sense of struggle. I began to scaffold their learning in ways that did not remove their autonomy but instead complemented it. Through appropriate scaffolding, encouraging efforts, and a positive environment where mistakes were not seen negatively, children became more confident in their abilities and learnt to persevere through challenges. Although it was challenging at first, this approach became one of the most important learning outcomes of the research for both me and the students involved.

Lastly, as previously mentioned, my role as their teacher underwent a significant transformation from dictator to facilitator. Initially, I experienced discomfort with this change, but as the intervention progressed, I began to observe its benefits. Textbooks were replaced with open-ended tasks, hands-on learning, and discussions. The previous teacher-led lessons were converted to student-led, and the instruction style I had previously engaged in was replaced with scaffolding. Nevertheless, these modifications did not occur immediately, and it was the benefits of reflection that brought me to this point.

The next section will discuss the limitations associated with this study.

6.3 Limitations

This study consisted of several limitations that may have influenced its outcomes. These included the small sample size, bias, the difficulty in measuring motivation, and the topics chosen. I will discuss these separately, giving insight into how they may have determined some results.

Firstly, the sample size of twenty-two students is relatively small. This may limit the ability to draw broad conclusions applicable to a larger sample size. A larger and more diverse sample would be necessary for increasing reliability and representing the findings more accurately.

Another limitation when conducting research and analysing data is the possibility of participant bias. When working with children, participant bias is common, as often children change their behaviours and answers to fit what their teacher wants to hear (Farnsworth, 2019). To avoid these scenarios for my study, I reminded the children about confidentiality and being honest throughout. I encouraged them to become critical as I was trying to improve my teaching. It is hoped that students were honest throughout; however, when working with children, especially as young as third class, bias can be a limitation to be cautious of.

Assessing motivation, a main aim of my research question, can be inherently difficult to measure. Although I had multiple data collection methods in the form of surveys, questionnaires, learning logs, and my reflective journal, which provided insights into motivation, it is a complex concept. Guay et al. (2000) state that motivation is challenging to measure due to its psychological complexity and, therefore, hard to observe. This was part of the reason for choosing a mixed-methods approach. I wanted to overcome this limitation while still aiming to answer my research. The use of both qualitative and quantitative data collection methods encouraged a richer and more credible understanding of children's motivation levels.

Finally, the chosen topics of multiplication, division, area, and length all suited the use of GD. The effectiveness of this intervention through these subjects may have potentially enhanced it. Reflecting since, I am aware that not all topics may lend themselves as naturally to GD. Some topics or curricular subjects may require more direct instruction than the ones I chose. Therefore, the positive results observed may be limited and reflect compatibility with this intervention and the chosen topics. I do, however, promote the use of GD as part of all topics and, with further research, will test its effectiveness across the mathematics curriculum.

These limitations should be considered when interpreting the results detailed in Chapter Five. For future research, it would be beneficial to increase the sample size, continue to include a mixed-methods approach, and use a broader range of topics/subjects. This will then provide a more comprehensive insight into the effectiveness of GD on children’s intrinsic motivation.

6.4 Implications for Theory and Classroom Practice

This study contributes to theoretical and practical discussions about the promotion of GD learning in mathematics to increase student motivation. Although there is a lack of studies in the Irish context, international examples have proven successful. The findings support the idea that when students are constructing their own knowledge, actively engaged, and provided with sufficient scaffolding, they demonstrate greater interest in learning (Bruner, 1961). This approach reflects the key principle of the SDT (Ryan & Deci, 2000), which identifies autonomy, competence, and relatedness as psychological needs to be met to improve intrinsic motivation. By incorporating GD in my classroom, the three needs were met. Autonomy was promoted by providing independence and choice. Competence was built through feelings of success when overcoming challenges and LTHC tasks. Finally, relatedness was encouraged through peer collaboration and teacher support.

However, as mentioned in my findings, productive struggle was an aspect of increased motivation for many of my students. Literature discussing the role of the SDT in promoting motivation often under-represents the role struggle can have on motivation. Throughout this study, it was evident that frustration was not always detrimental. In my journal, I noted that Child S stated, "When I feel frustrated during tasks, it actually motivates me to keep going so that I can figure it out on my own." In such cases, productive struggle leads to a more meaningful sense of achievement because the student feels they arrived at the correct answer independently. This finding suggests this sense of discomfort for students should not be overlooked and instead should be seen for its constructive role in the development of motivation, an aspect that the SDT and motivation literature often overlooks.

6.4.1 Recommendations

There are many recommendations for teachers that arose from this study to effectively implement GD. Firstly, teachers should be trained to implement GD. There are many aspects of GD that I was unaware of and only became confident in implementing through personal CPD. Teachers should be supported in designing open-ended tasks suitable for their class that allow for exploration. Recognising the need for and importance of support and scaffolding was crucial for this study and is an area where teachers need more guidance.

Secondly, there is a need for teachers to acknowledge and support struggle and frustration arising from challenging tasks. Instead of avoiding student frustration, which I was guilty of in past situations, educators should normalise it and scaffold it accordingly to make it productive. Implementing strategies that encourage perseverance, like those mentioned in Chapter Four, can encourage a sense of productive struggle.

A sense of relatedness is often lacking in classrooms. Many, like me, believe it can lead to negative behaviours. However, incorporating collaboration into my classroom has provided immense benefits for my students, particularly in developing their motivation. Teachers should encourage peer discussions as a way for students to learn from each other. Exploratory talk, discussed in Chapter Four, offers excellent insights into the benefits of peer collaboration.

In addition to this, the use of collaboration helps reduce the sense of isolation that may be felt during challenging tasks.

6.5 Impact of this Study

This study has impacted my teaching in multiple ways. In this section, I will outline the implications of the study for my practice. I will discuss how this study has served me as professional development, how reflection guided me, and how the conversations I had with my critical friend led me to work collaboratively and improve my practice further.

This study has enabled me to enhance my teaching practice by helping me align more closely with my values, answer the research question, and address the problems I initially identified. I have moved from a didactic style of teaching to one that aligns with my values and promotes student motivation. Initially, I believed that a child-centred classroom meant that I would stand back and encourage them do all the work, but it is only through this research that I have truly acknowledged the importance of scaffolding and teacher's guidance. I now understand that my perception of what makes a child-centred classroom was incorrect, and acting on my assumption was leading to frustrated students. Through reflection, I began to face this issue and become more equipped with dealing with any frustrations.

It is important to mention the role that reflection has played throughout this study and the impact it has had on me. I had not implemented reflection much in my previous teaching, and when I first realised its role in AR, I felt somewhat pessimistic. However, it has played a vital role throughout this study and has shaped my practice. Incorporating reflection in my daily routine allowed me to acknowledge how I confront challenges and understand the children to a greater extent, therefore making necessary adjustments to enhance their experience. I will continue to reflect on my practice in the future and use it as a tool to adjust it if I ever lose focus on my values.

The collaborative style of AR impacted my learning throughout this study. Kemmis & McTaggart (2014) emphasise the importance of working with others to co-construct professional knowledge and throughout the research I began to acknowledge the benefits. Discussions with my critical friend allowed me to hear their opinions and gather information that I may have been missing. I am also quite critical of myself so hearing reassurance from a colleague reassured me. I found the dual role aspect of AR, being a participant and a researcher often challenging and was worried I may become bias. Having another perspective to rely on did ease this burden. I have continued the sense of collaboration to disseminate my research. Recently, I presented my study to my fellow students in Maynooth University. I also plan to share the results with my colleagues.

6.6 Challenges

There is no doubt that this process was challenging at times. I initially struggled with the shift from instructor to facilitator. When I noticed students struggling, I wanted to offer answers immediately or instantly relieve their stress. I often link this back to my value of care. Tyminski (2009), however, titles this feeling as 'teacher lust'. He describes it as moments where teachers feel the urge to tell students exactly what to do. I had to conflict with these feelings as I knew that by giving them direct instructions, I was taking away their autonomy, a need vital for improving motivation. For fear of reverting to old habits, I instead avoided the situation and encouraged struggle in unproductive ways. Overcoming this challenge through reading extensive literature, reflecting, and discussions with my supervisor and critical friend was one of the highlights of this study. I now feel more comfortable when faced with challenges and can enforce reflection, learn through literature, and converse with others to expand my thinking.

Finally, I struggled with the length of time GD lessons took in comparison to my old style of teaching. Lessons often required longer periods of exploration, discussions, and reflection than didactic style lessons. Using open-ended tasks meant that more time was needed for pupils to engage meaningfully with concepts. This, along with the multiple strategies and materials that children could choose from, encouraged them to try different methods which took up extra time. I found this overwhelming at first, as I began to feel the curricular demands, a pressure discussed throughout this study. However, over time, I noticed their eagerness to try different methods and observed that they were fully engaged in the entire lesson, which I viewed as a positive outcome.

6.7 My Future Practice

My future practice will be of a child-centred, explorative nature. I intend to use my learning from this study throughout not only mathematics but also other subjects to increase students' motivation levels.

In addition, I intend to remain grounded in my educational values. Should challenges arise or if I drift from these principles, I will draw on the reflective strategies and theoretical insights developed throughout this research to realign my practice.

I aim to continue the use of reflection throughout not only school life but all areas of my life. I have acknowledged its positives from this study and so, plan to see its benefits in other areas of life.

Finally, I intend to disseminate my research further. I aim to share my findings with other teachers, specifically the ideas of GD and productive struggle. As mentioned, the link between productive struggle and motivation is often missed in research, so sharing this information will likely benefit others. By sharing my experience, I aim to support fellow educators in fostering more resilient and intrinsically motivated learners.

6.8 Conclusion

This research has been beneficial to me as both a teacher and a researcher. I now understand the many reasons why my previous teaching style did not motivate learners and the importance of the psychological needs of autonomy, competence, and relatedness in motivating students. This said, developing motivation was not the only benefit of my study. I now see students who are more resilient, confident, and persistent when faced with challenges. Not only have my students gained this skill, but I have also acquired greater resilience during times of frustration.

I plan to further develop my research by focusing on different class levels and evaluating the impact GD may have on other age groups. Expanding the age range and using learnings from this study will hopefully provide a more comprehensive insight into the effectiveness of GD.

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APPENDICES

Appendix 1: Ethical Approval Form

Ethics Approval for Master of Education (Research in Practice)
(*Please read the notes in this handbook before completing this form)*

Student name:	Anne-Marie McGill
Student Number:	17475464
Supervisor:	Joni Clarke
Programme:	Master of Education (Research in practice)
Thesis title:	Challenging children's poor motivation in maths: improving teaching and learning using a Guided discovery approach
Research Question(s):	How can I improve my practice in teaching maths by using a Guided discovery approach to support children's motivation?
Intended start date of data collection:	January 2025
Professional Ethical Codes or Guidelines used:	Department of Children and Youth Affairs (2012) Guidance for developing ethical research projects involving children, Government Publications: Dublin. Masters of Education: Research in Practice Student Handbook 2024-2025 Maynooth University Research Integrity Policy Maynooth University Research Ethics Policy Maynooth University Data Protection Guidelines My School's Data Protection policy and G.D.P.R. guidelines.

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

	TICK ALL THAT APPLY
Early years / pre-school	
Primary school pupils	√

Secondary school students	
Young people (aged 16 – 18 years)	
Adults	√

1(a) Individuals and their proposed role:

The proposed participants are the 21 Third Class students in the coeducational class in which I am the mainstream class teacher. The participant's role is to take part in daily maths lessons where a Guided discovery approach will be used, in addition the children will be a key data source. Participants will take part in questionnaires to determine their motivation and opinions on various lessons.

1(b) Recruitment and Participation/sampling approach:

I will invite all of the 21 children in my class and their parents or guardians to participate in this research. Participation and input from all parties will be used to paint a comprehensive picture and guide my research, therefore, developing my practice. I have a good relationship established with both children and their parents as I have been teaching them since the beginning of September.

Parental consent and child assent will be obtained. For consent to be valid it must be informed (Shaw et al., 2011). Parents and children will have full knowledge of what to expect from the process including activities involved, ways I will gather data and how their input will help me to improve my practice.

Parents will receive an information letter of the planned study. This letter will include detailed information about the purpose, methods, and duration of the study, along with assurances regarding confidentiality, anonymity and data protection. It will be made clear to parents that any changes in teaching and learning reflect the approaches espoused in the new Primary Mathematics Curriculum (PMC) (NCCA, 2023) and are aimed at improving the children's motivation in mathematics lessons.

Children will receive a child – friendly information letter and assent form in addition to a verbal explanation. All participants will be reminded that they are welcome to withdraw permission at any time.

The Board of Management's involvement will help establish trust and transparency in the research process. Board members will be fully informed about the study's aims, methodologies and ethical guidelines.

2. Summary of Planned Research

The location of this research is a co-educational primary school. The socio-economic status of the school is middle class in a rural setting.

The purpose of this research is to promote motivation in mathematics using a Guided discovery approach to teaching. I aim to better my practice and ensure that teaching and learning in maths lessons reflects the principles and methodologies espoused in the new PMC.

This study will employ an action research approach. Action research is a method of conducting research with the aim of improving practice (McNiff,2013). This is a cyclical process in which I will gather data, look at it, discuss it with others and then adjust actions to improve my teaching.

The following data collection methods will be used: observations, validation group surveys, children's documentation, post-it surveys, questionnaires and using a reflective journal. I will use a journal to record and reflect on my learning. This along with discussions with my critical friend and validation group will be used for reflection.

Parents/guardians participation includes being part of a validation group. Parents will have the opportunity to fill in a short survey based on their children's participation with Guided discovery.

Timeframe: The course of this study will take place over eight weeks. Children will take part in their daily mathematic lessons where Guided discovery will be the key approach.

Thematic analysis will be used. Data will be analysed with strict confidentiality. Findings will be used to inform practices that foster a more motivating and supportive learning environment.

3. Ethical Issues

Power Dynamics:

Power dynamics shape the interactions between researchers and participants. Researchers may hold more authority over the study design, while parents/guardians and children bring essential lived experiences as they are actively involved in the research. I will use a critical friend and my supervisor to provide objective and critical feedback. This will provide more balanced perspectives and mitigate researcher bias. I aim to work reflexively throughout this research. I will mindfully endeavor to interpret data as it is presented and avoid any bias or misrepresentation. I will be open to all answers and comments made from children and adults even if they are not positive in relation to my teaching or the Guided discovery approach. My reflections will be honest and stay true to the results and observations presented to me in the classroom. Working reflexively will help maintain transparency and to appreciate each participant's contributions, fostering a more collaborative and ethical research environment. Reflexivity will ensure that I am open to insights from all participants in the study. I hope that this then leads to richer, more grounded conclusions about the effectiveness of Guided discovery learning in mathematics.

Informed consent and assent:

Informed consent requires that parents fully understand the study's purpose, methods, and any potential risks. The onus is on me, the researcher, to show that I have taken the necessary steps to ensure that participants have been given requisite information that informs them of the research (DCYA,2012). For this research, consent and assent is needed from parents, children and the school's Board of Management. Children's information letters are to be presented in a child-friendly way it is easy for them to understand their role. I will regularly check in with children throughout the study to confirm continued willingness, honoring their ability to opt out of activities at any time. Participants, both children and adults, should also be fully aware that participation is voluntary and of their rights to withdraw from data collection. Finally, participants should be given time to read, ask questions and discuss the information letters before having to decide about their participation. This will be considered when looking at the event timeframe.

Confidentiality:

For this research, anonymity will be crucial. Protecting participant information helps to build trust, ensuring that all participants feel comfortable sharing their experiences and insights. I will establish clear protocols for handling data, such as anonymizing names, school information and details, and any identifiable details to protect the privacy of both parents and children. The school or area will not be mentioned in my research to ensure all privacy is kept intact.

Data Storage:

In this study, data storage is also critical. Transcripts, observations, and written notes should be securely stored. When discussing findings, researchers should avoid sharing specific details that could lead to participant identification as discussed. Digital files will be encrypted and stored on
password-protected devices. Access to data with be limited with permissions carefully managed to prevent unauthorized access. Physical data, like signed consent forms, will be stored in locked cabinets in a secure location.

Sensitivity:

Sensitivity will involve me being aware of and responsive to participants' emotional, cultural, and social contexts. Since the study includes children. I will use child friendly language and activities to make children feel safe and valued. If there is any indication of a child's well-being is being negatively affected then the research must be suspended until the issue in question has been addressed (DCYA,2012).

In relation to parents, sensitivity involves respecting diverse educational perspectives and experiences, which may influence their openness towards the use of Guided discovery. Parents own sensitivity towards their own mathematic ability could be a factor along with maths anxiety. Researchers should listen actively and avoid imposing personal biases, fostering an environment where parents feel their perspectives are respected. The DCYA (2012) suggests that researchers should not be judgmental about family circumstances and/or children's care experiences.

Declaration

I confirm that to the best of my knowledge this is a full description of the ethical issues that may arise while 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: Anne-Marie McGill

X

Anne-Marie McGill

Date: 18.11.24

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

Supervisor use only:

Date Considered: 06/12/2024 ✓ Approved ☐

Approved with recommendations (see below) ☐

Referred back to applicant ☐

Referred to Department Research and Ethics Committee ☐

Recommendations:

Signature of supervisor: J Clarke

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.	N/A

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Appendix 2: Parent/Guardian Information Letter

Maynooth University Froebel
Department of Primary and
Early Childhood Education

Roinn Froebel Don Bhun- agus Luath- Oideachas
Ollscoil Mhá Nuad.

02/11/2024

Dear Parent(s)/Guardian(s),

This year I am undertaking 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 on the use of Guided discovery during mathematics in third class as this is believed to improve motivation amongst students.

To do this, I intend to carry out research in the classroom by using teaching methodologies that align with the new Primary Mathematics Curriculum that has just been introduced in schools. I plan to use a Guided discovery approach to motivate students. Guided discovery encourages children to think about ideas and or solutions themselves with the guidance of the teacher. This will mean that I will facilitate learning while students are given the opportunities to use prior knowledge and/or scaffolding to find out new information. This approach helps to motivate students by giving them autonomy, choice and making the content more interesting to them. Importantly, Guided discovery helps students to better understand the mathematical concepts that they are learning rather than simply 'copying what the teacher does'.

Data will be collected using observations, reflections, children's documentation, surveys, questionnaires and post-it surveys. The children will be asked their opinions about how they feel about maths lessons and the Guided discovery approach. Each child will be asked for their permission to participate in the research, and I will respect their opinions throughout.

The children's names and the school's name will not be included in the thesis I write at the end of the research. You as a parent/guardian will be asked for consent to allow your child to participate in the research process. Your child can withdraw from the research process at any stage, and their data will not be included.

All information will be confidential and information will be destroyed in a stated timeframe in accordance with the University guidelines. The correct guidelines will be complied with when carrying out this research. This includes data being stored in **secure premises.** Password protection and data encryption will be used. All data collected will be relevant and not excessive. 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 anne.mcgill.2024@mumail.ie

Yours faithfully,

____
ANNE-MARIE MCGILL

Appendix 3: Board of Management Information Letter

Maynooth University Froebel
Department of Primary and
Early Childhood Education

Roinn Froebel Don Bhun- agus Luath- Oideachas
Ollscoil Mhá Nuad.

02/11/2024

Dear Members of the Board of Management,

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 the use of Guided discovery during mathematics in third class as this can be seen to improve motivation amongst students.

To do this, I intend to carry out research in the classroom by using teaching methodologies that align with the new Primary Mathematics Curriculum that has just been introduced in schools. I plan to use a Guided discovery approach to motivate students. Guided discovery encourages children to think about ideas and or solutions themselves with the guidance of the teacher. This will mean that I will facilitate learning while students are given the opportunities to use prior knowledge and/or scaffolding to find out new information. This approach helps to motivate students by giving them autonomy, choice and making the content more interesting to them. Importantly, Guided discovery helps students to better understand the mathematical concepts that they are learning rather than simply copying what the teacher does.

The data will be collected using observations, reflections, children's documentation, surveys, questionnaires, and post-it surveys. The children will be asked their opinions through discussing how they feel about maths and the Guided discovery approach. Each child will be asked for their permission to participate in the research, and I will respect their opinions throughout.

The children's names and the name of the school will not be included in the thesis that I write at the end of the research. Parents/guardians will be asked for consent to allow their child to participate in the research process. Each child will be allowed to withdraw from the research process at any stage.

All information will be confidential, and information will be destroyed in a stated timeframe in accordance with the University guidelines. The correct guidelines will be complied with when carrying out this research. This includes data being stored in secure premises. Password protection and data encryption will be used. All data collected will be adequate, relevant and not excessive. The research will not be carried out until approval is granted by the Froebel Department of Primary and Early Childhood Education.

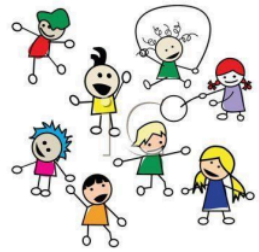
I would like to invite you to give me permission to conduct this research in the school.

If you have any queries on any part of this research project feel free to contact me by email at anne.mcgill.2024@mumail.ie

Yours faithfully,

____
ANNE-MARIE MCGILL

Appendix 4: Children's Information Letter



Child's name …………………….

I am trying to improve my teaching to help you learn maths in a fun way that is more interesting for you. I would like to find out more about this. I would like to watch you and listen to you when you are learning maths and to write down some notes about you.

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

I have asked your Mum 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 that could you sign the form that I have sent home?

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

Appendix 5: Parent and Guardian Information Sheet

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?

Teachers undertaking the Master of Education in the Froebel Department of Primary and Early Childhood Education at Maynooth University, are required to conduct an action research project, examining an area of their own practice. 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 can I increase motivation in children in middle-senior primary school classroom using a Guided discovery approach, during mathematics?

What sorts of methods will be used?

- Data will be collected using observations, reflective journal entries, surveys and questionnaires.

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 only 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.

Contact details

If you have any queries on any part of this research project feel free to contact me by email at anne.mcgill.2024@mumail.ie

Appendix 6: Parent and Guardian Consent Form

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 7: Board of Management Consent Form

Maynooth University Froebel Department of Primary and Early Childhood Education

Roinn Froebel Don Bhun- agus Luath- Oideachas Ollscoil Mhá Nuad.

Board of Management Consent Form

We, the Board of Management, have read the information provided in the attached letter and all of our questions have been answered. We agree to allow the student, Anne-Marie McGill, to conduct her research in our school.

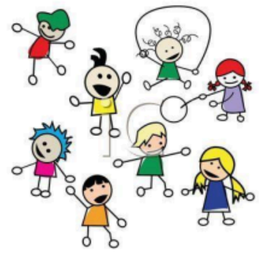
Chairperson's Signature __________________________________

(On behalf of all board members)

Date: _____________________

Appendix 8: 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):

____

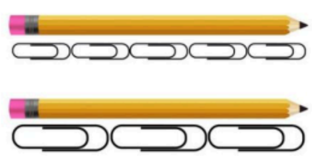
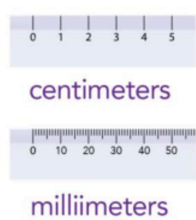
Signature: ____________________

Date: ____________________

Appendix 9: Sample Lesson Plan

Guided discovery Maths Lesson: Length: "The Broken Ruler"

Lesson plan made using the new Primary Maths Curriculum (PMC)

Strand	Measurement
Topic	Length
Stage	3
Class Level	3rd Class
Learning Outcome	Compare, estimate and measure length using appropriate instruments and record and communicate appropriately. Identify the relationship between equivalent units of measurement and rename measures using equivalent units.
Success Criteria	- I can use a ruler or metre stick to measure length correctly starting from zero. - I understand the importance of beginning measuring at 0. - I know how to solve a problem with a broken ruler.
Learning Intention	To understand the importance of accurate measurement starting at zero and to explore the relationship between cm and m.
Resources	Looney Math online tasks Interactive whiteboard Rulers Metre sticks Broken ruler resource Classroom objects to measure Concrete materials
Maths warm-up	Same but Different tasks based on length – taken from Looney Math   Children discuss in pairs and then as a whole class the similarities and differences within each image. These are LTHC where all children can begin and learning can be extended by some.

Starter Activity	Talk Task: "What do you already know about measuring things? What does 1 cm look like?" Use real objects for reference.
Main Guided Discovery Task	The Broken Ruler Problem (from Van de Walle) Children are given a ruler with the 0 cm mark missing (some starting at 2cm,5cm, etc.). Begin by estimating the different lengths of objects. Task: Use this "broken ruler" to measure the length of a pencil or object. Pupils should compare their answers from the broken ruler with an unbroken ruler. Were the answers the same? If not, why not? Prompt questions: - Is this measurement accurate? -Was the measurement the same as your estimation? Why not? -How are the two rulers different? - Why do we start measuring from 0? - How can we adjust for the missing 0?
Concrete Materials	- Variety of materials available to children to promote choice - Lollipop sticks - Blocks - String - Cubes
Scaffolding	- Model using a full ruler and then the broken one. - Use a visual number line to show the difference between starting at 0 vs 3. - Pair/group work for peer support. -Exploratory talk – teacher pauses lesson and asks someone to explain their learning – helps to boost others who may need ideas from peers.
Exploratory Talk Prompts	- "What answer did you get ___?" - "___ was your answer the same? Why do you think you have different answers?" - "How could we make this fair?" - "How could we figure out the length of this book even though the ruler begins at __cm?" - "___ do you agree with what ___ is saying?"
Reflection	Whole-class discussion: "What did we learn about rulers today?" "Why is 0 so important?" Revisit success criteria.
Assessment for Learning	- Teacher observation of group discussions - Anecdotal notes in reflective journal - Student questioning/ conversing - Student learning logs answering the following three questions: What did I learn? How did I learn it? How did I feel?

Appendix 10: Maths/Exploratory Talk Sentence Stems

Sentence stems

1. ________ and ________ are similar/different because ________.
2. ________'s idea reminds me of ________.
3. ________ is important because ________.
4. A better strategy would be ________ because ________.
5. A definition that I learned today was ________.
6. A new maths idea I learned was ________.
7. Another strategy would be ________ because ________.
8. I can prove my answer by ________.
9. I can show this idea by ________.
10. I have a different way to solve ________.
11. I noticed that ________.
12. I predict that ________.
13. I think ________ because ________.
14. I think that makes sense/doesn't make sense because ________.
15. I want to add to what ________ said ________.
16. If ________ then ________.
17. My first step was/is ________.
18. My strategy is the same as/different than yours because ________.
19. Next time I solve a problem like this, I will ________.
20. Something that is important to remember is ________.
21. The answer is ________ because ________.
22. The factors that are most important are ________.
23. The first thing I did to solve this problem was ________.
24. To prove my answer is reasonable, I can ________.
25. What would happen if ________?

(NCCA,2024)