“What are the perspectives of two teachers and their sixth-class students in two different DEIS schools on a problem-solving learning opportunity in the area of fractions?”

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Declaration

I hereby declare that this dissertation is a presentation of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly. This work has not been submitted previously at this or any other educational institution. The work was done under the guidance of (insert Supervisor's name) at the Marino Institute of Education, Dublin. I agree that the Library may lend or copy this dissertation upon request.

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Abstract

An analysis of the literature indicates how children from areas of low socioeconomic status (SES) are more likely to be excluded from mathematical classes, have poorer learning opportunities, and have lower levels of self-efficacy (Jorgensen, 2016). In Ireland, the DEIS school system aims to support children in SES areas in a variety of ways to help increase their achievement levels across the curriculum including mathematics education. One area where pupils are deficient is problem solving (TIMMS, 2019). The revised Primary Mathematics Curriculum, which will be implemented in the academic year 2024–2025, aims to support students' problem solving by making problems more engaging and relevant to real life. The research focuses on developing a learning opportunity in fraction problem solving for 6th class pupils in DEIS schools, which aligns with the new curriculum. A case study methodology was adopted, a two lesson learning opportunity was developed and delivered by teachers in two DEIS schools. Pre and post lesson implementation interviews with teachers were conducted, as well as learning surveys from pupils. Data was analysed thematically to address the research question. The findings reported the need for increased problem solving learning opportunities for pupils in DEIS schools in order to help consolidate learning and increase pupil self-efficacy. Furthermore, the findings highlighted the need for teacher training on how to effectively implement problem solving for pupils in primary school.

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List of Abbreviations

DEIS	Delivering Equality of Opportunity in Schools
DES	Department of Education and Skills
EAL	English as an Additional Language
NCCA	National Council for Curriculum and Assessment
OECD	The Organisation for Economic Cooperation and Development
RME	Realistic Mathematics Education
SES	Socio-Economic Status
SET	Special Educational Teacher
TIMMS	Trends in International Mathematics and Science Study

Chapter 1: Introduction

Overall Aim & Research Question:

Based on the study by Karakolidas et al. (2021), it appears that Ireland has made some progress in reducing inequality in numeracy levels in Ireland since the introduction of the literacy and numeracy strategy in 2011. There is still opportunity for improvement, though, as demographic and socioeconomic factors continue to account for a sizable amount of the variance in students' mathematics performance. An abundance of research indicates that children in homes of lower socio-economic status (SES) begin school on the back foot and this remains a pressing challenge (Jorgensen, 2016). The Delivering Equality of Opportunity in Schools (DEIS), introduced in 2017 aims to support children in lower SES areas to achieve their potential. Delivering equality of education in DEIS schools is of utmost importance for educators.

Furthermore, transmissionist pedagogies have led to an increase of general deterioration in students' inclinations towards studying mathematics throughout their education (Williams and Choudhury 2016). The ability to solve problems is one area where pupils struggle the most. Problem solving is one of the 28 competences in the Organisation for Economic Co-operation and Development's (OECD) Education 2030 Project (Cao et al. 2020). It says that in order to investigate different approaches to problem solving, students need be given opportunities to do so. Studies have indicated that the most significant cognitive influence on students' learning occurs during problem solving exercises (Mc Cormick, 2016). Tasks that require pupils to think critically through reasoning and problem solving are known as cognitively challenging tasks. (Smith & Stein, 1998). As they prepare to begin the next phase of their educational journey, senior primary pupils will be the specific focus of this study.

The new Primary Mathematics Curriculum, which is set to be rolled out in the academic year 2024/2025 supports reform. The curriculum offers a fresh vision for children's mathematical learning that is categorised by playfulness, creativity, challenge, risk-taking, partnership and opportunities for reasoning and solving real-life problems (NCCA, 2023). It informs educators that every child is capable of participating in mathematical ideas from their early years and this can be deepened and enhanced over time. It is hoped that with the

transformation of the primary maths curriculum, that children will foster positive dispositions towards being innovative and self-assured, logical and investigative, as well as inspired and adventurous (NCCA 2023). Now is the perfect time for teachers to change their pedagogical practices and witness the benefits of promoting a positive disposition in their pupils through cognitively engaging tasks. The new curriculum offers opportunities to uncover effective strategies to enhance maths and decrease the achievement gap, particularly for students from low socioeconomic backgrounds.

This premise of this study aims to analyse how pupils from lower socio-economic backgrounds engage when presented with problem-solving opportunities. Data from the study will be analysed to seek knowledge that will support these pupils to extend problem-solving skills, while also with the aim of closing the mathematical attainment gap. This research not only sets out to assist pupils with developing and harnessing their problem-solving skills, it also hopes to shed light on what recommendations can be made to primary school teachers in Ireland as they begin to embrace and implement the new curriculum in September 2024.

The key aim of this study is to investigate a problem-solving learning opportunity for senior primary students in DEIS schools in the area of fractions. This topic of problem solving interested the researcher during the undertaking of Module 5 of this course. The module "Differentiation & Challenge in Primary Mathematics" appealed to the researcher as it provided valuable insights into cognitively challenging tasks, strategies for maintaining cognitive demand and the resulting benefits. The researcher wanted to focus on this concept particularly in the context of DEIS schools, to help mitigate learning disadvantages that can come with a child's lower socio-economic status. Pupils from lower SES can often be faced with unequal opportunities in life. The researcher wanted to explore the teachers and students perspectives on a problem-solving learning opportunity in DEIS schools to increase knowledge that could ultimately benefit pupils in DEIS schools, not only in primary school but as they transition into secondary school and beyond. The research question this study addresses is :

“What are the perspectives of two teachers and their sixth-class students in two different DEIS schools on a problem-solving learning opportunity in the area of fractions?”

Chapter 2: Literature Review

Introduction

This literature review first looks at the effects of socio-economic disadvantage on education and the DEIS system in Ireland. Next, the mathematics attainment gap is discussed. This is followed by a review of studies about how to increase student engagement in mathematics. Next, literature pertaining to the importance of teachers' influence on students' outcomes is reviewed. This is followed by literature that specifically looks at approaches to teaching through problem solving, specifically in fractions. The literature review will now proceed with understanding the impact of Socio-Economic Disadvantage on a child's education.

The Impact of Socio-Economic Status on Education

The home environment and elements of parenting, such as parent-child relationships, school involvement, home teaching and parental education are all potential predictors of math attainment trajectories throughout childhood and adolescence (Evans & Field, 2020). Children from working-class families are more likely to have poor learning opportunities, have lower self-efficacy, and avoid engagement in maths lessons (Jorgensen, 2016). According to Doodman, Zadeh, and Changizi (2017), there is a relationship between academic achievement and self-esteem, with higher self-esteem generally translating into better academic performance and lower self-esteem into worse academic outcomes. Despite educators being aware of the risks faced by children from lower SES, it appears strategies to closing the gap remain a challenge.

Socio-Economic Disadvantage in Education

In order to help students from lower SES, it is important to understand how socio-economic disadvantage in education is defined. PISA categorise socio-economic status by parents' education, parents' occupations and possessions found in the home environment. To be more specific:

> It is derived from several variables related to students' family background that are then grouped in three components: parents' education, parents' occupations, and an index summarising a number of home possessions that can be taken as proxies for

> material wealth or cultural capital, such as possessions of a car, the existence of a quiet room to work, access to the Internet, the number of books and other educational resources available in the home (OECD, 2018, p.52).

The background to understanding the PISA categorisation comes from research. For example, Reardon (2011) states that children's cognitive development is strongly linked with parents education. Traditionally, children spend more time with mothers and have greater exposure to a mother's values and ambitions. Education provides mothers with abilities such as problem-solving and language skills. Higher educated mothers can then apply these various abilities to improve their children's academic results, for instance through language use and through the quantity and quality of maternal involvement in intellectually stimulating parenting techniques (Harding et al. 2015). Similar to this, children with highly educated parents begin school with higher levels of academic proficiency (Lee & Burkham, 2002). LeFevre et al. (2010) argues that the latter may not always be the case. Examining parents' education only and its impact on a child's numeracy skills, they found a positive link in Greece, but no significant connection in Canada. Suggesting that it is country or culture dependent.

Cheung et al. (2020) argue that family income was not a factor in numeracy skill, rather it was a parent's own interest in maths or mathematical activities that take place at home. It was also reported that families with a history of mathematic difficulties place less emphasis on numeracy in the home environment. However, research shows that parents with lower SES are typically those with less education.

The formal and informal activities that parents engage their children in, as well as the educational tools (such as toys, print materials, games), that parents give their children, can all be categorised as part of the home numeracy environment. During an intervention conducted by Niklas et al. (2015), it showed how children aged 4, improved their numerical competencies with non-intensive mathematical activities at home. Similarly, in an Irish study, it was found informal numeracy activities such as jigsaws and puzzles can positively affect children's mathematical competencies (Conica, et al. 2023). LeFevre et al. (2009) reinforces this concept, describing that the incidence with which young children engaged in

playing board games, card games, cooking, and shopping predicted their maths expertise and fluency. These resources however may not be readily available for children from lower SES. The latter studies may only be true if the children in question have not already engaged in prior numeracy activities. Mutaf Yildiz et al. (2018) believe that mathematics must be challenging for the children for their skills to significantly develop. In other words, if the skills are within the child's zone of proximal development (Vygotzky, 1978).

Delivering Equality of Opportunity in schools

The Education Act of 1998 describes educational disadvantage as: "the impediments to education arising from social or economic disadvantage which prevent students from deriving appropriate benefit from education in schools" (The Education Act, 1998, 32).
In Ireland, the DEIS programme was set up in 2005. Schools included in the programme were those whose students had parents who were unemployed, lived in local authority accommodation, from lone parent families, from a travelling background, from large families and those entitled to free books (DES, 2005). The DEIS scheme provided additional support to schools who had high numbers of pupils from low SES. In a 2017 review, one key target that it set out was the improvement of literacy and numeracy standards among pupils (DES, 2017). Although there have been many benefits to the DEIS programme, such as additional funding and the school meals programme, there are arguments that gaps still exist among pupils. According to the Higher Education Authority, (HEA, 2021), of those accessing the most prestigious courses at third level, only 4% of them are from disadvantaged backgrounds. This leads us to the mathematical attainment gap, which will be looked at in greater detail.

The Mathematical Attainment Gap

Students from low-income homes exhibit the greatest drop in maths and numeracy achievement. Analysis of TIMMS data depicts that the mean mathematics score of pupils in non-disadvantaged schools was notably greater than that of students in disadvantaged schools in both 2011 (g=0.58) and 2015 (g=0.52) (Karakolidas et al. 2021).
This attainment gap is pervasive across the curriculum and appears at the earliest stages of learning. Sosu & Ellis (2014), report that children between the ages of 12-14 years who do

well in numeracy are more than twice as likely to come from wealthy backgrounds as those who do not. Hobbs (2016), claims that a father's occupation can impact on attainment trends. Children whose father held a non-professional occupation achieved lower than their peers with fathers with a high status occupation. Similarly, when looking at the math attainment of 11 year olds in the UK, Evans & Field (2020) discovered that mathematical attainment was increased as parents' educational qualifications increased.

The significant achievement gap may have its roots in the fact that high-income pupils may attend better schools and have more effective teachers. Social and cultural resources available to children from more affluent backgrounds can be regarded as capital. This implies that children who have the correct habits having an advantage in school and being able to trade in their attitudes for grades, certifications, and other things (Gates, 2013). Looking through the eyes of the theorist Bordieu (1990), industrialised cultures' educational systems function in a specific way to legitimise class disparities. The ability to succeed in the educational system is facilitated by having cultural capital and higher-class habits. Since lower-class students typically lack these characteristics, it is inevitable that most of them will fail (Sullivan 2002). Additionally, pupils who are taught that hard work and talent are the keys to success may perceive status hierarchies as justified since they represent variations in individual merit (O'Brien & Major 2009).

A pupil's self-efficacy can be correlated with their parents' socio-economic background. According to Bandura (1997), self- efficacy occurs when children have the belief that they have abilities to organise and accomplish the action required to deliver certain attainments to succeed. Bandura (1997) claims that self-efficacy is one of the strongest factors contributing to a child's academic achievement. Pupils from lower socio-economic backgrounds, with lower social capital tend to accept their position in the system. Lower class pupils, either consciously or unconsciously, can believe that they do not have the capability necessary to achieve in school (Wiederkehr et al. 2015). Self-efficacy can also be influenced by their prior experiences to problem solving. Therefore, if pupils from lower SES are not being giving the opportunities to problem solve, then it is unlikely that their self-efficacy will increase (Usher & Pajares, 2008). If pupils don't have self-belief in their abilities

in mathematics, this may lead to maths anxiety. Math anxiety is a negative emotional reaction to an impending or actual mathematical situation. This can impede on their learning (Hill et al. 2016) as well as their mathematical performance (Qin et al. 2009). Carol Dweck (1997) is an avid believer in growth mindset. According to research carried out by Dweck (2007), children who have a growth mindset, or the belief that they can learn anything and that their intelligence grows with knowledge, do better than those who have a fixed mindset, or the belief that their intelligence is fixed (Blackwell et al. 2007 & Good et al. 2007). This is something that may considerably benefit pupils from lower SES families. Helping children develop a growth mindset can help them succeed.

Language also plays a huge role in the disparity between children from lower SES. Legitimate participation in math classes is learned and achieved by proficiency with spoken, written, or both types of language. Students need to be competent with these types of materials in order to be considered a successful maths learner (Zevenbergen, 2005). Pupils have to be familiar with common mathematical terminology (Trakulphadetkrai et al. 2020). Studies have demonstrated connections between children's math proficiency and literacy-related activities and other elements of the home learning environment. Children's math achievement, for instance, is correlated with parental expectations for their children's future academic success and reading at home (Sonnenschein & Galindo, 2015). Therefore, children from higher SES will be supplied with rich linguistic capital from home.

Increasing Mathematical Engagement among Students

It could be argued that teacher instruction is the second most important factor in a student's success after the home environment. This begs the question, why do student achievement gaps still exist? Studies, however, highlight the challenge of upholding both the goal of equity and the goal of academic achievement at the same time (Van de Werfhorst & Mijs, 2010). Another factor to consider is teaching quality. According to Fauth et al. (2014), this can be categorised by supportive climate, classroom management approach and cognitive activation.

Cognitively Challenging Tasks

Research has shown that problem-solving activities have the greatest cognitive impact on student learning (Mc Cormick, 2016 & Mata-Pereira & da Ponte, 2017). Cognitively challenging tasks are those that encourage students to think more critically through reasoning and problem-solving. (Stein & Smith 1998). In a 2019 study, Di Martino found that pupils' positive attitudes towards problem solving decreases as they get older. Russo & Minas (2021) examined the attitudes of pupils towards learning through problem solving, not only did they find it improved their learning, but they also found it enjoyable and fun. Cognitively activated tasks can have a positive affect on children's learning outcomes, therefore it makes sense that teachers adopt such practices to lower the attainment gap among pupils from lower SES. Downtown & Sullivan (2017) promote this idea. Problem-solving lessons in schools can often present themselves as standalone lessons, acting as a supplement to the curriculum (Foster, 2019). Rather than being part of a well-planned teaching plan. Understanding pupil struggles when problem solving is an essential skill for teachers (Teuscher et al. 2016). Kapur (2015) promotes productive struggle to enhance learning. Contrastingly, some researchers believe that promoting skills such as problem solving, and productive struggle will not be of benefit to all. According to Gao (2014), students with low, medium, and high ability levels in various nations react differently to instructional methods based on traditional or constructivist paradigms. There is proof that low ability pupils and those from less affluent socioeconomic situations benefit more from teacher-directed educational methods than high ability students and those with greater advantages. Pupils from lower SES want to be explicitly taught the steps that will enable them to achieve the grades. This discovery may be explained by the fact that this instructional strategy (problem solving) is unknown to people from lower socioeconomic status (SES) homes and more consistent with the intellectually stimulating child-rearing practises of parents with higher SES. Once more, this relates to Bordieu's (1990) idea of cultural capital.

Teacher - directed educational methods, as mentioned, could include the use of textbooks and routine tasks. Routine tasks are categorised as the backbone of school mathematics. They involve using a recommended method that they have already been taught. The pupils

are familiar with what is being asked of them (Foster, 2023). In contrast, non-routine tasks are also referred to as problem-solving tasks. They are problematic for the pupils. The solution method is not immediately known (Foster, 2023).

Textbooks are loaded with routine tasks. In an Irish study by Duffy (2022), she revealed that 52 out of 53 class teachers followed a mathematics textbook scheme. A large proportion of the teachers, both class and special educational teachers, valued the textbook as a fundamental teaching tool. With such a dependence on the textbook, it leaves little time for enriched problem-solving activities for pupils.

According to research, numeracy interventions work best when given regularly, presented in a way that is interesting and inspiring to the child, and lead to group discussion. (Slavin et al., 2009). Engaging curricular pedagogies, such as problem solving or non-routine tasks, can instil in children that mathematics can be enjoyable and applicable to their own daily lives. Problem-solving tasks can be given as part of collaborative learning within mixed ability groupings. Mixed-ability grouping, according to Georges (2009), is advantageous for raising mathematical attainment children from lower SES backgrounds (Ceri, 2013 & HMIE, 2007).

The government's DEIS plan (2017) sets out five goals in its 2016-2019 plan. One focus is to improve the learning experience and outcomes of pupils from disadvantaged backgrounds. This is promoted by supporting good practice within schools and encouraging creativity. This is inextricably linked to the notion of educators implementing cutting-edge approaches to foster a mathematical environment that is more cognitively demanding. In his study, Wright (2020) demonstrates how some lower-achieving and formerly disengaged pupils showed the most pronounced improvements in motivation for learning mathematics and favourable reactions to the alternative practises used by the teacher researchers through engaging lessons. To conclude with Boaler (2009), she believes that if children are informed of the meaningful value of mathematics then despite their SES, all pupils from all backgrounds have something to gain.

Teachers' influence on student outcomes

Frenzel et al. (2016)' s discoveries indicate that enjoyment of teaching, can positively influence pupil enjoyment of learning and boost teachers in their desire to advance the quality of their teaching. Research has also shown that how teachers view their students, has an impact on students' learning (Dee, 2015). Teachers most likely have a significant influence on students' perceptions of their academic future (Dee, 2015), especially for relatively underprivileged students who don't often interact with adults with college degrees outside of the classroom. Pupils from socioeconomically disadvantaged backgrounds are found to be particularly impacted by the quality of their teachers in terms of academic attainment. According to Trigwell (2012), teachers who defined negative emotions towards their teaching inclined to be teacher-focused in their teaching approach, selecting transmissive approaches that were perceived as safe.

In a report conducted by Kavanagh et al. (2017), which looked at the achievement and attitudes of pupils attending DEIS schools from 2007 to 2016, principals from schools who made marked gains over this period were interviewed on what they thought attributed to such gains. Increased support from home and raised teaching standards were two notable factors for the success.

Pedagogical content knowledge is also necessary for teachers to teach mathematics effectively. In other words, the ability to convert comprehension of the subject matter into teaching and learning activities (Cox et al. 2015). It is commonly known that attainment-based segregation practices negatively impact students assigned to low attainment groups, who progress less than their peers in higher attainment groups (Francis et al. 2019). Therefore, it raises the question of whether these students are being given opportunities for cognitive challenge?

With the introduction of the new mathematics curriculum in Ireland, now is a vital time for school leaders to ensure that their teachers receive adequate training for the curriculum to be rolled out effectively, but more importantly to benefit all pupils in equal measure.

Fractions & Problem Solving

Fractions are one of the crucial mathematical concepts that pupils need to grasp before they can progress to more complex mathematical ideas (Lortie-Forgues et al,2015) Nonetheless, most pupils can find fractions to be difficult to learn. Some disputed that this was due to the confusing relationships between different fractional concepts and mathematical procedures. The fact that multiple processes are needed for different operations, denominator equality, and different types of fractions adds another fundamental challenge to fraction mathematics. For example, when adding and subtracting fractions, the denominator must be equal. When multiplying fractions, you simply multiply across. And with the division of fractions, the divisor must be inverted and then you proceed to multiply. Hence, the computation of fractions can be challenging for children (Braithwaite et al. 2017 & Gabriel et al. 2013). Polya's Problem Solving and collaborative learning were employed by Simpol et al. (2017) and was found to aid in the learning of fractions.

Hiebert (1985) makes the suggestion that by situating fractions in a realistic situation or story, that this could enhance understanding for pupils. Conversely, in a study by Mostert and Hickendorff (2023), they found that fraction division was greatly enhanced using word problems. The same applied when multiplying a fraction by a whole number. However, symbolic fractions were more advantageous when it came to adding, subtracting and multiplying two fractions. Therefore, well-chosen word problems may improve fraction arithmetic ability, especially for intricate and abstract arithmetic operations.

Conclusion

It is clear from the literature that has been reviewed that there is a strong link between a child's SES, parental involvement, and teaching pedagogies on their future mathematical outcomes. It is evident that children from disadvantaged backgrounds face challenges with acquiring equal education and self-efficacy in their own mathematical abilities.

The home numeracy environment was a factor that impacted on mathematical success, as well as teacher pedagogical practices in the classroom. Effective teaching practices, such as problem solving, can help with narrowing the attainment gap among children from lower socio-economic backgrounds. It is also clear that with the new mathematics curriculum set

to be rolled out in the coming academic year, ongoing teacher training is imperative, for effective and inclusive practices to take place. Therefore, it is important that research in the area of problem solving among pupils in DEIS schools is investigated in order to shed light on how schools leaders and policy makers can make the transition of the new maths curriculum as seamless as possible for both learners and educators in order to support academic success among pupils from low socio-economic backgrounds. The next chapter will investigate the research methodologies of this study.

Chapter 3: Methodologies

Introduction

The purpose of this chapter is to discuss and explain the research methodologies used as part of this research. Firstly, the aim of the research will be outlined. Next, the researcher will give details about the research participants and how they were recruited. The permission and consent process will be summarised and how it was obtained. The research design of the interviews, pupil learning surveys and problem-solving lessons will be discussed, and data collection will be explained in greater detail. Validity and reliability along with data analysis will also be described. Finally, ethical considerations and limitations will be explained and to conclude the researcher's positionality will be justified.

Research Purpose

A case study approach was adopted for this research. That is, a comprehensive examination and explanation of a bounded system (Merriam, 2009). Case studies can adopt experiments, action research or historical research (Cohen et al. 2017). In this instance, a case study is a comprehensive investigation of a small sample (Cohen et al. 2017) in relation to problem solving.

In particular, the purpose of this study was to create a two-lesson learning opportunity in problem solving for senior pupils in DEIS schools. Its aim specifically was to investigate the perspectives of two teachers and their sixth-class students in two different DEIS schools on a problem-solving learning opportunity in fractions.

The two-lesson learning opportunity focused particularly on problem solving for children in fractions, that aligned with the new curriculum, engaged students' interest, connected to real life and supported them to make their thinking visible. Fractions had been chosen as this is the strand unit where the pupils were working on in January and February when the study took place.

Research Participants

This study was implemented in two DEIS classrooms in North Donegal. The two teachers and their sixth classes were the participants in the study. When specific settings, persons, or

activities are chosen intentionally to provide information that is particularly relevant to your questions and goals, and that cannot be obtained as well from other choices, that is known as purposeful sampling (Palinkas et al. 2013). Since participants are required to contribute to the investigation of the study's goals and objectives, the researcher was unable to select them at random. In this instance, participants were teachers working in DEIS school settings. An email was sent to principals of local DEIS schools explaining the nature of the study. Participants were contacted through their school principal.

Ethical Issues

For this research, the names and specific location of the school and participating pupils have remained anonymous. Prior to initiating any research, the researcher acquired the willing participants' informed consent. This is crucial to make sure everyone involved knows why they are being asked to participate in the study and what its goal is. Participants, both teachers and pupils, were made aware that taking part is voluntary and they have the right to disengage as they wish (Cohen et al. 2017). The consent form outlined the data generation process and the advantages of the ongoing research for the teaching community (please see Appendix A). Assent and parental consent (Appendix B & Appendix C) were obtained from the pupils who took part in the research (Cohen et al. 2017).

Background of the Teachers

The two participating teachers were both from native to Donegal. Their names are replaced with pseudonyms. Claire graduated from Marino Institute of Education in 2016, where she studied the undergraduate degree in primary school teaching. She has been teaching ever since, eight years in total. Claire teaches 6th class and has 22 pupils. Claire has a number of pupils in her class with EAL. Kate has been teaching since 2006. She has been teaching for 17 years in total, having travelled to Australia for several years during her career. Kate studied a Bachelor of Education and then did a post- graduate in early childhood studies. This is her third time to have 6th class during her career to date. Kate has 17 pupils in total, she teaches 15 of them for mathematics.

Research Design & Data Collection

This study used a mixed methods design (Cohen et al. 2017). The qualitative component of the mixed methods was the interviews with the teachers and the quantitative component

was the pupil learning survey for the students. The teachers were interviewed before and following the two-lesson learning opportunity and the students completed the questionnaire after they had completed the lessons. The two-lesson learning opportunity was implemented by the sixth-class teachers in the two classrooms in DEIS schools and they also administered the consent forms for the students and the questionnaires. 35 students in total took part in the study.

The research began with interviewing the teachers and introducing them to the learning opportunity (please see Appendix D for interview questions). Teachers were asked about their educational background. They were asked about how they teach fractions. Questions about their thoughts on how their students engage with problem solving were also be posed. Open-ended questions allow for authenticity and depth within a response (Cohen et al. 2017).

The two-lesson learning opportunity

The two lessons being taught were "Andy's Marbles" (Appendix F) and "Peaches Today, Peaches Tomorrow" (Appendix G). Both lessons were adapted from the NRICH website (NRICH, n.d.). "Andy's Marbles" focuses on challenging pupils on their knowledge of fractions. Included are aspects of multiplication and division. It is a multi-layered problem with numerous steps involved. The second lesson, "Peaches Today, Peaches Tomorrow" is also a multi-step process. There are three parts to this problem, and as it evolves, the questions become more open-ended. This lesson gives pupils an opportunity to develop their problem-solving skills with fractions. Given the busy time of year, and the demands of sixth class, teachers were asked to complete the lessons as they fitted in with their timetables.

The pupil learning survey

Once the two-lesson learning opportunity had been implemented, the children were asked to fill in a pupil learning survey in response to their lessons, and particularly their feelings towards problem solving (please see Appendix E). This was completed in the presence of their class teacher. Pupil learning surveys were first studied in Module 4 of this current Masters "Mathematics Learning Difficulties and Interventions". During this module, the

importance of student voice was valued. Student voice is described as the way students participate in or have an impact on educational decisions. This is the central principle of student voice: students know what is and is not working in their classrooms and schools. To improve students' educational experiences, it is necessary for everyone to pay attention to their perspectives, solicit their ideas, and take their feedback seriously (Mitra, 2018). Incorporating student voice can improve student achievement and overall culture of a school. Eight questions were asked in total. The first seven questions were multiple choice, where the children had to circle their answers. Some examples of questions asked were: "Do you enjoy being challenged during problem solving activities?" and "Do you think problem solving is good for your learning?".

The final question of the survey was open-ended allowing the pupils to convey their feelings more freely regarding problem solving. It asked: "How do you feel about learning mathematics through problem solving?". The purpose of the final questions is to elicit an honest and more personal response from the students (Cohen et al. 2017).

Subsequently, the teachers were reinterviewed post the learning opportunity (see appendix D). The aim of this second interview was to gain impressions of how the learning opportunity went for both the teachers and the students. Questions asked included: "How did implementing the two-lesson learning opportunity go for you?" and "Did you students see reward in productive struggle?". All teacher interviews were conducted over Microsoft Teams. Both teachers opted for interviews to be carried out using video conferencing. Interviews took place in the evenings after school.

Piloting the lessons and questionnaire

The two lessons had been implemented in the researcher's own 6th class, not for data collection purposes, but to ensure the lessons were age appropriate and reasonable for the participants. It also allowed the researcher to give informed advice to the teacher participants, who would also be carrying out the lessons with their class. Similarly, the pupil learning surveys were given to the researcher's class. They were asked not to write their name, as it was only to give the researcher feedback on the survey. Such constructive feedback that was provided was that they suggested adding in "sometimes" into the multiple-choice answers, rather than just "yes" and "no". Completing a trial study of the

questionnaire was important as it increased the validity of it (Cohen et al. 2017). The researcher communicated with her research supervisor to also ensure that the lessons and pupil learning survey were appropriate for the data collection.

Data Analysis

The data collection tools used for this study were both of a qualitative and quantitative nature. Data collected from interviews and the learning survey were analysed using thematic analysis to address the research question. This triangulation of data collection helped improve the validity of the study (Briggs et al. 2012).

Qualitative Data Collection included teacher interviews, pre and post the two-lesson learning opportunity. Interviews are more than just about collecting data, it involves human interaction. In this instance, this interaction involved a specific purpose. The questions in the interview took the form of standardised open-ended questions. The two participants answered the same questions, leading to comparability of responses (Cohen et al. 2017) and ease when analysing the data. Interviews were conducted online to suit the participant's teaching schedules.

Quantitative Data Collection involved pupil learning surveys. Surveys gather data in an efficient manner. They gather both numerical and descriptive data (Cohen et al. 2017). The final question in the pupil learning survey falls under the remit of qualitative data collection as it allows for the students to write their own descriptive answers.

Thematic analysis by Braun and Clarke (2006) was used to generate themes based on the information supplied by the two teacher participants. According to Braun & Clarke (2006), the aim writing a thematic analysis report is to create your own data story that proves to the readers that your research is legitimate and holds value. When analysing the data the six steps that were completed were:

Familiarising yourself with the data

Generating initial codes

Searching for themes

Reviewing themes

Defining and naming themes

Producing the report

Data familiarisation was developed through reading and re-reading the whole collection of data from the interview. This process informed data analysis and the content for themes. Colour-coding and naming of themes included comparing and contrasting data from each teacher's pre and post interviews from the learning opportunities (please see Appendix J). The questionnaires were studied closely (please see Appendix K). Each question and response were analysed to link the answers with the appropriate theme. The themes coded were discussed with the research supervisor. This allowed for interrater reliability. This occurs when two or more examiners agree on coding information. It allows for reliability and consistency of data (Lange, 2011).

Ethical Considerations

Confidentiality was at the forefront of this research. Names of teachers and the participating schools will not be published in the research. Following GDPR guidelines, electronic data will be contained in a password protected laptop, while pupil surveys will be secured in locked storage (BERA, 2018). Consent was obtained by all relevant parties, teachers and parents. Assent was received from the participating pupils. Information regarding the aim of the study, the methodologies, the right to leave the study at any time were all included in the information letters. The participating teachers distributed the consent letters to their pupils and asked them to discuss it with their parents or guardians at home. Information letters for the pupils involved were read out by their class teachers. The class teachers explained the nature of the study to their pupils.

Limitations

A key limitation to this study was the small number of participants who took part. With 35 pupils and two teachers taking part, the views of the participants cannot be generalised. In future work it would be ideal to extend this study to include teachers and children in other classes, in other DEIS schools. Another limitation is that there was only time for a two-lesson learning opportunity. In future studies it would be beneficial to provide teachers and students with a longer time to work through problem solving. Another limitation might be that the study did not ask the students about their perspective on problem solving before

the learning opportunity. In future work it would be beneficial to collect some information of this type.

Researcher's Positionality

I elected to study the effects of lower SES on a child's mathematical achievement and productive disposition. My own personal and professional experiences have impacted my worldview and the way I think about education as one of the most powerful methods to transform your life.

Growing up in North Donegal, I attended primary and secondary schools, both with DEIS status. As a child, I had self-awareness of my own SES, but it wasn't until I attended third level education in UCD that made my awareness broadened. With only over twenty places available in my college course, I realised that almost one fifth that sat in the lecture hall with her had attended private second level education. This was the first time I was introduced to the idea of a "private school". After graduating with a degree in both paediatric and general nursing, I went onto to study primary teaching. My first teaching interview when graduated was a success, and I gained employment in a fee-paying primary school. Over the 5 years that I worked there I realised that yes, these pupils may have more resources than those attending DEIS schools, but all children are equal. When thinking of Bordieu's concept of cultural capital it didn't consider that all children, despite their background, can come from broken families, suffer from anxiety and face parallel problems to those from lower SES. During my time in this school, I taught 6th class for three years. Now back teaching 6th class in Donegal, it is anticipated the children from lower SES, through this study, will see the value and meaning in mathematics and education in general and go onto achieve success in their own education and future careers.

Chapter 4: Findings & Discussion

Introduction

In this chapter, the findings related to the research question, "What are the perspectives of two teachers and their sixth-class students in two different DEIS schools on a problem-solving learning opportunity in the area of fractions?" are considered.

The findings will be presented in four themes. The themes which all relate to problem solving are: *Challenges and Opportunities for Learning, The Need for Learning Support, Students' Ability, Self-Efficacy and Developing Confidence and Rewards Achieved Through Problem Solving*. The findings chapter aims to present a broad analysis of the data collected through teacher interviews regarding their experiences of problem solving within the classroom. Data from pupil learning surveys are analysed to shed light on their experiences of being presented with a problem-solving learning opportunity. The benefits of the learning opportunities for both educators and pupils will be explored to investigate their effectiveness on student learning and engagement, along with their support of the new Primary Maths Curriculum. The five themes will be split into sub-themes. Each theme will be discussed in detail. For each theme, the findings will firstly be related to the teacher interviews, then the pupil learning surveys. The findings within each theme will then be related to relevant literature. The chapter will finish with a summary of the findings.

Theme 1: Challenges and Opportunities for Learning

This theme concerns how educators have incorporated problem-solving activities in the past and if the implementation of the learning opportunities as part of this research has changed their views. Challenges to implementing problem solving faced by the teachers will be shared. This theme will also delve into the role of the new Primary Maths Curriculum and its correlation with problem solving in the classroom. Pupil insights into problem solving will be examined and whether they feel it is beneficial for their learning. These findings will be discussed in relation to relevant literature. The two sub-themes are: Challenges to Integrating Problem Solving and Curriculum Opportunities.

Challenges to Integrating Problem Solving

Teacher Responses:

This section will examine teachers perspectives in implementing problem-solving learning opportunities for their pupils. Prior to the implementation of the learning opportunities, both teachers were asked about how they currently use problem-solving in their maths teaching, around fractions. Both teachers, Claire, and Kate, expressed challenges in integrating problem-solving activities into their teaching due to current curriculum constraints. Claire noted that "*the curriculum can kind of get in the way*" and that *"I don't use it as much as I should".*

She felt that the curriculum required her to teach them adding, subtracting and changing to mixed numbers etc., and therefore little time was left to add problem-solving into the mix. Similarly, Kate remarked that she felt the textbook was a barrier to the implementation of problem-solving *"in Australia, a lot of things was hands on, but I feel like since I came back I went straight back to the textbook, and then you know what I mean, got stuck in the book"*.

The challenges faced by the teachers in this study can be closely linked to what it seen in the literature. Both teachers desire to engage their pupils in richer problem-solving opportunities, but curricula and dependency on textbooks can hinder this. In this literature review, Duffy (2022) described how the class teachers in her study saw great value in textbooks. Yet the Special Education (SET) teachers in her study had differing views. 38% of them felt concrete materials were not utilised due to textbooks, with a SET expressing textbooks were not challenging enough and did not give opportunities for problem solving. The sixth-class teachers in this study had similar misgivings with the textbooks.

Curriculum Opportunities

Teacher responses:

The new curriculum, which will be rolled out in the academic year 2024/2025 encourages the role of open-ended questions to stimulate learning. The first interviewee, Claire, was hopeful that the new maths curriculum would lead to greater opportunities for problem solving in the classroom. She also emphasised the need for resources to incorporate problem solving effectively*"with the new maths curriculum and If we get more resources and stuff that we can start using it".* Having just taken part in the new maths curriculum

training a few months prior to the interview, Kate felt that this had inspired her to integrate more problem-solving into her teaching *"when we did the new curriculum in December, I was like right from January I'm not doing the book".*

In her interview, post the learning opportunities, Kate explained how she felt the new curriculum would support learning through problem solving. She witnessed merit in the two lessons, as it allowed for differentiation and inclusion for all pupils in their class. They were engaged, while working at their own pace and level *"Yeah, I do. Especially for the likes of that boy that was struggling. I've started only doing open-ended questions with them. So then for him it can be easier, but he's still in the same as everyone else".*

In my study, both teachers showed a great willingness to continue with incorporating problem solving into their teaching. The reform of the new curriculum was something they both hoped would support this. Boaler (2015) reinforces this thinking. She believes there should be a move away from calculations and algorithms, leaving opportunities for learning and struggle, which will lead to pupil growth. It is clear from my study that the teachers have a positive outlook on the new maths curriculum and hope there will be a shift away from the textbook. On the contrary, only 6% of teachers in Duffy's (2022) study expressed a desire to move away from the textbook when the new curriculum is introduced.

Despite open-ended questions allowing for entry points for all students, both teachers highlighted the need for student support during the learning opportunities. This will be discussed further under the next theme.

Pupil Responses:

In the pupil learning survey on problem solving, pupils were asked:

Do you think problem solving is good for your learning?

Yes = 22 Sometimes = 9 No = 4

Some responses to the open-ended question "How do you feel about learning mathematics through problem solving?" included:

"I think problem solving is very effective and I learn from it and it helps me in upcoming tests. It is a funner way in my opinion".

" I feel that it helps me to look in different ways when problem solving"

Out of 35 students who took part in the problem-solving learning survey , the majority believed that problem solving did enhance their learning. The tasks that the children in this study engaged in were problematic in nature. Mc Cormick (2016) believes these type of tasks influence pupils' thinking and so influences their learning. Russo & Minas (2020) carried out research to investigate pupils' attitudes towards problem solving. Fraction based tasks were also part of their research. Their findings correspond to those of this study. Three quarters of participants responded positively to problem solving. Like some of pupils in this study, they too felt that this instructional approach enriched their learning.

Theme 2: The Need for Learning Support

Both teachers and students mentioned the need for support that was required for students during the problem-solving processes. Both teachers stressed the importance of scaffolding and encouraging their students during the productive struggle phases of the lessons. Responses from pupils also indicate that they felt a need for support from their teachers. These interconnected themes will be discussed, referencing relevant literature to support the findings. The sub-themes include: Language Barriers and Scaffolding.

Language Barriers

Teacher Responses:

Language barriers was identified as one factor that hindered student performance during the two lesson learning opportunities. When asked about her impressions of pupils' abilities in problem solving prior to the lesson implementation, Claire revealed that she had several pupils in her class with English as an additional language (EAL), she felt that for those children to even decipher what was being asked of them would be a challenge in itself: *"we have lots of students EAL, just for them to even understand the wording…what is actually being asked of them"*. In her second interview, Claire felt that many pupils found the language vast in one of the lessons "*Some of them found all the words in Andy's marbles overwhelming".*

Kate, when asked about her impression of her pupils' abilities in problem solving, prior to the lesson implementation, she felt that her class were reliant on the textbook and anything

different to that could be a challenge "t*hey're just so used to the book and everything being so direct".*

Irish classrooms have witnessed a large increase of pupils with EAL in recent years. Research has shown that pupils with EAL face obstacles when problem solving due to difficulty understanding the vocabulary. Problem solving, as we know, places great cognitive demand on pupils, but for pupils completing tasks in a second language, the demand increases. Not only do pupils have to learn common mathematical terminology, but problem-solving tasks now are heavily based on everyday contexts (Trakulphadetkrai et al. 2020). In their study, Trakulphadetkrai et al. (2020) found that pupils ages 9-10 years old with English as a first language, outperform their peers whom English is an additional language. In this study, it was evident from teacher responses that EAL pupils found the two problem-solving opportunities challenging. Support from teachers is crucial to help EAL pupils overcome these language barriers in problem solving.

Pupil Responses:

When asked:

"How do you feel about learning mathematics through problem solving?" ,

this sixth class pupil responded:

"It's okay, I don't mind if I understand it but if I don't, I ask my teacher but it's harder than any other mathematics because it's tough words".

This pupil also echoes what a teacher respondent remarked, that pupils found the words "overwhelming". Not forgetting in which the context of this study took place. The research being investigated was focused on pupils in DEIS schools. According to Le Fevre et al. (2009), children whose home environment promotes activities like card games and jigsaws can enhance their problem solving skills. Moreover, low-income children are also less likely to interact in verbal or reading activities that enhance their cognitive abilities. Children from low-income and middle-class homes may hear different languages at home, which could affect how prepared they are for or comprehend what they learn in school (Galindo & Sonnenschein 2015).

Scaffolding

Teacher Responses:

Scaffolding came up at various stages throughout the pre and post interview processes. On the topic of problem-solving within fractions, Claire directly described that her pupils require regular reinforcement of fraction concepts, even without open-ended questions integrated *"you can see problems with the fractions, even like when we're doing adding and subtracting, just the simple ones, without having the word problems in there, I had to go over it three times even this year".*

Following on from the two lessons, when interviewed, Claire depicted one pupil's inability to explain and justify their solution pathway to one of the problems *"one got it straight away, but couldn't explain how he got it".* When asked to go through the process of his of solution pathway, he replied *"I don't know how" he's just like "I just know that's what it is".*

When Kate was questioned about her pupils' abilities in problem solving, she also described the need for assistance. She felt that almost immediately when faced with a open-ended problem they can fold instantly *"they need help…they just buckle right away".* She continued by stating that a little help can be a lot in terms of getting them on the right track *"if you point them in one way, point in the right direction…then they're like we're away and they can do another bit"*

When Kate was asked her impressions of her pupils' abilities to power through productive struggle, she communicated that some may work well collaboratively, but for the most part they would be teacher dependent, given their reliance and over familiarity with the textbook *"It depends. Like there's some that would bounce well off each other and help each other through it, but most of them would be looking at you", "they still need a lot of direction with it*".

Kate was also asked how she perceived her students would do in the problem-solving learning opportunities. She stated that if they had to work independently without any help, she contemplated if they would complete the task or not *"if they were left to their own devices to do it, I'm not even sure half of them would finish it…they need the supports…scaffolding to get through it"*

Support that is defined as scaffolding includes flexibility, gradual fading of support, and handing over control of learning or a task to the student (Van de Pol et al. 2010). Scaffolding and Vygotsky's (1978) concept of the zone of proximal development are closely related. The gap between what a student can accomplish on their own and what they can accomplish with the assistance of someone who is more experienced is known as the zone of proximal development. Kate, during her interview, remarked that when her pupils were guided towards the right track, they were able to work on the task in hand.

These findings are in line with Chiu (2004). In that study, it was demonstrated that after a teacher leaves, pupils' problem-solving behaviour was frequently improved following that help from the teacher. Since they could modify their support to meet the needs of the pupils, it seemed that the teachers' evaluation of the group's understanding and development had the biggest impact on the pupils' on-task behaviour and problem solving. Although scaffolding is imperative for pupils to achieve progress. Maintaining the cognitive demand of tasks is equally as crucial for learning. Students can perform mathematics by maintaining a high cognitive demand, which entails exploring, representing, and observing as well as justifying and expressing outcomes. However, Smith & Stein (1998) advocate that scaffolding of pupils' thinking and reasoning helps in the maintenance of high-level cognitive demand tasks.

Claire referred to having to revise fractions three times this year already. She conveyed even without word problems, fractions were a challenge for her class. In a Belgian study by Gabriel et al. (2013), pupils from 4^{th} to 6^{th} grade were assessed on their fraction knowledge. It showed that the operations of fractions proved challenging, similar to Claire's class.

Pupil Responses:

In the student learning survey, students were asked if they would prefer to get an explanation from their teachers or not. Additionally, they were asked to indicate the kind of assistance they would prefer to receive when they had difficulties in mathematics.

Would you rather try to figure out a problem on your own or be given a teacher explanation first?

Independently = 12 *Teacher Explanation = 23*

What do you do if you get stuck in maths?

Give Up = 2 Ask a Friend = 11 Try another way = 9 Ask my teacher = 12

**One person circled "ask a friend", "try another way" and "ask my teacher"*

Both pupils and their teachers referenced the importance of support during the problem-solving tasks. Over half of the pupils stated they would rather a teacher explanation when initiating a problem-solving task. The majority also stated that they ask their teacher for help when stuck on a problem. It is clear from this data, that the children are reliant on teacher guidance during mathematical tasks. This relates back to Gao (2014) from the earlier literature review. Gao (2014) states that learners of low, middle and high ability respond differently to teaching strategies. Research shows that pupils with lower socioeconomic status and lower ability levels gain more from teacher-directed instruction than pupils with higher socioeconomic status and higher ability levels. Pupils from lower socioeconomic backgrounds want to be specifically taught the skills that will help them succeed.

The pupils in this study were questioned about what steps they take if they find a mathematical task challenging. The majority of pupils selected "ask my teacher". Helping pupils by describing the solution may seem beneficial to some, but research shows that when pupils construct their own solution pathways, this leads to the greatest learning (Shoenfeld, 1985). For math instruction to lead to increased learning, it is the pupil's own thinking that must be supported (Smith & Stein, 2011). Therefore, noting and interpreting pupil struggles when problem solving is an important skill for teachers (Teuscher et al. 2016). If teachers follow the general guidelines, like not lowering the level of challenge, asking pupils to explain "why," highlighting or asking them to identify valid and invalid justifications, and pushing them beyond the task at hand, pupils' reasoning processes will be supported (Mata-Pereira & da Ponte, 2017). The teachers in this study were advised to provide the children with autonomy when working withing their groups. The teachers provided scaffolding when required, but groups were left to work on the solutions collaboratively.

It was noted by the teachers, that support was not the only factor, which was required to get them through the tasks, but confidence did appear to be a deterring factor when it came to the pupils engaging with problem solving. This will be discussed further in the following theme.

Theme 3: Students' Ability, Self-Efficacy and Developing Confidence

There were numerous references to confidence, or a lack of, among the students when it came to their engagement and their teacher's impressions of how they think they would do with problem solving activities. In this sub-section, these findings will be presented and the relationship between pupil confidence versus pupil ability and self-efficacy will be discussed. The findings will be discussed in relation to the relevant literature. The sub-themes incorporate Student Ability and Developing Confidence.

Student Ability

Teacher Responses:

In her pre-lesson interview, Claire remarks on a gap between student capability among her pupils: " *I would say the top half of my class would do really well with problem solving, but the bottom half would struggle big time".* The inability to picture what was being asked of them was a barrier to engagement. Claire states: *"sometimes they can't visualise it at all…so that problem holds them back a bit".* After Claire had completed the two lesson learning opportunities with her class, she described how two pupils in particular disengaged *"two of them just sat back and didn't even bother"*.

Claire noticed examples where certain students disengaged during problem-solving activities. She speculated whether this disengagement stemmed from a lack of understanding, leading to frustration and giving up, or if it was influenced by attitude, particularly in 6th class *"I don't know is it that they couldn't understand it? So then just kind of gave up, or is it just some attitude with sixth class".*

Doodman, Zadeh, & Changizi (2017) assert a correlation between academic success and self-esteem, indicating that higher self-esteem tends to lead to better academic performance, while lower self-esteem is associated with weaker academic outcomes. Math self-efficacy,

as defined by Bandura (1997), is the assessment of one's ability to successfully complete domain-specific activities, such as solving word problems or fact problems.
In Claire's research , she observed a significant gap in student capability within her class, with the top-performing students excelling in problem-solving tasks while the bottom-performing students struggled, with two even giving up. Claire revealed in her pre-lesson interview that she hadn't incorporated enough problem-solving activities into her teaching. It's plausible that the students' disengagement stemmed from a lack of experience in problem-solving and low self-efficacy at that time.
Studies shown that children's maths self-efficacy is largely shaped by their prior experiences with mathematical problems (Usher & Pajares, 2008). Additionally, math self-efficacy can be influenced by various factors such as the reception of efficacy-related information, including encouraging social messages regarding math performance and teacher evaluations, as well as physiological and emotional responses.

In contrast to the findings of Usher & Pajares (2008), Kaskens et al. (2020) noted that self-efficacy did not significantly influence 4th-grade pupils when it came to problem-solving tasks. However, they suggested that maths self-efficacy might become more significant later in life, beyond the fourth grade, as children become better equipped to evaluate and align their expectations with their perceived abilities in certain math problems (Pajares & Miller, 1994).

Pupil Responses:

As part of the problem solving learning survey, children were asked:

Do you enjoy being challenged during problem solving activities?

Yes = 4 *Sometimes = 24* *No = 7*

The open-ended question at the end of the survey allowed the pupils to elaborate on their feelings:

How do you feel about learning mathematics through problem solving?

Some of the students responses were:

"I feel ok but it's a bit hard when I work on my own so I rather work in a group."

"Bad wouldn't recommend it."

"I think it's great."

"I don't really feel sad I just feel nervous".

The responses from the survey are somewhat differing. Only 4 pupils affirmed that they enjoyed being challenged through problem solving. The majority of pupils stated that only sometimes they appreciated it. While a clear 7 of the pupils stated "no". In the study by Russo & Minas (2020), they found that 23% of their pupils surveyed enjoyed learning through problem solving because they like being challenged.

When investigating the problem-solving learning opportunity, one quote from a pupil that struck the researcher was *"I just feel nervous",* in response to how they felt about learning through problem solving. According to Hill et al. (2016), math anxiety is defined as a negative emotional response to a potential or actual mathematical situation. Anxiety related to maths can hinder a student's love of the subject, lead to concern and frustration, and ultimately hinder their learning. Research has indicated that worry might modify the activation thresholds of prefrontal brain areas, potentially affecting the brain's working memory (Qin et al. 2009). This may be the only explanation for the relationship between maths anxiety and performance. Perhaps this pupil in question and the pupil who "wouldn't recommend it" were experiencing maths anxiety.

Developing Confidence

Teacher Responses:

Building confidence was identified as a pertinent aspect of this theme. When questioned if there was any aspect of the learning opportunities that she would have altered, Claire mentioned that the learning opportunities gave her an insight into how the pupils' confidence in problem solving had to be improved *"If I could change anything it would be, say beforehand, some of the work to do to build up on their confidence".*

She also felt that she could have worked on fractions more in the lead up to the problem-solving tasks, in order to instil confidence in themselves *"I would kind of build up more use of fractions for the "Andy's Marbles"…"they were getting all the fractions they could see and then bunching them altogether".*

Claire, based on her impressions of the learning opportunity, saw herself incorporating more problem-solving tasks into her teaching. She felt that this would help increase confidence among her pupils:

> *I know the maths curriculum is so compact and there's so much to get through, but I think I would try and just look at the objectives and show right exactly do they need, or the other four days, maybe on a Friday it's problem solving day. So give them opportunities like that maybe related to what we have done that week too, just to kind of build their confidence (Claire).*

She continued by saying that this too would benefit her EAL pupils, as previously mentioned, the language in itself can be overwhelming for them. "With some of our EAL, they are just like why is there so many words? Whereas, if they were just used to it more, they mightn't find it as daunting. So we've got to definitely try and include more".
Self-efficacy is a person's belief in their own ability to plan and carry out the necessary actions to accomplish specific goals (Bandura 1997). Pupils' self-belief and confidence was referenced several times during the interviews. Claire stated in her interview that she wanted to build the confidence of her pupils. Studies has shown that growth mindset interventions for pupils can impact positively on their grades (Blackwell et al. 2007, Good et al. 2003). Jo Bolaer et al. (2018) created an online growth mindset course specifically for learning mathematics. Of those pupils who took the year-long course, a significant number achieved greater success in their mathematics. The pupils in this particular study could find this useful. Considering the previously discussed effects of low SES on self-efficacy.

More opportunities for problem solving and increasing confidence were key aspects of these findings. Boaler (2022), also states that it is beneficial to use open-ended tasks that have a low floor and high ceiling—that is, tasks that are accessible to all pupils but extend to high levels and can be tackled in various ways. This can be a crucial component of a mathematical mindset teaching strategy. Many closed, limited questions are asked in maths classes, which goes against the growth mindset philosophy. Because there is just one correct answer per topic and one valuable approach, pupils often view mathematics as a fixed subject. On the other hand, if questions are open-ended and encourage pupils to

draw, discuss, and draw connections with what they already know, they are more likely to perceive mathematics as a topic that they can learn and grow in, and thus developing their confidence.

This was one of many benefits of problem solving witnessed by the teachers during the research. Other such benefits will be looked at in the next theme.

Pupil Responses:

What did the students say about their own confidence on the question about confidence?

Do you feel confident when completing problem solving tasks?

Yes = 11 Sometimes = 17 No = 7

In response to the question: How do you feel about learning mathematics through problem solving? Students responded:

"I will feel confident doing it".

"I don't really feel sad I just feel nervous".

"I don't mind doing it".

"Sometimes good".

One barrier to students learning effectively through problem is their confidence in their own ability. In this study it can be seen that teachers were concerned about students' confidence and so many students expressed that they did not always feel confident about their ability when problem solving. In the literature the impact of pupil self-efficacy has been linked to lower socio-economic status. Bourdieu believes that educational settings work in a certain approach as to validate class inequalities. To explain, if pupils are instructed that success comes from hard work and high abilities, status hierarchies might be observed as legitimated as they are viewed as the reflection of differences in individual merit (O'Brien and Major 2009). This concept has consequences. The pupils who possess more resources, i.e. those from higher socio-economic backgrounds, are viewed to have more talents and have worked harder, than their peers from lower status groups. Therefore, those pupils from both higher and lower status groups adopt and internalise their positions within the

system (Bourdieu, 1990). The fact that just 11 out of 35 students said they felt confident tackling problems raises the question of whether the students who chose "no" and "sometimes" thought less of themselves academically.

Research also depicts that self-efficacy of pupils is linked with parents' socio-economic status. Specifically, parents' perceptions of their own abilities to give their children the best possible opportunity for development are actually the cause of this effect. In a study by Wiederkehr et al. (2015), it showed that the relationship between SES and maths grades was influenced by self-efficacy. In other words, because they have lower levels of self-efficacy, pupils from lower socio-economic backgrounds perform worse in mathematics than pupils from advantaged backgrounds.

Theme 4: Rewards Achieved Through Problem Solving

Despite the challenges that were encountered, both teachers highlighted the advantages of problem solving that they witnessed. This section will share the findings about the rewards witnessed by the teachers for both themselves and their pupils during the two lesson problem solving learning opportunity. The benefits to incorporating open-ended questions for inclusion will be discussed. As well as how the pupils coped with productive struggle, and whether they managed to persevere or not. The viewpoints of the pupils about group work and both routine and non-routine tasks will be evaluated, with each point being connected to the pertinent body of literature. The sub-themes in this section are: Importance of Problem Solving and Pupil Reward.

Importance of Problem Solving

Teacher Responses:

When reflecting on the two lesson problem-solving learning opportunity, the teachers acknowledged the importance of problem solving for their pupils. Claire described how she hopes to continue including open-ended questions as part of her pupils' learning experiences in the future *"even for myself to try and include more problem solving even like get the on a Friday into groups".*

Claire felt that the lesson opportunities were informative for her as a teacher, as it showed her where her children were at on the topics of fractions "one girl thought she could simplify the fractions, so it just kind of showed me as well that more work needs to be done". She continued to say *"it was nice to see things like that, like right we need to go over that".* While also she herself was grateful to be given the opportunity to implement the lessons herself *"thank you for letting me do it".*

Not only was this insightful or a positive experience for the teachers, but from their point of view they both felt the children found merit in taking part.

Claire talks about how the learning opportunity informed her of the need to go over the basics of fractions. However, in a study by (Downtown & Sullivan, 2017), they argue against the conventional planning guidance given to maths teachers, which seems to be to start with basic examples and raise complexity gradually. In other words, giving pupils more complex tasks to complete could lead to pupils to using more advanced strategies. Pupils in the aforementioned study were given complicated multiplication problems, which revealed that they enriched their multiplicative skills when given more complex multiplicative tasks.

It was evident from the researcher's first encounters with the two teacher participants, that they both had a great love of teaching, with a keen interest in maths in particular. Both teachers relayed positive outlooks on their participation and implementation of the two problem solving lessons. As we saw in the literature review, Dee (2015) claims that teachers' attitudes and behaviours do affect pupils' learning. Academic achievement is found to be strongly influenced by the quality of teachers for pupils from socioeconomically disadvantaged homes.

Enjoyment, being a positive emotion, is the personal sense of pleasure connected to a certain activity or occasion. It is thought to result from emotions of control over a situation that is both sufficiently interesting and valued (Pekrun, 2006). There are numerous benefits that teachers' enthusiasm of their work has for the environment and instruction in the classroom. As noted in the literature, Frenzel et al. (2016)' s found that teachers who gain pleasure in their teaching are likely to use this as an incentive to improve the quality of their instruction. On the other hand, teachers who report negative feelings towards their practice tend to adopt teacher focused pedagogies (Trigwell, 2012). In contrast , Stipek et al. (2001)

found that student-focused teaching methods are associated with a higher risk, that involve cognitive challenge, open class talk and discussion and increased interaction between pupils and pupils and their teachers. All these ingredients make for the perfect problem-solving learning environment for pupils.

Pupil Responses:

When questioned about their preference on how they learn mathematics, the following results were observed:

Would you rather learn from problem solving tasks or through more routine tasks?

Problem solving= 18 Routine Tasks= 16

**One child wrote down "both"*

Only the slight majority stated that they prefer learning mathematics through problem solving. Confidence, as previously discussed, could be a determining factor as to why almost half of the pupils choose routine tasks over problem solving. A routine task is one which is multi-step, but it is routine in the fact that the pupils knows exactly what they must do before attempting it. In the literature review, Gao (2014) told us that pupils from lower socio-economic families prefer to be explicitly taught skills in order to achieve the desired outcomes.

In a 2019 study, Di Martino examined kindergarteners as well as first-, third-, and fifth-graders. It was discovered that as pupils become older, their perceived problem-solving ability declines and their negative feelings towards mathematical difficulties increases. Webb, Moses, and Kerr (1977) discovered that the most significant factors influencing problem-solving performance are willingness to solve problems, perseverance in trying to find a solution, and self-confidence in one's ability to solve problems. Students are more task-oriented and easier to encourage when they are eager to work on a variety of maths problems and stick with them until they find an answer.

Pupil reward

Teacher Responses:

Kate, in her post interview comments, stated that the lessons actually helped to consolidate her pupils' learning in the area of fractions. It help confirm to her their understanding of previously taught ideas *"Actually consolidated some of their learning…you know and then working in groups, they were able to help each other to do it so, it definitely it confirmed that they knew what they were after."*

High engagement levels were seen for the most part from the two class groups. Claire described her class being motivated and wanting to achieve the correct solution *"I would say 19/20 out of the 22 were really engaged with it. They wanted to try it. They wanted to work it out".*

The lessons created a sense of excitement among the pupils, as to who could reach the solution first *"They were getting annoyed at themselves" "Why didn't we think of that?" "You could see the competitiveness as well"*.

Both teachers observed that most of their pupils did push through the productive struggle of the cognitively challenging tasks as a result felt the reward for persevering, Claire mentioned *"Yea definitely. When they were working it out and then whether they got it at the end, they were all proud of themselves and if they didn't, they were kicking themselves, being like we could have got that".*

Kate echoed this sentiment by saying *"to look at it to begin with. They were just like what the hell?... they very quickly worked back once they got it, like very quickly and they were delighted with themselves then, yeah"*

One teacher alluded to the fact that the lessons allowed for inclusion among the pupils, where most pupils gain a sense of success *"even the weaker ones were getting that bit of accomplishment…"I can do this" When it was a whole group"*.

A very important reoccurring theme from these findings was that the teachers felt that the lessons allowed for entry points for all students in their class and it led to a sense of achievement within them. It has been demonstrated that teaching with challenging tasks, like problem solving, and a framework may accommodate the diverse needs of pupils in the classroom. Sullivan et al. (2016) takes diversity into account by purposefully differentiating tasks and offering enabling and extending prompts. Pupils who complete an original activity

quickly are given the option to extend suggestions, which should ideally elicit abstraction and generalisation. For pupils who are unable to continue at first, enabling prompts can involve cutting steps, breaking down numbers, or using different types of representation. The specific goal is for pupils to go back to the original assignment after completing the enabled prompts. For the purpose of this learning opportunity, the participating teachers were advised to place pupils in mixed ability groups. In the lesson notes given to the participating teachers, extension prompts for early finisher groups were supplied (see appendices). For example for "Peaches Today Peaches Tomorrow" the extension prompt included drawing a diagram to show their workings, or if they could work out their solution another way. In the lesson "Andy's Marbles", extension prompts included asking pupils to write a paragraph to explain their strategy and to draw a visual representation of their method. These aforementioned lessons allowed for entry levels for all pupils promoting inclusion within mathematics.

Giving pupils more accountability and responsibility in their learning of mathematics and exposing them to a productive struggle has been shown in the past to be important in the teaching and learning of mathematics (Kapur, 2015). To learn problem-solving skills, instead of following a familiar procedure, pupils must encounter productive struggle and create their own strategies to find solutions.

However, it is likely that compared to pupils who use memorised procedures, pupils who develop their own problem-solving techniques make more mistakes and struggle for longer periods of time to solve those problems. Research has indicated that students who create their own approaches, even if they make mistakes along the way, do better on exams than students who follow instructions. It is evident, that the pupils in this study, from the teacher's feedback, enjoyed being challenged. They began to get competitive and wanted to succeed in finding the solution. When the teacher stated "*they were kicking themselves, being like we could have got that".*

Perhaps with more experience and opportunities for problem solving in the classroom, they will now see the benefit and reward of persevering for themselves.

For the most part, both class groups displayed high levels of participation in this study. Research carried out by Boaler et al. (2021), on the teaching of mathematics through open tasks that allow for multiple entry points showed substantial engagement levels from

students. The teachers observed that the openness of the tasks increased success among the pupils. As a result, this increased student enjoyment and engagement, leading to a decrease in maths anxiety and the fear of making a mistake. In their study, as the camp progressed, teachers recounted narratives of pupils participating more in group work, discussing and expressing their ideas more freely, persevering with issues instead of giving up, and developing confidence in their mathematical thinking. It is clear that open-ended tasks can have benefits for pupils and this was reflected in the teacher responses in this present study.

Pupil Responses:

When problem solving, would you rather work independently or in a group?

Independently= 10 Group work = 25

In response to the question: How do you feel about learning mathematics through problem solving. Pupils responded:

"I feel it is ok But I tend to get frustrated when I can't get it. I also think that sometimes part of problem solving questions are not needed. Overall it is fine."

"I feel happy sometimes and annoyed sometimes".

"Challenged which is good"

"On the two tasks that you gave us I wanted to cry in the toilet again, but on regular problem solving that's a bit tricky but I can still figure out I enjoy"

"I consider it to be no different to normal maths, it's mainly just maths"

For this problem-solving learning opportunity, it was advised to the participating teachers to place students in mixed ability groups. During Module 3 of this Masters programme, ability grouping was studied in detail, as well as the benefits of it. Mixed ability grouping is the most valuable grouping practice for a pupil's education because learners of different levels of ability, interests and backgrounds can interact and learn with each other (Ceri, 2013). Ability grouping, also known as heterogenous, is capable of advocating co-operative learning amongst different groups of learners, promoting social acceptance and the learning of social skills. Key characteristics of inclusion are also reflected which are: age of learners,

gender and learners' backgrounds. This is something that is imperative in DEIS schools as it allows for inclusive educational practices to take place, but research shows its also improves a child's attainment. Mixed ability grouping, according to Georges (2009), is beneficial for improving the academic achievement of children from lower socio-economic backgrounds. Children should be collaborating to solve problems in the classroom, according to HMIE (2007), which supports this idea.

It is evident that the vast majority of pupils in this study preferred group work over working independently. Similarly, in the study by Russo & Minas (2020), the pupils in this study rated problem solving highly as it allowed to work with their peers collaboratively. Simpol et al. (2017), used collaborative learning and Polya's Problem Solving to help with the learning of fractions. The study found an increase in the understanding of fractions, but moreover, pupils conveyed their enjoyment of working with their peers. Opportunities were given to pupils to communicate and organise their thinking, while additionally trying to understand their partner's thinking.

The themes and subthemes discussed offer important insights into teachers' and pupils' experiences, encounters and thoughts on problem-solving instruction in their classroom. The perspectives of teachers and students in this study were that problem solving provides challenges and opportunities for learning. Students have varying abilities and self-efficacy and need practice to develop self-confidence. However, there are great rewards to be gained from problem solving, including increased enjoyment of students and teachers. Especially of problem solving in mixed ability groups. Students consolidated their learning of fractions and deepened their understanding of their own and each other's learning.

Chapter 5: Conclusion & Recommendations

Conclusion

This research study posed the question:

"What are the perspectives of two teachers and their sixth-class students in two different DEIS schools on a problem-solving learning opportunity in the area of fractions?"

The findings revealed that teachers and pupils found the problem-solving opportunity both *Challenging while also providing Opportunities for Learning*. Teachers and students outlined that *There is a The Need for Learning Support, while* pupils have differing Abilities and require S*caffolding*. Increased S*elf-Efficacy and Developing Confidence* can improve academic achievement and help in narrowing the attainment gap among pupils from lower SES. Given all this there are great *Rewards* achieved through problem solving. Pupils detailed that they enjoyed working as a group, while their teachers illustrated that the experience of being challenged led pupils to strive for success.

Key barriers faced by the teachers when implementing problem-solving activities included time constraints of the current maths curriculum and the need for new resources to be provided to complement the introduction of the new maths curriculum. With that said, both teachers acknowledge the importance of problem-solving as a teaching pedagogy. Both teachers hope that the new curriculum will help them to integrate it into their teaching moving forward.

This research sheds light on the different challenges faced by pupils themselves with problem-solving. Language barriers, pupil ability and confidence were all factors that hindered on engagement. Both teachers stressed the importance of supporting their students to help them engage with problem-solving in maths.

Overall, the findings depict the significance that problem solving can have on a pupil's learning. It highlighted that open-ended problems can help in the consolidation of pupils' learning and when they persevere through productive struggle, it can give a great sense of achievement for all pupils involved.

Recommendations

The researcher recommends that teachers provide increased opportunities for problem solving in mathematics. Irish primary school teachers are in a perfect position now to implement problem solving as part of their teaching with the introduction of the new mathematics curriculum. The teachers in this study discovered pupils' learning was consolidated through problem solving. While the majority of pupils in the study believed that problem solving was good for their learning.

Another recommendation from the study advises the incorporation of mixed ability grouping with problem solving tasks. A resounding number of pupils in this study favoured group work over independent work during problem solving tasks. Mixed ability grouping is beneficial for all pupils as it advocates for the inclusion of pupils of varying abilities, backgrounds and interests (Ceri, 2013). The teachers in this study described how the open-ended tasks along with the collaborative learning gave all the children in their class access points to the lessons and provided them with a sense of accomplishment.

A further recommendation from these findings indicates the need for developing confidence and increased self-efficacy among pupils from lower SES. In the pupil learning survey, it depicted how only 11 out of 35 pupils felt confident in problem solving. Fostering a growth-mindset among pupils and provided them with greater opportunities for problem solving has proven to increase self-efficacy (Dweck, 2007 & Boaler, 2018). This is particularly crucial for pupils in DEIS schools, as Jorgensen (2016) claims that those from lower SES backgrounds are more likely to have decreased self-efficacy.

Finally, the concluding recommendation derived from the data suggests that teachers in DEIS schools need to support their pupils through problem solving. The need for support was referenced by both pupils and teachers. Teachers must be able to evaluate and understand the needs of their pupils to scaffold them appropriately (Chiu, 2004), while still maintaining the cognitive demand of the tasks (Smith & Stein, 1998). It is advised that teachers received training on how to effectively implement problem solving activities in addition to the new mathematics curriculum training from OIDE.

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Appendices

Appendix A : Teacher Information Letter & Consent

18th January 2024

Dear Teacher,

My name is Ciara Sweeney. I am currently studying at Marino Institute of Education for a Masters in mathematics education. I am writing to ask for your help with a case study that focuses on the development of a learning opportunity for problem solving for pupils in DEIS schools that is aligned with the new maths curriculum. The research project involves learning more about how pupils engage in problem solving activities. I hope that the findings of the study will inform teachers on how they can engage their pupils' interests and connect problems to real life and support them to make their thinking visible.

There are three parts to the study: i) 2 lessons based on problem solving to be implemented by the teacher), (ii) teacher interview before and after the learning opportunity has been implemented : iii) a pupil learning survey after the learning opportunity has been implemented

The first phase of the study involves a teacher interview. This is to gain your opinions and feelings towards problem solving in the classroom. You are under no obligation to answer every question, if there is a question you do not wish to answer, you can simply skip it. The interview will take no more than 30 minutes and it will be recorded on audiotape. The interview can take place face to face or via video conferencing.

Next, teachers will be asked to implement two mathematical lessons based on problem solving. Lesson content will be explained and provided to teachers. Lessons will take approximately 45 minutes up to 1 hour.

The third phase of the study involves administering the pupil learning survey. This is to determine pupils' attitudes towards problem solving. Similarly, teachers will be interviewed after the implementation of the lessons, to find out what they thought of the lessons and how it went.

I hope you will be willing to participate because your responses are important and a valued part of the study. Your participation along with you pupils' will remain strictly confidential. Your name and those of your pupils' will not be attached to any of the data you provide. You are welcome to discontinue participation in the study at any time, should you wish to do so. The risks of participation in the study are very low and of a social or reputational nature. The interview audio will be kept in a secure location or on an encrypted device without your name attached to it. The audio will be retained only for the purposes of the current study. Once the study

is completed, the audio will be destroyed on the basis of the schedule outlined in the Institute's data retention schedule. If you would like more information on how long the audio data will be retained for, please don't hesitate to contact me directly. There are no risks or direct benefits in participating in the interview. You will be asked to sign forms (below) indicating agreement to participate in the different parts of the study.

If you agree to participate please contact me in one of the following ways:

Email: csweeneympm22@momail.mie.ie

Contact: 085 7461540

If you are willing to participate, it would help me greatly to know this as soon as possible so that your participation can begin as soon as possible.

Your participation in this project is sincerely appreciated. I understand that your time is valuable .

Thank you for volunteering to participate in this research. Should you have questions regarding your participation, please do not hessite to contact me on the contact details provided .You may also contact my advisor for the project, Carol Rees. Email: carol.rees@mie.ie

This study has been considered from an ethical perspective by the Marino ethics in research committee. Should you have any questions or concerns about the ethical approval or conduct of this study, please contact MERC@mie.ie

Yours faithfully,

Ciara Sweeney.

You will be given a copy of this information to keep for your records.

Statement of Consent:

Please read the questions below and indicate whether or not you would be willing to participate in the study as described.

Do you consent to participate in the study by implanting two lessons with your class as described above?	Yes	No

Do you consent to be interviewed based on the research topic and to have the interview audiotaped?	Yes	No
Do you consent to have pupils surveyed in your classroom for the purposes of gaining their insights on problem solving?	Yes	No

Signature:_____ Date: _____

Signature of Investigator:_____ Date: _____

Appendix B : Parent Information Letter & Pupil Consent

18th January 2024

Dear Parent/Guardian,

My name is Ciara Sweeney. I am currently studying at Marino Institute of Education for a Masters in mathematics education. I am writing to ask for your help with a case study that focuses on the development of a learning opportunity for problem solving for pupils in DEIS schools that is aligned with the new maths curriculum. The research project involves learning more about how pupils engage in problem solving activities. I hope that the findings of the study will inform teachers on how they can engage their pupils' interests and connect problems to real life and support them to make their thinking visible.

As part of the study your child's teacher will carry out two problem solving maths lessons.

The next part of the study is where your child will be asked to complete a learning survey questionnaire. Some examples of questions might include: *"Do you think problem solving is good for your learning?", "When problem solving, would you rather work independently or with a group?".*

Since your child's responses are significant and an invaluable component of the study, I would greatly appreciate your permission for them to participate.

Your child's participation will remain strictly confidential. Your child's name will not be attached to any of the data they provide.

You will be asked to sign forms (below) indicating consent for your child to participate in the learning survey and two lessons. Your consent and child's participation in this project is sincerely appreciated

This study has been considered from an ethical perspective by the Marino ethics in research committee. Should you have any questions or concerns about the ethical approval or conduct of this study, please contact MERC@mie.ie

Yours faithfully,

Ciara Sweeney.

You will be given a copy of this information to keep for your records.

Statement of Consent:

Please read the questions below and indicate whether or not you would be willing to participate in the study as described.

Do you give consent for your child to participate in the study which will be led by their class teacher?	Yes	No

Signature of parent/guardian:_____ Date: _____

Signature of pupil: _____ Date:_____

Appendix C : Pupil Information Letter

Dear Pupil,

I am a teacher who is back at college at Marino Institute of Education in Dublin studying best ways to teach maths. I am writing to you to ask you to be part of my study. I want to know what you think of some lessons I have created for sixth class. To find out what you think I will be asking you to fill out a questionnaire in class to let me know what you think of a couple of lessons that your teacher will be trying out in your class.

The questionnaire is anonymous meaning you do not have to write your name on it. No-one except you will know how you answered. Filling out the questionnaire should only take about 1-2 minutes at the most. You do not have to fill out the questionnaire and you can stop at any time. Participation is completely voluntary.

If you agree to take part, I will keep your questionnaire safe on a password protected laptop or in a locked drawer until the study is over. I will be using the results for my dissertation (this is a long essay I have to write at the end of the study). The results might also be published later.

There is a form going home to your Mam/Dad/Guardian and they will be discussing with you – if you agree to take part in my study please sign the form they have.

Thank you,
Ciara Sweeney

Appendix D: Teacher Interview Questions

Questions for the Teacher Interviews

Pre- two-lesson learning opportunity

Teacher's Professional Background:

1. How long have you been teaching?
2. What is your Educational background?
3. How many pupils are in your class?

Teachers' approach to teaching fractions:

4. How do you usually teach fractions?
5. Do you use problem solving usually with fractions?
6. Can you give an example of the kind of problem you would ask the students' to solve?

Teachers' impressions of students' problem-solving abilities with fractions:

7. How well do you think the students' in your class do at problem solving?
8. Do you see your students having any particular kinds' of struggles with problem solving with fractions?

Post - two-lesson learning opportunity

Impressions of the learning opportunity:

1. How did implementing the two-lesson learning opportunity go for you?
2. Were there any issues or aspects you would change?
3. Would you see yourself incorporating this kind of learning opportunity into your classroom?

Impressions of how the learning opportunity went for the students:

4. Did the students seem engaged by the learning opportunity?
5. Can you comment on your impression of their learning from the activity?
6. Did they see reward in the productive struggle of the lessons?
7. Do you think the new maths curriculum will support this type of learning?

Pupil Learning Survey on Problem Solving

Please circle your answer.

1. **Do you enjoy being challenged during problem solving activities?**

   Yes **Sometimes** **No**

2. **Do you feel confident when completing problem solving tasks?**

   Yes **Sometimes** **No**

3. **Do you think problem solving is good for your learning?**

   Yes **Sometimes** **No**

4. **Would you rather learn through problem solving activities or through more routine tasks?**

   Problem Solving **Routine Tasks**

5. **When problem solving, would you rather work independently or in a group?**

   Independently **Group work**

6. **Would you rather try to figure out a problem on your own or be given a teacher explanation first?**

   Independently **Teacher Explanation**

7. **What do you do if you get stuck in maths?**

Give up Ask a friend Try another way Ask my teacher

8. **How do you feel about learning mathematics through problem solving?**

_____

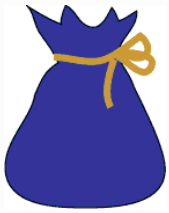
_____

_____

Thank you for taking your time to answer the survey questions.

Andy's Marbles

Andy and his friend Sam were walking along Letterkenny Main St. together. Andy had a big bag of marbles.

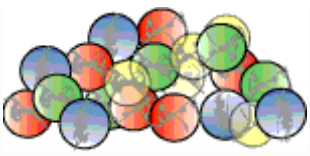


Unfortunately, the bottom of the bag split and all the marbles spilled out. Poor Andy!

One third (1/3) of the marbles rolled down the street too quickly for Andy to pick them up. One sixth (1/6) of all the marbles disappeared into the rain-water drain.

Andy and Sam picked up all they could but half (1/2) of the marbles that remained nearby were picked up by other children who ran off with them.

Andy counted all the marbles he and Sam had rescued.



He gave one third (1/3) of these to Sam for helping him pick them up. Andy put his remaining marbles into his pocket. There were 14 of them.

1. How many marbles were there in Andy's bag before the bottom split?

2. What fraction of the total number that had been in the bag had he lost or given away?

Lesson 1: Problem Solving with Fractions

Time: 45 mins – 1 hour

Learning Objective:

- To provide students with a learning opportunity on problem solving that involves fractions.
- To provide students the chance to reason with fractions in a challenging way that tests their comprehension of the related concepts.

Lesson Activity:

- Place students in mixed ability groups of 3-4.
- Introduce the topic of problem solving, children could give their own interpretation of what problem solving in mathematics looks like for them.
- Give each group a copy of the task. Ensure each group has paper and pencils.
- Read out the task for the class.
- Maths Talk: Ask the pupils (without them giving you any solutions to the task) some of the following questions:

- Have you ever completed a maths problem like this before? Think with your group what steps were involved.
- Can you use a visual diagram to help your thinking?

- Allow students to work on this task with their groups.
- Observe, do you notice any students giving up/persevering?
- When students have completed the task (20/25 minutes) ask students to share their solutions to the class.
- Maths Talk: Whole class discussion
  - Did anyone do it differently?
  - Which strategy is most efficient?
  - Who can explain how "John" came up with that answer.

Extension activities:

- Ask students to write a paragraph to explain their strategy.
- Ask students if they could work out the solution using a different way?
- Ask students could they draw a visual representation of their strategy.

Peaches today peaches tomorrow

Part 1:

A little monkey had 60 peaches.

On the first day, he kept $\frac{3}{4}$ of his peaches, gave the rest away, then ate one.

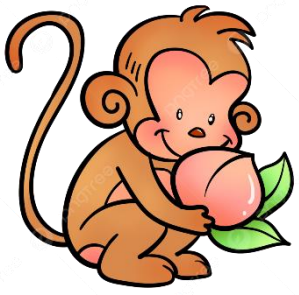
On the second day, he kept $\frac{7}{11}$ of his peaches, gave the rest away, then ate one.

On the third day, he kept $\frac{5}{9}$ of his peaches, gave the rest away, then ate one.

On the fourth day, he kept $\frac{2}{7}$ of his peaches, gave the rest away, then ate one.

On the fifth day, he kept $\frac{2}{3}$ of his peaches, gave the rest away, then ate one.

How many peaches did he have left?



Part 2:

A little monkey had 75 peaches.

Each day, he kept a fraction of his peaches, gave the rest away, and then ate one.

These are the fractions he decided to keep:

$\frac{1}{2}$ $\frac{1}{4}$ $\frac{3}{4}$ $\frac{3}{5}$ $\frac{5}{6}$ $\frac{11}{15}$

In which order did he use the fractions so that he was left with just one peach at the end?

Lesson 2: Problem Solving with Fractions

Time: 45 mins – 1 hour

Learning Objective:

- To provide students with a learning opportunity on problem solving that involves fractions.
- To provide students with the opportunity to estimate and use trial and error.
- To provide the students to recognise denominators and use them to problem solve.

Lesson Activity:

- Place students in mixed ability groups 3-4
- Introduce the problem solving task.
- Give each group a copy of the task. Ensure each group has paper and pencils.
- Read out the task for the class.
- Maths Talk: Ask the pupils (without them giving you any solutions to the task) some of the following questions:
  - What strategies did you use in your last problem solving task that might help you with this one?
  - Is this task similar to the one we completed yesterday/last week?

- Allow students to work on this task with their groups. Let children know that they must be able to explain how they approached the task at the end of the lesson.
- Observe, do you notice any students giving up/persevering? What problem solving strategies are they using?

- When students have completed the task (20/25 minutes) ask students to share their solutions to the class.
- Maths Talk: Whole class discussion
  - Was this task similar or different to the one we did yesterday/last week?
  - Did anyone use a different strategy?
  - Which strategy is most efficient?
  - Who can explain Mary's strategy in their own words?

Extension activity:

- Draw a diagram to represent your workings
- Could you have work at the solution pathway using a different strategy?

Appendix H: Ethical Approval Application Form

Policy Title:	Application Form for Ethical Approval of Research Proposals
Description:	Marino Institute of Education requires all research activity involving people as participants to be subjected to ethical scrutiny and this form is designed to enable the Marino Ethics in Research Committee to assess any research proposed by members of staff, students, or external researchers where the research has not been subject to ethical scrutiny by another ethics board.
Author (Position):	Marino Ethics in Research Committee
Version:	2
Approved By:	MIE Governing Body
Policy Approval Date:	January 2019
Date of Next Policy Review:	April 2023 (or as necessary)

Application for Ethical Approval of Research Proposals

Notes for Investigators Prior to Completing Application Form:

1. Marino Institute of Education ('The Institute', MIE) requires all research activity involving people as participants to be subjected to ethical scrutiny and this form is designed to enable the Marino Ethics in Research Committee (MERC) to assess any research proposed by members of staff, students, or external researchers where the research has not been subject to ethical scrutiny by another ethics board.

   If your research does not involve human (or animal) participants, their material or data you do not need to proceed with this form, for example:

   1. Quality assurance studies (e.g. assessment of one's own teaching practice)
   2. Audits of standard practice (not involving identifiable records)
   3. Research on publicly available information, documents or data
   4. Historical research in education
   5. Research that uses pre-existing data in the public domain (e.g. data from the Growing up in Ireland study)
   6. Review of literature or research
   7. Document analysis

   Such research is considered to be at Level 0. If you are a student, please agree this course of action with your supervisor.

2. You must state whether you require ethical approval at **Level 1** or **Level 2** as outlined below.

Level 1 Ethical Approval

This is **no risk to relatively low risk research** – i.e. research carrying little or no risks or discomfort greater than usually encountered during normal daily life, for example:

1. Anonymous surveys of a non-intrusive personal nature.
2. Unrecorded and anonymous observation of individuals in public areas.
3. Analysis of irrevocably anonymised and appropriately collected data.
4. Interviews (consensual) with non-vulnerable adults.
5. Some action research
6. Surveys where respondents can be identified and where respondents have given

appropriate consent.

Level 2 Ethical Approval

Moderate to high risk research – i.e. risk or discomfort is greater than that usually encountered during normal daily life – includes ALL RESEARCH WITH CHILDREN (i.e. under 18 years of age) AND VULNERABLE ADULTS[1].

MODERATE RISK

1. Surveys asking questions of a sensitive or private nature
2. Questionnaires or observational studies involving children or vulnerable adults.
3. Research where there is a risk of a participant feeling undue pressure to participate by virtue of his/her relationship with the researcher (e.g. student/supervisor; teacher/student; assessor/student).
4. Projects involving a justifiable degree of deception.
5. Some action research.

HIGH RISK

1. Research involving children and vulnerable adults.
2. Research where identifiable information obtained may have legal, economic or social consequences for research subjects.
3. Research that may identify illegal activity.
4. Projects where each subject is paid (over and above token gestures).
5. Research that may potentially endanger the subjects, and/or researchers, and/or third parties, and/or the environment.
6. Research that may have a direct military role.
7. Research conducted outside Ireland.
8. Research involving psychological intervention.
9. Research where a potentially beneficial or harmful treatment, information or learning method may be withheld from some participants.
10. Video recording or observation.

Additional notes:

[1] See Child Safeguarding Statement, Safeguarding Policy: Children and Safeguarding Policy: Vulnerable Persons

i. In situations where research ethics approval has been granted by an appropriate research ethics committee elsewhere, the submission may qualify for fast-tracked approval processing in MIE.
ii. Unless otherwise noted, research involving adults assumes adults with a capacity to consent.
    - Vulnerable groups/persons are described as: Individuals who face excessive risk of being enrolled in research, including those with limitations in their ability to provide informed consent to research because of factors such as immaturity, cognitive impairment, or language competence.
    - Vulnerability can also stem from individuals' relationships with others, and it is imperative that coercive situations are avoided. Such cases may occur when an employee/student/dependent is asked to participate in research being conducted by a supervisor/mentor.
iii. Additional social factors, such as poverty and lack of access to health care, can also make individuals vulnerable to coercion, exploitation or other risks and need to be considered in reviewing applications.

1. The primary focus for approval is research involving people. Where the participants include **children or vulnerable adults**, research cannot proceed unless all researchers involved have obtained Garda vetting[2]. In principle, all research in MIE should be conducted in a manner that respects the rights of all participants (including to privacy of data, confidentiality and anonymity as appropriate), causes no harm to participants or researchers, and requires the active, fully informed consent of all participants and their parents, carers, guardians or relevant responsible others.
2. In the case of **Level 2 ethical approval applications**, consent forms, **must be attached to the application**, and therefore demonstrate clearly that prospective participants are being fully informed about the purpose of the research and their role in it, how their data will be gathered, the purposes to which their data will be put and how their right to privacy (confidentiality and anonymity) will be respected (for research involving

[2] See Garda Vetting for Students Procedure and Vetting Policy (Staff)

children, use the ethics guidelines produced by the Department of Children and Youth Affairs.

3. Educational research undertaken outside Ireland must adhere to the same ethical standards as research Ireland. Any additional regulations (e.g. police clearance) and cultural sensitivities of the host country must also be observed.
4. Some **Level 2 ethical approval applications** may need to be referred to expertise beyond that available to MERC where proposals:
    - have the potential to cause harm to participants or researchers, directly physical or psychological;
    - may give rise to situations in which the researchers have to make statutory disclosure of illegal activity, whether on the part of participants or others;
    - seek to deceive participants for any reason;
    - may give rise to situations that may put the participants or researchers in any form of jeopardy.

Such cases and the nature of referral will be decided by MERC on a case-by-case basis.

5. If any changes to the approved research proposal are made:
    i. **For Students**: these must be discussed with your supervisor, and may require additional ethical approval[3];
    ii. **For Staff**: substantive changes need to be clarified with the MERC and may require additional approval.

8. This form along with any correspondence that is undertaken as a follow-up (e.g. approval letter, request for amendments etc.) will be kept as a formal record of the scrutiny process, for inspection as required by the University authorities. As such, proposers should ensure that proposals are presented to a professional standard as they will be returned for resubmission if deemed not to have been adequately prepared.

Please email the completed ethical approval application form, consent form(s) and a cover email requesting ethics review to the MERC administrator: (Mai Ralph, mai.ralph@mie.ie)

[3] See Ethics in Research Policy and Procedure for Ethical Approval of Research Proposals

In the case of student applicants, the form MUST be signed off by the supervisor prior to submission, or it will be returned.

Responsibility

Responsibility for processing completed application forms rests with the MERC Committee.

Related Documents

- MIE Privacy Policy
- Ethics in Research Policy
- Procedure for Ethical Approval of Research Proposals
- Safeguarding Policy: Children
- Safeguarding Policy: Vulnerable Persons
- Child Safeguarding Statement
- Garda Vetting for Students Procedure
- Vetting Policy (Staff)

Appendix 1: Application for Ethical Approval of Research Proposals

Title of Research

_____

Research Reference Number[4]

_____

Researcher's Name

_____

Email Address

_____

Category of Proposer (please tick)

Student ☐ **Principal Investigator (Staff)** ☐

If you are a student, please complete the following: Student Number:

_____

Course of Study: B.Ed.___ B.Sc.___ PME ___ MES ___ OTHER: ___

Please indicate the level of approval required (see accompanying notes).

Level 0	**Level 1**	**Level 2**
☐	☐	☐

[4] Research reference number (available from Mai Ralph (mai.ralph@mie.ie) prior to submitting the application). This number should be at the start of the file name of any document or mail submitted in relation to this application. Please follow the reference number with 1, 2, 3, etc. corresponding with the number of documents submitted with the application.

1. Please give a structured abstract of the proposed research, including the methods you intend to use (approx. 300 words).

Please tick √

2. Please answer the following questions in relation to your proposed research. Questions (b), (c) or (d) will require detailed explanations if answered 'yes' and will be referred for additional scrutiny by the MERC.	**Yes**	**No**
a. Does the research involve work with children (under-18) or vulnerable adults? If 'Yes', has appropriate Garda clearance (or equivalent) been obtained (include details)?		
Please provide the date of issue on the Certificate of Garda Vetting.		
b. Does the research involve work with students on a module you coordinate, teach or assess or a course you coordinate?		
c. Could any aspect of the research give rise to any form of harm to participants, including the researcher(s)?		
d. Could any aspect of the research produce information that could lead to criminal prosecution of the participants or others?		
e. Is deception of the participants planned in any aspect of the research? If yes, provide details.		

f. Does any aspect of the research involve patients (or their relatives or carers) or other users of health and social care services, the premises or facilities of such services, access to personal records or the participation of health or social care staff?		
g. Does the Researcher plan to disseminate the work? If yes, provide details of how and where?		

3. (a) Who are the proposed participants, e.g. teachers; students?

(b) What is your relationship with them? (If you are in a position of authority, for example, indicate how you will deal with the potential influences of such a relationship.)

(c) What data will be used?

(d) How will the data be collected?

(e) How will the data be used?

4. (a) How will you recruit participants?

(b) Please detail any ethical aspects that must be considered, including the proposed use of any incentives.

5. (a) What is the location(s) at which the data collection will be undertaken?

(b) Describe any circumstances that might give rise to security concerns for participants or researchers.

(c) Describe any conflicts of interest where data might be critical of working practices, people etc. or disclosure of illegal activities.

6. Please indicate how informed consent of all participants will be gained. For participants under the age of 18, indicate how the informed consent of both the participant and the participant's parent/guardian will be gained. (Draft consent forms MUST be attached – see question 8 for guidance.)

7. (a) Please indicate how the participants' rights to privacy (inc. confidentiality and anonymity) and the privacy of their data will be protected. Highlight potential limitations of confidentiality in the ethics form and information sheets for participants (e.g. for small samples or insider research and how this will be addressed). **(b) Please clearly outline what measures you will take for encrypting data.** **(c) Please also indicate how the data will be stored (and ultimately destroyed as appropriate).** **(d) Please outline what considerations you have taken in relation to GDPR and the potential GDPR implications for the proposed research.**

8. Please complete the checklist below to confirm you have considered all ethical aspects of consent. **(Note that the consent forms that must accompany this application; any omission or inadequacy in detail will result in a request for amendments).**	**Please tick √**
I have attached (an) appropriate consent form(s) which include the freedom to withdraw at any stage without having to offer a reason.	

Each consent form has full contact details of the researcher 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)	

Has your proposal been submitted to any other Research Ethics Committee? Yes / No If yes, please provide details:

_____

_____

_____

Declaration by All Proposers:

I have read and understood Marino Institute of Education's policy on ethics in educational research: and the Trinity College Dublin, the University of Dublin Good Research Practice Policies:

I declare that the details above reflect accurately my research proposal and I undertake to seek updated approval if substantive changes are proposed after this submission. I have consulted an authoritative set of educational research guidelines.

Signed: **Date:**

(Students Only) My proposals are based on consultation with my supervisor(s).

Signed: **Date:**

Supervisor's Signature: (**Student Proposal Only**, first supervisor only if there are two)

Signed: **Date:**

In instances where supervisors feel that their specialised expertise may be important information for the MERC to take into account (e.g.in relation in researching highly sensitive areas such as trauma/abuse), please submit an additional page with any relevant information.

Final Approval Signed-Off by Research Ethics Committee

Signed: **Date:**

Appendix 2: List of Research Methods that do not Typically Require Ethics Approval

- Historical research in education
- Research that uses pre-existing data in the public domain (e.g. data from the Growing up in Ireland study)
- Review of literature or research
- Document analysis
- Quality Assurance studies
- Audits of standard practice and research on publicly available information, documents or data

Appendix 3: Bibliography and Useful Reading re. Ethics in Research

British Educational Research Association (2011). *Ethical guidelines for educational research*. London: Author.

Department of Children and Youth Affairs (2012). *Guidance for developing ethical projects involving children.* Dublin: Author.

Strike, K.A. (2006). The ethics of educational research. In Green, J.L., Camilli, G., & Elmore, P.B. (Eds.). *Handbook of complementary methods in education research.* Washington, D.C.: American Educational Research Association.

Appendix I: Official MERC Approval Letter

Dear Ciara Sweeney,

the sub-committee of the Marino Ethics in Research Committee (MERC) and the dissertation committee met again on Monday January 8th 2024, for the second round of review the master's in education studies Primary Mathematics applications for ethical approval for conducting their research projects. Thank you for your application. There was an internal delay due to further discussions being needed within the committee.

The decision of the committee is that your application is now approved. Your supervisor will be contacting you regarding signatures on the MERC form. Your signed MERC form and your consent letter will be stored by the committee. It is the responsibility of you and your supervisor to ensure that you follow the protocol you have outlined in your MERC application, and that you use the consent letter that is approved. If at any time you need to make a change due to unforeseeable circumstances you will need to contact the MERC committee for approval.

Kind Regards,

on behalf of

The MERC sub-committee and dissertation committee

Appendix J: Teacher Interview Code

Quote from Data – pre lessons	Code	
"The curriculum can kind of get in the way"	Problem Solving in maths: not consistent with current Maths curriculum.	More opportunities
"don't use it as much as I should. But hopefully now with the new maths curriculum and If we get more resources and stuff that we can start using it"	Problem Solving in maths: hopeful new maths curriculum will allow for more opportunities to problem solve.	More opportunities
"lot of students EAL just for them to even understand the wording…what is actually being asked of them"	Problem Solving in maths: wording difficult from EAL pupils	Confidence
"there's other ones that just don't even basically attempt because they're kind of like, I'm not going to be able to do this".	Problem Solving in maths: too difficult to attempt/confidence	Confidence
"so it's probably the confidence there as well"	Problem Solving in maths: too difficult to attempt/confidence	Confidence
"sometimes they can't visualise it at all…so that problem holds them back a bit"	Problem Solving in fractions	Confidence
"you can see problems with the fractions, even like when were doing adding and subtracting, just the simple ones, without having the word	Difficulty with fractions in general	Need Support

problems in there, I had to go over it three times even this year"		

Teachers' perspectives on problem solving/fractions/teaching fractions

Teachers' impressions of students' problem solving abilities/math abilities

"in Australia, a lot of things was hands on, but I feel like since I came back I went straight back to the textbook, and then you know what I mean got stuck in the book"	**Teaching Fractions in general: reliant on textbook**	**More opportunities**
"when we did the new curriculum in December, I was like right from January I'm not doing the book".	**Teaching fractions/maths: hopeful new curriculum will allow for more hands on content.**	**More opportunities**
"they need help…they just buckle right away"	**Problem solving in maths: too difficult/confidence**	**Need support/confidence**
"if you point them in one way, point in the right direction…then they're like we're away and they can do another bit" "they still need a lot of direction with it"	**Problem solving :require help**	**Need Support**
"it depends. Like there's some that would bounce well off each other and help each other through it, but most of them would be looking at you"	**Problem solving: response to productive struggle**	**Need Support**

"they're just so used to the book and everything being so direct"	Problem solving: response to productive struggle, student reliance on book	Need support
"if they were left to their own devices to do it, I'm not even sure half of them would finish it…they need the supports…scaffolding to get through it"	Problem solving in fractions	Need support

Quote from Data – post lessons	Code	
"Some of them found all the words in Andy's marbles overwhelming"	Problem solving: words overwhelming	Need support
"one got it straight away, but couldn't explain how he got it"	Problem solving: justifying answers/maths talk	Need support
"I don't know how" he's just like "I just know that's what it is"	Problem solving: justifying answers/maths talk	Need support
"two of them just sat back and didn't even bother"	Problem solving: confidence?	Confidence
"I don't know is it that they couldn't understand it? So then just kind of gave up, or is it just some attitude with sixth class"	Problem solving: confidence	Confidence
"even for myself to try and include more problem	Problem solving: continue it, saw merit in it	Rewarding

solving even like get the on a Friday into groups"		
"even the weaker ones were getting that bit of accomplishment…"I can do this" "When it was a whole group"	Problem solving: rewarding, merit in it, inclusive	Rewarding
"If I could change anything it would be, say beforehand, some of the work to do to build up on their confidence"	confidence	Confidence
"yea definitely" I know the maths curriculum is so like compact and there's so much to kind of get through… give them opportunities like that maybe related to what they have done that week too, just to kind of build their confidence.	Confidence/curriculum/continue with problem solving	More opportunities/Confidence
"I would say 19/20 out of the 22 were really engaged with it. They wanted to try it. They wanted to work it out"	Good engagement with problem solving	Rewarding
"they were getting annoyed at themselves" "Why didn't we think of	Good engagement/working through productive struggle	Rewarding

that?" "you could see the competitiveness as well"		
"yea definitely. When they were working it out and then whether they got it at the end, they were all proud of themselves and if they didn't they were kicking themselves, being like we could have got that"	**Working through productive struggle/rewarding**	**Rewarding**

Themes:

Problem solving:

- Children need more opportunities (old vs new curriculum)
- Need support
- Confidence
- Rewarding

Appendix K: Pupil Learning Survey Code

Pupil Learning Survey results: 35 Participants

1. Do you enjoy being challenged during problem solving activities?

Yes = 4 Sometimes = 24 No = 7

2. Do you feel confident when completing problem solving tasks?

Yes = 11 Sometimes = 17 No = 7

3. Do you think problem solving is good for your learning?

Yes = 22 Sometimes = 9 No = 4

4. Would you rather learn from problem solving tasks or through more routine tasks?

Problem solving= 18 Routine Tasks= 16

- One child wrote down "both"

5. When problem solving, would you rather work independently or in a group?

Independently= 10 Group work = 25

6. Would you rather try to figure out a problem on your own or be given a teacher explanation first?

Independently = 12 Teacher Explanation = 23

7. What do you do if you get stuck in maths?

Give Up = 2 Ask a Friend = 11 Try another way = 9 Ask my teacher = 12

- One person circled "ask a friend", "try another way" "ask my teacher"

8. How do you feel about learning mathematics through problem solving?

“I don’t know.”

“Ok”.

“I like mathematics”.

“I feel ok but it’s a bit hard when I work on my own so I rather work in a group.”

“I feel it is ok But I tend to get frustrated when I can’t get it. I also think that sometimes part of problem solving questions are not needed. Overall it is fine.”

!Bad wouldn’t recommend it.”

“IDM”

“Ok, but normal is good too.”

“It’s alright”.

“It’s ok”.

“Sometimes good”.

“I will feel confident doing it”.

“I don’t really feel sad I just feel nervous”.

“I feel happy sometimes and annoyed sometimes”.

“I don’t mind doing it”.

“It’s okay, I don’t mind if I understand it but if I don’t I ask my teacher but it’s harder than any other mathematics because it’s tough words”.

“Not too bad, but is okay”.

“Good”.

“Okay”.

“Okay.”

“It’s ok”.

“I think it’s great.”

“I think problem solving is very effective and I learn from it and it helps me in upcoming tests. It is a funner way in my opinion”.

“Okay”

“good”

“All right”

“challenged which is good”

“ I feel that it helps me to look in different ways when problem solving”

“On the two tasks that you gave us I wanted to cry in the toilet again, but on regular problem solving that’s a bit tricky but I can still figure out I enjoy”

“ok”

“grand”

“I consider it to be no different to normal maths, it’s mainly just maths”

“good”

“not good”.