A study of the attitudes of fourth and fifth class pupils in one school towards mathematical problem-solving.

By

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A dissertation submitted to Marino Institute of Education in fulfilment of the requirements for the degree of Professional Master in Education (Primary), May 2019.

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Declaration

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Abstract

The fundamental goal of this research is to investigate the attitudes of fourth and fifth-class pupils in one school to mathematical problem-solving. Problem-solving is a key element of mathematical teaching and learning as it develops higher order thinking skills while also highlighting how mathematics can be used in real-life. However, there is a problem with the performance level of Irish pupils in problem-solving and therefore the researcher feels that there is a need for an investigation into pupils' attitudes towards this process. This study describes the attitudes of fifty-six fourth and fifth-class primary school pupils to their school, to mathematics and to mathematical problem-solving. The introductory chapter outlines the focus of the study, the research rationale, the research question and the researcher's personal motivation to complete research in this area. The dissertation includes a critical review of pertinent literature and this is where the initial research for this dissertation began. The comprehensive literature review includes information and educated opinions from various forms of national and international literature. A quantitative method of data collection was employed to complete this research and compile it in a manner fit for publishing. The methodological instrument employed was a child friendly questionnaire and this ensured that data based on the pupil's attitudes was effectively gathered. The findings revealed that pupils in this sample value mathematical problem-solving, however the research suggests a lack of enjoyment to the mathematical process. Furthermore, some pupils express their lack of confidence towards problem-solving and lack the motivation needed to complete mathematical problems on a frequent basis. The dissertation outlines specific recommendations based on the findings which include the adaption of teaching methodologies during mathematic lessons and the maintenance of an online platform encompassing an archive of mathematical problems.

Acknowledgements

I would like to thank all those who supported and helped me through these past two years and through the completion of this dissertation.

Thank you to my supervisor, Dr Ann Marie Gurhy for providing me with encouragement and advice to successfully complete this study. Your support and guidance through the year and during this lengthy process has been greatly appreciated, so thank you for all your help.

I wish to thank Dr Rory McDaid and Dr Barbara O'Toole. Without your continued guidance and support throughout the duration of the module, the process of writing this dissertation would have proved to be much harder.

Thank you to the school, teachers and pupils that made this study possible, your assistance and time is greatly appreciated.

Finally, thank you to my family and friends especially my parents, Paul and Eilish. Thanks for all your support, patience and understanding.

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List of Abbreviations

ASP	Advanced School Placement
DCYA	Department of Children and Youth Affairs
DES	Department of Education and Skills
GoI	Government of Ireland
IEA	International Association for the Evaluation of Educational Achievement
INTO	Irish National Teachers' Organisation
LTHC	Low Threshold High Ceiling
NA	National Assessments of Mathematics and English Reading
NCCA	National Council for Curriculum and Assessment
PDST	Professional Development Service for Teachers
PSMC	Primary School Mathematics Curriculum
RME	Realistic Mathematics Education
TIMSS	Trends in International Mathematics and Science Study

Chapter One

Introduction

Studies on attitudes to mathematical problem solving amongst Irish primary school pupils is one that few scholars have undertaken studies on. As years progress, examples of mathematics that are relatable to daily life are proliferating, which highlights the importance of this research in order to be opportunistic as an educator. Actioning a research study on the attitudes to problem-solving amongst senior primary level pupils has shown to illustrate somewhat striking results. The research seeks to unravel the ongoing discussions around problem-solving in mathematical lessons, with the focus of this research on fourth and fifth class pupils' attitudes. It could be said that at this transitional period for pupils soon to be departing primary level education, the correct methods to educate pupils on critical-thinking and problem-solving is crucial information that educators themselves should be fully competent in. The importance of problem-solving is suggested by Monaghan, Pool, Roper & Threlfall (2009) as they pose the question "what is the use of students learning mathematics, if they cannot use it to solve problems?" (p. 21). The research questions that constructed this study is now outlined.

Research Question

Specifically, the study investigates the following research question:

What are the attitudes of fourth and fifth class pupils in one school towards the process of mathematical problem-solving?

Subsequently, several sub- related questions are also explored. These include:

- What are pupil's attitudes towards their school?
- Where does mathematics rank in their favourite/least favourite school subjects?
- What are pupil's attitudes towards mathematics in general?

The researcher investigated the attitudes of the pupils towards to their school as this may influence their attitudes to mathematics and problem-solving.

Research Rationale

The research study was influenced by various factors. The Irish primary school mathematics curriculum (PSMC) (Government of Ireland, 1999a) considers problem-solving as a key element of mathematical teaching and learning since it develops higher-order thinking skills and highlights how mathematics can be used in everyday life. However, evidence from the Department of Education and Skills (DES) (2011) suggests that problem-solving has not been developed and implemented in numerous Irish primary school classrooms. Furthermore, research shows that performance on word problems is a weakness in national surveys as far back as 1977 (Eivers, Close, Shiel, Millar, Clerkin, Gilleece, & Kiniry, 2010). In addition to this, results from the National Assessment of Mathematics and English Reading (NA) 2014 and NA'09 suggest that Irish pupils need to improve further on mathematical processes including applying and problem-solving (Shiel, Kavanagh & Millar 2014). Similarly, as outlined by Close (2013), Irish pupils struggled in the ability to reason in TIMSS 2011. This struggle was again evident in the TIMSS conducted in Irish fourth classes in 2015 (Clerkin, Perkins & Cunningham, 2016). Finally, project maths is the new second level mathematics curriculum and it involves connecting maths to real-life situations through increased use of problem-solving. Therefore, it is vital for pupils leaving primary school to have a positive attitude towards problem-solving and so the researcher aims to acquire information about their attitudes to the process. The researcher's personal motivation to complete this study is now outlined.

Personal Motivation

The researcher selected this topic as he has a high interest in primary school mathematics, especially the process of problem-solving. The researcher's interest in this area

has resulted from a combination of his primary and secondary school experiences and his third level experience of primary school mathematics here in Marino Institute of Education. In school, the researcher had a passion for mathematics and really enjoyed completing problems which made him concentrate and develop mathematical strategies in order to obtain the correct answer. The researcher's interest in this area has also developed throughout his school placement experiences, where he thoroughly enjoyed teaching and planning mathematic lessons, both at junior and senior level. The researcher feels it is of utmost importance that pupils engage in problem-solving and that they have a positive attitude towards it. The method whereby problem-solving is essential is from the beginning to end of primary level education as it sets the foundation for the intellectual development of pupils. Chapter Two now critically analyses the relevant literature which enabled the researcher to reach comprehensive conclusions.

Chapter Two

Literature Review

"Developing the problem-solving competence is the most important goal of Mathematics Education"

(Marchis, 2013, p.59).

This research study aims to investigate senior primary school pupils' attitudes towards mathematical problem-solving. This chapter utilises literature from both national and international research to identify key concepts and theories pertaining to children's attitudes to problem-solving, particularly in mathematics. The first section explores the various key terms related to the research topic. Next, the literature explores what an effective problem is and then the problem-solving journey in mathematics. This is followed by literature on problem-solving in the Irish context which includes the performance levels of Irish pupils in mathematical problem-solving. Thereafter, literature based on student voice and attitudes towards mathematical problem-solving is reviewed. Finally, mathematization is examined and this is linked with the theory of Realistic Mathematics Education. The researcher aims to give a clear overview of why the study of pupil's attitudes towards mathematical problem-solving is topical. The literature review now begins by exploring the key terms pertinent to this research.

Key terms – Mathematics, Numeracy, Attitudes and Problem-Solving

For the purpose of this paper, mathematics is conceptualised using the following definition: "Mathematics may be seen as the science of magnitude, number, shape, space, and their relationships and also as a universal language based on symbols and diagrams" (Government of Ireland, 1999a, p.2). In mathematics, information is handled, predictions are made, and problems are solved using concise and accurate language (GoI, 1999a). Therefore,

mathematics encompasses the study of a range of topics and skills and when mathematics is acquired the child is enabled to "develop an understanding of particular and important dimensions of the physical world and of social interactions" (GoI, 1999a, p.2)

It can be argued that the term numeracy is becoming more frequently used in Irish schools, national reports and strategies. Numeracy is defined as "the ability to use mathematics to solve problems and meet the demands of day-to-day living" (Department of Education and Skills, 2011, p.8). This definition suggests that numeracy involves much more than just acquiring traditional arithmetic skills such as addition, subtraction, multiplication and division. Jeffrey (2011) defines numeracy as "the knowledge, skills and understanding necessary to move around in the world of numbers with confidence and competence" (p.6). Therefore, this implies that for an individual to be numerate, they must be able to be "competent in dealing with mathematically related aspects of life" (Irish National Teachers' Organisation, 2013, p.67). While acknowledging that some scholars distinguish between the term's mathematics and numeracy, the researcher believes that they are analogous and so, intends to use them interchangeably throughout this research.

The National Literacy and Numeracy Strategy (DES, 2011) emphasises that the "development of positive attitudes and motivation are vital for progression in literacy and numeracy" (p.43). The literature refers to attitude as a learned predisposition that involves an individual having either a positive or negative feeling about an object, issue, concept or another person. Previous studies on mathematics report that attitudes towards maths have a significant role on the learning of the subject, and that students with positive attitudes will score high in the subject (Tapia & Marsh, 2004; Zan & Di Martino, 2007; Guner, 2012).

One final term pertaining to this research that needs clarification is problem-solving. Hatfield, Edwards, Bitter and Morrow (2008) argue that problem-solving is the oldest intellectual skill known to humanity and without the ability to solve problems, human beings

would have become extinct. Therefore, we encounter and solve problems daily and in fact in today's modern society, "all of life is problem-solving" (OECD, 2014, p.26). However, in mathematical terms, Kaur (1997) argues that mathematical problem-solving is a "complex process" where an individual must "coordinate previous experiences, mathematical knowledge, understanding and intuition" to reach the end goal (p.95). Similarly, Cai and Lester (2010) suggest that problem-solving involves the engagement in mathematical tasks that have the potential to provide intellectual challenges that enhance students' mathematical development. Therefore, this signifies that an individual's mathematical skills are developed when a problem is encountered, however this problem must provide a sufficient level of challenge. The NCCA (2016) agree with these definitions as they argue that through engagement with the problem-solving process, mathematical understanding is expanded. This may also suggest that problem-solving occurs more effectively when the individual has previously acquired the required mathematical skills. Finally, Mann (2006) argues the importance of problem-solving as he states that children need to master more than just the computational skills and through engagement with problems, they will develop as mathematicians. Regarding problem-solving, significant research has been completed on pupils' performances and scores in mathematical problem-solving. However, insufficient attention has been given to the attitudes of the pupils towards the process. We now look at what comprises an effective problem.

What is an Effective Problem?

Van de Walle, Karp & Bay-Williams (2010) state that an effective problem should include the following three features: "It must begin where the students are", "the problematic or engaging aspect of the problem must be due to the mathematics that the students are to learn" and "it must require justifications and explanations for answers and methods" (p.37-38). Similar to Van de Walle et al., (2010), Delaney (2012) states that a good problem should leave the solver feeling challenged at first and should also require pupils to validate their

answers and methods. He further suggests that problems should involve different maths topics and that they should be relatable to the children's lives and experiences (Delaney, 2012). However, as argued by Delaney (2012) pupils should not complete a high number of problems in one lesson as the use of fewer problems, but ones that are more open-ended, should be implemented in Irish primary school classrooms. This is the approach undertaken in Japan where one problem only is presented and when it is worked on individually, and then in groups, students present and discuss one or more solution methods (Delaney, 2012).

McClure (2013) suggests that pupils should be solving both problems that they pose for themselves and problems that are set by others. Various researchers including McClure, Woodham & Borthwick (2011) suggest that 'Low Threshold High Ceiling' (LTHC) tasks are a good way to engage children in problem solving. A LTHC task "is a mathematical activity where everyone in the group can begin and then work at their own level, yet the task also offers lots of possibilities for learners to do much more challenging mathematics too" (McClure et al., 2011, p.1). LTHC tasks allow pupils to engage in problem-solving and develop critical problem-solving skills. Due to all children working on the same task, LTHC tasks create a positive classroom culture and allow all children to work at their own level as mathematicians (McClure et al., 2011). LTHC tasks could be extremely effective if implemented in Irish primary school classrooms. Other ideas that are suggested in the literature regarding an effective problem are that the use of real-world problems, especially ones arising from experiences, could give our children the motivation and opportunity to engage in and develop their computational thinking (NCCA, 2016). The succeeding section critically discusses the problem-solving journey in mathematics.

The Problem-Solving Process in Mathematics

Berman (2003) argues that "math instruction should focus more on process and problem-solving than on computation and using only one method to solve a problem"

(p.172). Individuals must realise that confusion is part of the process when solving problems (Burns, 2007). Acting on this confusion and furthering the thought process to overcome and engage with the problem is a productive exercise which leads to valuable mathematical development. Delaney (2012) states that solving a problem takes times and may sometimes even take days to complete. The persistence illustrated by pupils to revisit problems with fresh eyes may be a reflection on the pupils' attitudes towards the problem-solving process. This persistence shown could also develop productive struggles. Granberg (2016) argues that productive struggles occur upon returning to explore and analyse a problem and that it aids pupils in constructing new knowledge. The engagement with the problem-solving process could also develop student's growth mindset. Growth mindset refers to abilities and intelligence being developed as a result of effort (Dweck, 2015). Therefore, engagement with the problem-solving process could result in productive struggles and also develop the growth mindset of an individual.

There are many strategies that can be used to assist individuals in solving problems. One of the earliest strategies for problem-solving was proposed by George Polya (1945). He identified that problems can be solved using a simple four step process; Understand the problem, devise a plan, carry out the plan and finally look back. The RUDE strategy is another strategy for solving mathematical problems which involves reading the problem, underlining the key words, drawing a diagram of the problem, estimating an answer and finally solving the problem. However, as argued by Haylock & Manning (2014) the most important strategies are the most obvious strategies which are to "make sure you understand what you are given and to ensure what you understand what the goal is" (p.57). In addition to this, as argued by Delaney (2012), there is very little evidence to suggest that these strategies are effective and that the best way to learn to solve problems is through practise.

Rasiman (2015) argues that the ability to solve mathematical problems is influenced by both internal and external factors. For successful problem-solving to occur, pupils need

to be motivated (Marchis, 2013). Pupil's motivation is strongly related with their beliefs about the usefulness of mathematics in their future (Marchis, 2011). Therefore, the attitudes of the pupils towards the problem-solving process is critical for meaningfully learning to arise. The next section explores the process of problem-solving in the Irish context.

Problem-Solving in the Irish Context

Curran (2014) states that problem-solving has become a buzzword of late in primary mathematical education and while it is a term that can spark enthusiastic reactions it mainly causes a large amount of "ambiguity and confusion" (p.1). Both the PSMC (GoI, 1999a) and the Literacy and Numeracy for Learning and Life National Strategy (2011) outline specific goals in relation to problem-solving and highlight the importance of the process. Similarly, the Background Paper and Brief for the development of a new Primary Mathematics Curriculum (2016) identifies the importance of problem-solving in mathematical development which suggests that the new PSMC will include an increased emphasis on problem-solving.

The 1999 Curriculum takes a constructivist approach to mathematical learning and therefore, problem-solving plays a central role in the curriculum as it develops higher-order thinking skills. The DES Mathematics Teachers Guidelines states that "problem-solving experiences should develop the ability to plan, take risks, learn from trial and error, check and evaluate solutions and think logically" (GoI, 1999b, p.35). The Literacy and Numeracy for Learning and Life National Strategy (2011) defines numeracy as having the ability to use mathematics to solve problems. This strategy further emphasises the need to develop numeracy skills as it is "fundamental to the life chances of each individual and essential to the quality and equity of Irish society" (p.9). From this, it is suggested that problem-solving is outlined as being hugely important in mathematical development. However, research

suggests that the implementation of problem-solving in our classrooms and the development of problem-solving skills have not been as successful as planned (DES, 2011).

Results from the Chief Inspector's Report (DES, 2013) suggests that there is a lack of talk and discussion, and collaborative learning occurring throughout math lessons. These findings are of concern as these approaches play a significant role in problem-solving. In relation to the use of mathematics textbooks, Delaney (2012) highlights that the problems in Irish text books are of a poor quality and that there are too many of them. In a similar vein, the INTO (2013) argue that the textbooks contain a predominance of word problems allocated in specific sections of various chapters and there is "less evidence of a problem-solving approach permeating the overall structure of the chapters" (p.42). The literature now discusses the performance levels of Irish pupils in relation to mathematical problem-solving.

Irish Pupils' Performances in Mathematical Problem-Solving

Irish pupils have not performed well in problem-solving tasks in comparison to other countries with research showing that performance across word problems is a weakness in national surveys as far back as 1977 (OECD, 2014; Eivers, Close, Shiel, Millar, Clerkin, Gilleece, & Kiniry, 2010). Curran states that teachers and pupils express high levels of ambiguity and confusion in relation to problem-solving (2014).

The 2009 National Assessments of Mathematics Achievement (NA) reveals that second and sixth class pupils in Ireland struggle with the measures strand and the ability to problem solve. An observation that can be made is that overall performances in mathematics was higher in NA'14 in comparison to NA'09. It can be argued that this increase in performance may be as a result of the 2011 Literacy and Numeracy for Learning and Life Strategy as the 2014 results reflect a time "where there was an increase emphasis on numeracy in schools" (NCCA, 2016, p.24). However, as argued by Shiel, Kavanagh &

Millar (2014), it is important to note that students must still improve further on higher level mathematical processes including applying and problem-solving.

For the first time in sixteen years, 2011 saw fourth class children in Ireland participate in the Trends in International Mathematics and Science Study (TIMSS). According to Close (2013), the Irish performance in this study was of a satisfactory level, but Irish children still displayed a weakness in measures and in the ability to reason. The study was completed for a second time in 2015, with Irish pupils performing significantly better overall in comparison with the 2011 study (Clerkin, Perkins, Cunningham, 2016). Reasoning was again a relative weakness, but it is imperative to note that "applying was in line with overall performance" (Clerkin, Perkins, Cunningham, 2016, p.61). The increase in the performance of the pupils from 2011 to 2015 may suggest the impact that the 2011 National Literacy and Numeracy Strategy had in our classrooms. However, it appears that problem-solving and reasoning abilities need considerable improvement and these findings may indicate that pupils are not being exposed to problems that require higher order thinking on a consistent basis. Student voice will now be discussed from a critical perspective.

Student Voice

The importance of student voice is now being recognised (Fleming, 2016). It is defined as "an overarching term that concerns dialogue, discussion and consultation with the students about their experiences in our schools and their classrooms" (Fleming, 2016, p.40). An argument has been made that the voice of the students has often been overlooked and therefore students have been unable to express their feelings or views about their education (Fleming, 2016). Students have the right to have a voice and article 12 of the United Nations Charter on the Rights of the Child (UNCRC, 1992) assures this. Therefore, it is vital in our education system that students have the right to express their own views freely. Student voice

and attitudes have a significant link as the pupils must be involved and listened to in relation to their education.

Attitudes towards Mathematical Problem-Solving

Abu-Rabia (2003) simply defines attitude as "a general and enduring positive or negative feeling about some person, objects or issue" (p.349). In relation to education, Tapia and Marsh (2000) outline the importance of student attitudes as they are "critical in relationship to immediate and long-term goals of teachers, parents and students" (p.12). Furthermore, the importance of student attitudes is highlighted by Ajisuksmo and Saputri (2017) as the attitude's students possess affect their cognitive activities.

Zan and Di Martino (2007) define attitude towards mathematics as the positive or negative emotional response associated to mathematics, the confidence to succeed in mathematics and strategies in coping with mathematical problems. For the purpose of this study, attitude is defined as a combination measure of an individual's value, self-confidence, enjoyment and motivation (Tapia & Marsh, 2004, 2005). A study conducted by McCoy, Smyth and Banks (2012), suggest that attitudes to mathematics in Irish classrooms are "finely balanced between positive views and ambiguous or even negative views" (p.44). However, findings from Irish fourth-class pupils who participated in TIMSS 2015 suggest that 80% of the participants indicated that they like mathematics (IEA, 2016). Interestingly, 76% of Irish fourth-class pupils who participated in TIMSS 2011 stated that they like mathematics (IEA, 2012). This increase in positive attitude may be due to the National Literacy and Numeracy Strategy (DES, 2012) as an emphasis is placed on the "the development of positive attitudes and motivation" as these are "vital for progression in literacy and numeracy" (p.43). Similarly, both NCCA research reports (Reports 17 and 18, 2014) highlight the importance of children's attitudes to their mathematical learning and development.

Findings from TIMMS 2015 suggest that 72% of Irish fourth-class pupils like to solve mathematical problems (IEA, 2016). The curriculum background paper argues that pupil engagement with problem-solving activities will "not only help develop children's higher-order thinking skills but also reinforces positive attitudes to mathematics" (NCCA, 2016, p.35). Similarly, Lampert (2001) argues that problem-based instruction is supposed to improve students' performances and increase their motivation to learn as it allows school to become more relevant and understanding more solid. Therefore, it is vital pupils are given opportunities to engage in problem-solving tasks. Literature on mathematization will now be discussed and analysed.

Mathematization

Another concept that is important in relation to problem-solving in mathematics is mathematization. This term originates from the work of Freudenthal (1973), as he believed for children to learn mathematics, it was essential for them to be involved in mathematization. Ginsburg's (2009) defines mathematization as a process involving "children interpreting and expressing their everyday experiences in mathematical form and comprehending the relations between abstract mathematics and real situations in the world around them" (p.30). From a similar perspective, Rosales (2015) simply defines mathematization as "the process of understanding maths within the contexts of children's daily lives" (p.1) and he argues that the process of mathematizing allows math concepts to become more engaging and realistic for children. Therefore, utilising mathematization is believed to develop children's mathematical knowledge by encouraging them to think mathematically.

Several processes of mathematization were used in the PSMC and these processes have been implemented in our classrooms to date (NCCA, 2016). Mathematization was discussed in relation to primary mathematics education here in Ireland as a result of Research

Reports 17 and 18 in 2014 (Dunphy et al., 2014; Dooley et al., 2014). These reports argue that "mathematization should be central to the mathematical experience of all children" (NCCA, 2016, p.30). Mathematization has a strong link with the theory of realistic mathematics education (RME) and this theory will now be explored.

Realistic Mathematics Education

Realistic mathematics education, "is a domain-specific instruction theory for mathematics, which has been developed in the Netherlands" and has been successfully implemented in Dutch schools for over forty years (Van den Heuvel-Panhuizen & Drijvers, 2014, p.1). RME involves a problem-solving based learning approach involving rich, "realistic" situations being given a prominent position (Van den Heuvel-Panhuizen & Drijvers, 2014). The realistic aspect of RME refers to students being offered problem situations which they can comprehend and contextualise (Van den Heuvel-Panhuizen & Drijvers, 2014). RME supports the process of mathematization as it allows mathematics to be applicable to everyday situations. In Ireland, Ward (2009) and Cassidy (2009) have undertaken action research studies on the effect of RME in Irish primary school classrooms.

Ward's (2009) study was based on research conducted by Verschaffel and DeCorst (1997). The findings revealed that both the pupils and teacher felt that the realistic mathematical problems provided more interesting and challenging activities when compared to class textbooks. Also, findings from the study suggest that the use of realistic non-routine problems motivated pupils to complete them and this engagement created a more positive attitude towards mathematics. Research findings also indicate that through practice, pupils can improve their problem-solving skills and improve their mathematical thinking. This study appears to support Delaney's (2012) view that the best way to acquire the skill to problem-solving is to engage in solving problems.

Findings by Cassidy (2009) appear to affirm those by Ward (2009) in that they also suggest that pupils of all levels of ability displayed a positive attitude towards numerous problem-solving situations when they encountered realistic contextual problems. The implementation of this approach resulted in pupils becoming task orientated, as well as being very engaged in attempting to solve problems and think mathematically. The study indicates that pupils also displayed enthusiasm for the problem-based learning activities, and that the pupils also maintained a positive attitude throughout. These Irish studies appear to indicate that a problem-based approach, similar to RME, could be successfully implemented in Irish primary school classrooms.

Conclusion

The literature discussed in this chapter focuses on the process of problem-solving, attitudes and mathematization. As a result of introduction of the National Literacy and Numeracy for Learning and Life Strategy in 2011, it can be said that there is an increased emphasis on numeracy in our primary school classrooms. The process of problem-solving is pivotal to an individual becoming numerate. However, as outlined in the literature, Irish pupils are underachieving in this complex process. This underachievement is of course due to various reasons, one being that our pupils are not given frequent opportunities to mathematize and to work like mathematicians on a consistent basis. Attitudes also play a significant role in performance levels on mathematical problem-solving as there is a strong correlation between both. Therefore, it is vital that the attitudes of pupils towards problem-solving is investigated in order to gauge capabilities and sentiment. The following chapter examines the research methodology chosen to complete the research.

Chapter Three

Research Methodology

This chapter discusses and justifies the research methodology employed to complete this research. This chapter utilises literature from publications on educational research. First, the researcher will outline the purpose of the research. Then, the researcher will discuss how access and permission was granted to the sample by the relevant parties. Next, the research design is outlined, and the method of data collection is justified. The researcher then discusses the research sample and the pilot study. The processes involved in collecting the data and analysing the data are then outlined and finally, ethical considerations and research limitations are discussed. The researcher will now restate the purpose of research study.

Research Purpose

As highlighted in the literature chapter, the research study was influenced by various factors. The main purpose of the research was to identify the attitudes of senior primary school pupils in one school towards mathematical problem-solving. The research was designed in order to investigate pupil's attitudes towards the complex process of problem-solving and this is outlined in the following sections.

Access and Permission

Prior to commencing this research project, the researcher had to obtain consent from all relevant parties involved. The researcher discussed the project with the principal and approached him with a 'plain language statement' (Appendix A) as he is the 'key gatekeeper' of the school (Lochmiller & Lester, 2015). The statement outlined the focus of the research, the research methodology, the anonymity aspect, the storage of the data and the participants' right to withdraw from the research at any time. The principal agreed pending approval from the Board of Management and so he approached the Board of Management with an

information letter (Appendix B). Permission was granted by the Board of Management. The researcher then discussed the project with the relevant class teachers and sought permission to carry out the research in their respective classes. Both teachers read a plain language statement (Appendix C) and signed an individual consent form for the research to be carried out in their class. Thereafter, the researcher drafted an information letter and consent form for parents/guardians and approached the principal with this, amending it accordingly based on feedback. These letters and consent forms were distributed to all pupils in fourth and fifth class (Appendix D). The researcher discussed the letters and the project with the pupils and advised the children to discuss these with parent/guardians and return the permission slip to the researcher. Permission was attained from the parent/guardians of all fifty-six children in fourth and fifth-class. Finally, the researcher spoke to the pupils, explaining the research project and prior to starting the research, the pupils signed a student assent form (Appendix E).

Cohen, Manion & Morrison (2007) outline the process involved in seeking informed consent from a minor, for example a school pupil. The researcher strictly adhered to this process by first gaining permission from all adults involved and then gaining permission from the minors themselves.

Methods of Data Collection

Regarding research methods, there tends to be three approaches one can take in order to gather data (Creswell, 2013). These approaches are quantitative, qualitative and mixed methods. For the purpose of this research study, the researcher selected a quantitative method of data collection as he felt it was the most suitable method. Quantitative research "usually refers to studies that are highly objective and projectable, using closed-end, forced-choice questionnaires" for example, and these "studies tend to rely heavily on statistics and numerical measures" (Watson & Noble, 2014, p.41).

Creswell (2013) outlines that a quantitative method can be used in order to gather data based on an individual's attitudes. Therefore, the researcher believed that this method of data collection was suitable for the research study. The methodological instrument selected by the researcher was a questionnaire. The questionnaire was designed with the aim of collecting data to measure the participants attitudes through structured closed-end questions. Denscombe (2010) outlines that group administered surveys work well with naturally occurring groups and that they suit small scale research projects. When the questionnaires are collectively calculated, they can provide a comprehensive report of quantitative analysis which will be discussed in Chapter Four.

Questionnaire Design

The questionnaire (Appendix F) was designed specifically to obtain the relevant data needed to examine participant's attitudes towards mathematical problem-solving. The questionnaire explored pupils' attitudes, particularly their value set, self-confidence and enjoyment of school life, mathematics and problem-solving (Tapia & Marsh, 2004, 2005). It also investigated the pupils' motivation and engagement levels with mathematics and problem-solving. The researcher attempted to ensure that each question was clear with the wording unambiguous and suitable for the age of the participants (Denscombe, 2010, p.171). Therefore, this helped to increase the reliability of the questionnaire. The questionnaire was also piloted, and this will be discussed later in the chapter.

The three-scale questionnaire included closed questions, continuous scales, categorical scales and a four-point Likert scale with the values "agree a lot", "agree a little", "disagree a little" and "disagree a lot" (Cohen et al., 2007; Denscombe, 2010). Prior to completing the questionnaire, participants were required to complete sample questions similar to those in the actual questionnaire. The first scale of the questionnaire asked the participants to identify their gender and age as these are valuable aspects to consider when

analysing the research findings. The second scale required participants to state their opinion regarding five statements based on school and rank their top three and least three favourite subjects. Scale three required participants to use the Likert scale to respond to statements about mathematics and mathematical problem-solving. Specific instructions were given for the completion of the questionnaire. Sections of the questionnaire included questions from both the TIMSS 2011 and 2015 student questionnaires and therefore this enabled comparison between findings while also ensuring the relatability of the questionnaire.

Research Sample

The research was undertaken with fourth and fifth class in a vertical mixed DEIS Band 11 school in the north-west of Ireland. The research sample included twenty-five pupils in fourth class and thirty-one pupils in fifth class. The pupils in both classes are taught Mathematics by the class teacher for a period of 45-50 minutes daily without any additional in-class support.

The fourth-class teacher informed the researcher that the pupils in the class complete one entire lesson based on problem-solving weekly. The teacher informed the researcher that this lesson usually consists of problems based on content that the pupils have previously acquired and that the pupil's complete various problems individually, in pairs and as part of a group.

The researcher had taught fifth class as part of Advanced School Placement (ASP) for the three weeks prior to the research being conducted. During this three-week block, the researcher used mathematical problems as frequent as possible during mathematics lessons. Before this three-week block, the class had minimal experience of mathematical problem solving throughout this school year, with their main experience of the concept coming from problems in the text-books. However, in the previous school year, the fifth class had the same teacher as the fourth-class in this sample, and therefore they may have been exposed

to problem-solving on a more frequent basis. During the ASP teaching block, the researcher used a mixture of problems including contextual real-life problems, Low Threshold High Ceiling (LTHC) tasks and word problems.

Validity and Pilot Study

Cohen et al., (2007) suggest that by completing a pilot study "the reliability, validity and practicability of the questionnaire" is increased (p.341). As the methodological instrument used was a closed and structured questionnaire, a pilot study was particularly important "so that the final version contains as full a range of possible responses as can be reasonably foreseen" (Cohen et al., 2007, p.321). The validity of the questionnaire was also considered as the researcher consulted with peers and professionals including a primary school teacher and his research methods supervisor in order to ensure that the questionnaire was suitably appropriate.

The pilot study was conducted with three children from a different school. Two of these children are in fourth class, one male and one female, and the fifth-class child is male. These children completed the questionnaire with the researcher being present. The completion of this pilot study allowed the researcher to ensure that the questionnaire did not pose any difficulties for participants and it also allowed the researcher to gain an understanding of how long the questionnaire took to complete. Once the questionnaires were complete, the researcher engaged in discussion with the children regarding their thoughts on the questionnaire and the researcher amended the questionnaire appropriately.

Data Collection

Once access and permission were granted to the sample and the participants' assent was acquired, the researcher accessed the sample in their respective classrooms. Questionnaires were distributed to each participant and these were completed in the presence of the researcher and the presence of the class teacher. The researcher instructed participants

to place a copybook beneath each question to ensure that they were completing the correct question. As the researcher was present, any relevant queries were addressed promptly. Therefore, this eliminated the chance of any errors being made by the pupils.

Data Analysis

"Quantitative data analysis is a powerful research form, emanating in part from the positivist tradition" (Cohen et al., 2007, p.501). The researcher began the data analysis process by scoring the data through coding and inputting the data into a Microsoft Excel sheet. The data was then categorised and checked, ensuring that all sections were completed and identifying any errors (Creswell, 2013). Once this initial stage was complete, the researcher explored the data, noting any "obvious trends or correlations" (Denscombe, 2007, p.240). The researcher then analysed the data using inferential and descriptive statistics. The mean and mode of answers to the various questions was explored, and this aided the researcher in describing the trend of the data (Denscombe, 2007). The researcher also facilitated analysis by the gender and class level of participants.

Ethical Considerations

The researcher sought ethical approval for the proposed research study. The Marino Institute of Education (MIE) ethics policy was followed and strictly adhered to. First, the researcher sought approval from MIE by completing a Marino Ethics in Research Committee (MERC) form. This form addressed various aspects of the research project including; the project description, the proposed methodology, risk management, access and permission, confidentiality, anonymity and finally the storage and protection of the data. Following approval from the MERC, the next protocol was followed. The researcher adhered to the process of seeking informed consent from a minor and sought consent from all relevant parties (Board of Management, Principal, Class Teachers, Parents/Guardians) and then finally, assent from the minors themselves (Cohen et al., 2007). When seeking assent from

the children, the researcher gave “adequate information about the project’s aims, methods and potential outcomes” (Department of Children and Youth Affairs, 2012, p.2). Children were also informed that their participation was completely voluntary, and they had the right to withdraw at any time (DCYA, 2012).

Limitations

Regarding the research method and analysis, like all methods of data collection, questionnaires have strengths and weaknesses (Denscombe, 2010). First, the sample size was small with only fifty-six participants, and so it is difficult to generalise claims regarding the data collected. Secondly, as the questionnaires involved a significant amount of ‘ticking the box’, participants may have felt frustrated and restricted throughout. This may have led some to answer the questions in an erratic manner resulting in inconclusive findings (Denscombe, 2010). Finally, as outlined by Cohen et al., (2007), due to the presence of the researcher in the classroom the participants may have felt pressurised to complete the questionnaire, and thus did not thoroughly think about their answers.

Conclusion

This chapter discusses and justifies the research methodology utilised during the completion of this research study. The researcher restates the purpose of the research. The research design and the design of the methodological instrument is justified. The chapter discusses the sample and the pilot study which was employed and outlines the data collection and data analysis processes. The researcher clearly outlines ethical considerations, including access and permission to the sample which is significant due to the participation of minors. Finally, the limitations of the research are discussed. The following chapter presents the findings of the research study. These findings will be analysed and discussed with reference to relevant literature and research studies.

Chapter Four

Findings, Analysis and Discussion

This chapter analyses and discusses the findings of this research study. First, the profile of the fifty-six participants is provided detailing their class level, gender and age. Next, the researcher will present, analyse and discuss the participant's attitudes to their school and school subjects. Then, findings pertaining to the pupil's attitudes to mathematics and to learning mathematics is analysed and discussed. The researcher will analyse and discuss these findings and compare them with national and international data from the Trends in International Mathematics and Science Study (TIMSS) 2015. Finally, the researcher explores the data pertaining to pupil's attitudes to mathematical problem-solving by analysing and discussing the findings from eight specific statements. The profile of the participants involved in this research study is now outlined.

Profile of Participants (N=56)

Table 1

Class level, gender & age of participants

No. of participants	Class level	Male	Female	9 years old	10 years old	11 years old
25	4th Class	12 (48%)	13 (52%)	7 (28%)	18 (72%)	N/A
31	5th Class	15 (48%)	16 (52%)	N/A	6 (19%)	25 (81%)

Table 1 summarises the basic profile of the participants of the research study. The sample for this research included pupils from both fourth and fifth class in a DEIS band 11

primary school in the north-west of Ireland. The research study obtained the views of fifty-six participants; twenty-five fourth-class pupils and thirty-one fifth-class pupils. There was a relatively even split in the gender of the pupils, with twenty-nine females and twenty-seven males participating. The participants had an average age of 10.3 years at the time of the study. The average age of the participants of this research study is identical to the average age of Irish fourth-class pupils that participated in TIMSS 2011, and very similar to the average age of participants in TIMSS 2015 (10.4 years) (Eivers & Clerkin, 2013; International Association for the Evaluation of Educational Achievement, 2016). Findings relating to the participant's opinion of their school and school subjects will now be presented, analysed and discussed.

Participants Attitudes to their School and School Subjects

This scale in the questionnaire is divided into three parts. The first section analyses the participants attitudes towards their school and the second section reports the pupil's favourite and least favourite school subjects. Lastly, the researcher discusses the pupil's attitudes to the core subjects of English, Irish and Maths.

Participants attitudes to their school (N=56)

The participants were presented with five statements regarding their attitudes towards school (Appendix F). The five statements were;

- I like being in school.
- I feel safe when I am at school.
- I feel like I belong at this school.
- I am proud to go to this school.
- I learn a lot in school.

Students had to choose one option from; *agree a lot, agree a little, disagree a little, disagree a lot.* Fourth-fifths (80%) of the pupils in this sample *agreed a lot* or *agreed a little* that they liked being in school. Interestingly, 32% of the pupils *agreed a lot* with the statement, with 48% of the sample only *agreeing a little.* However, it is noteworthy that only one female disagreed with this statement, with over one third (37%) of the male participants indicating that they do not like being in school. In comparison with TIMSS, these findings are similar as 74% of Irish pupils *agreed* that they like being in school in 2011 and 79% of the 2015 sample *agreed* with the statement (Eivers & Clerkin, 2013; IEA, 2016). The other four findings are consistent as they indicate a high agreement rate with the statements, and these support the findings of TIMSS 2011 & 2015 (Eivers & Clerkin, 2013; IEA, 2016). The findings are presented in Figure 1.

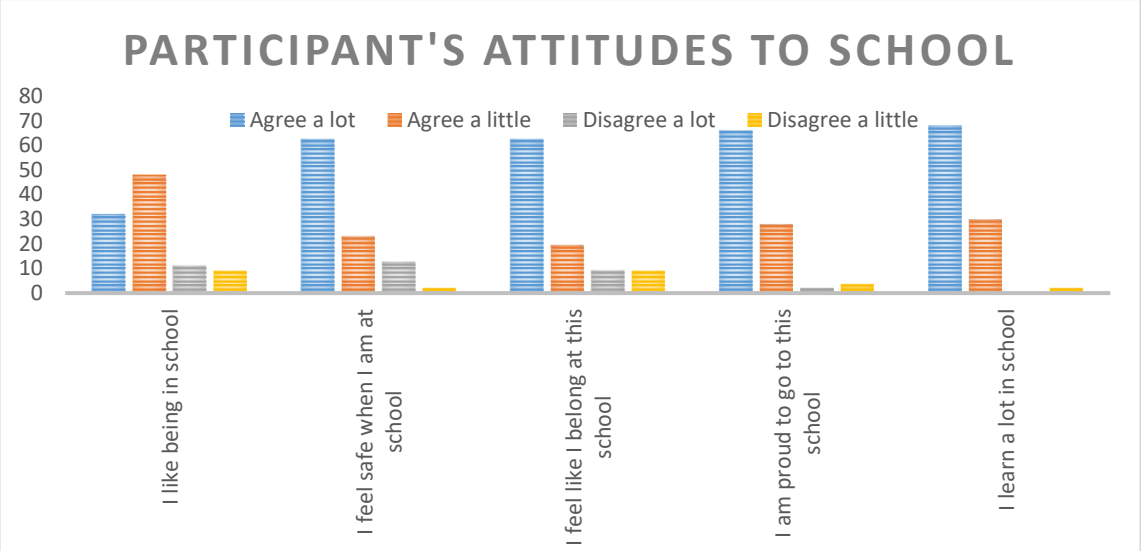

Figure 1. Participant's attitudes to their school.

Participant's favourite and least favourite school subjects (N=55)

The researcher will now analyse and discuss the pupil's favourite and least favourite school subjects. Pupils were presented with a list of the school subjects and were asked to rank their top three favourite and three least favourite subjects (Appendix F). As displayed in Figure 2, one third (33%) of participants selected physical education as their favourite subject and this was closely followed by 31% of the pupils selecting visual arts as their favourite subject. Notably, mathematics was the third highest selected favourite subject, however, this only constituted 9% of the sample which the researcher was surprised by. There was no difference in the gender and class level of the pupils that selected mathematics as their favourite subject. In relation to the pupil's least favourite subjects, Irish was clearly the least favourite subject with 42% of the pupils selecting it as their least favourite subject. It is significant to note that mathematics was the second least favourite subject with 24% of the sample selecting it as their least favourite subject. Therefore, over twice as many pupils selected mathematics as their least favourite subject as opposed to their favourite subject.

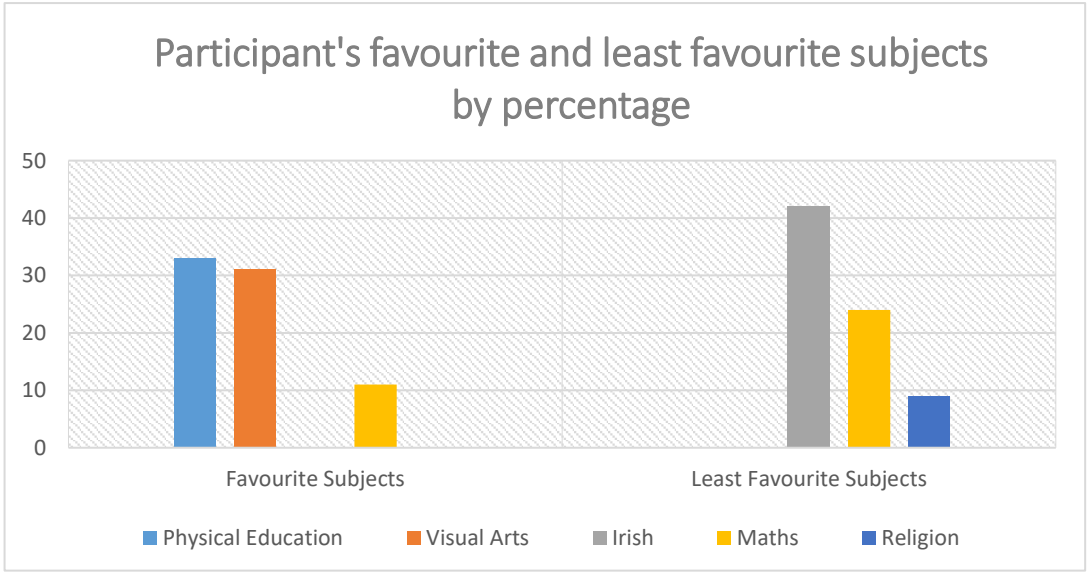

Figure 2. Pupils favourite and least favourite subjects by percentage.

Pupils' attitudes towards the core subjects; English, Irish and mathematics (N=55)

Using the data gathered from the favourite and least favourite school subjects' section, the researcher will now compare attitudes to the three core subjects; English, Irish and mathematics. Figure 3 presents the findings of the percentages of pupils that selected a core school subject in either their top three favourite or three least favourite subjects. As it can be seen from Figure 3, mathematics is the favourite core subject with 27% of the pupils selecting mathematics in their top three subjects. However, the percentage of pupils that selected mathematics in their three least favourite subjects is considerably high as more than half of the sample (53%) state that mathematics is one of their three least favourite subjects. Interestingly, in comparison to mathematics, 80% of the pupils stated that Irish is one of their three least favourite school subjects, with only 7% identifying Irish as one of their three favourite school subjects.

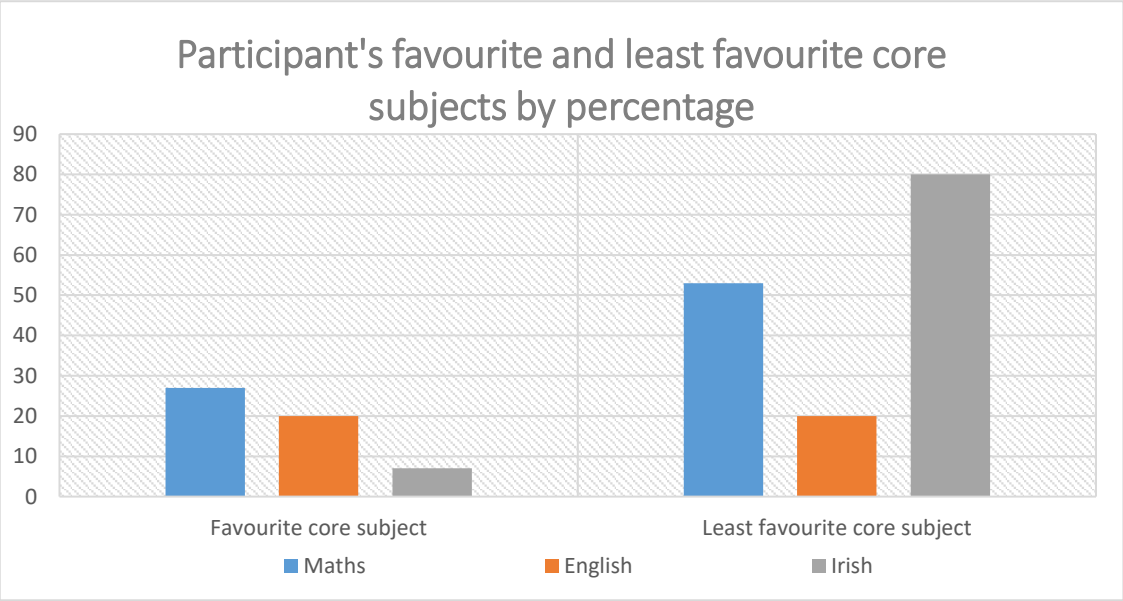

Figure 3. Participant's favourite and least favourite core subjects by percentage.

Attitude to Learning Mathematics

In this section, findings are presented in tabular format regarding the participant's responses to nine statements based on learning mathematics (Appendix F). These nine statements were taken from the TIMMS 2015 student questionnaire and therefore a comparative analysis with national and international data can be made. Table 2 presents the statement, gender differences in the responses, combined *agree* (agree a lot & agree a little) percentages from the Likert scale and national and international findings from TIMSS 2015.

Table 2 *Participant's attitude regarding their mathematical learning.*

Statement	% of Females that agreed	% of Males that agreed	Combined % agreeing	TIMSS 2015 Irish data	TIMSS 2015 Inter-national data
a) I enjoy learning maths	62	52	57	82	84
b) I wish I did not have to study maths	48	33	41	31	26
c) Maths is boring	62	48	55	33	26
d) I learn many interesting things in maths	72	85	79	87	88
e) I like maths	51	46	49	80	82
f) I like any schoolwork that involves numbers	55	55	55	70	77
g) I like to solve maths problems	52	55	54	72	75
h) I look forward to maths lessons	34	41	38	63	71
i) Maths is one of my favourite subjects	31	41	36	64	69

Following a detailed exploration of these nine statements, the data reveals that overall, the pupils in this sample had a negative attitude towards learning mathematics as opposed to their national and international counterparts that participated in TIMSS 2015. 57% of the pupils indicated that they *enjoy learning maths.* This percentage is significantly below both the national average of 82% and the international average of 84% from TIMSS 2015 (IEA, 2016) and it reveals that out of the research sample of fifty-six, twenty-four *do not enjoy learning maths.* However, when asked if *they wished they did not have to study maths*, 41% of the pupils agreed with this which is substantially closer to the national agreement rate of 31% (IEA, 2016). Only 26% of international 4th grade students agreed with this statement (IEA, 2016). The researcher's findings are consistent as 43% indicated that *they don't like learning maths* and 41% stated that *they wish they did not have to study maths.*

With a significant negative attitude towards the enjoyment of maths, the researcher was not surprised that a high percentage of the participants believe *maths is boring*. More pupils agreed with this statement (55%) than disagreed. This finding is interesting when compared to data from TIMSS 2015 as only one third (33%) of Irish pupils and 26% of international participants agreed with the statement (IEA, 2016). The findings also revealed that there is slight difference in the class levels of the pupils indicating that *maths is boring*, with 48% of fourth-class and 61% of fifth-class pupils agreeing.

79% of the pupils stated that they *learn many interesting things in maths.* This finding is relatively similar to national and international findings from TIMSS 2015 with 87% and 88% agreeing with this statement respectively (IEA, 2016). However, this finding surprised the researcher due to the high percentage of pupils stating that they have a negative attitude towards the learning of maths and the high percentage of pupils that selected maths in their three least favourite subjects. This suggests that although pupils may not enjoy learning

mathematics, they believe that the content is interesting, and thus the teaching methodologies employed in the classrooms may not be adequate.

Interestingly, slightly more pupils agreed with the statement *I like any schoolwork that involves numbers* as opposed to the statement *I like maths* with 55% and 49% agreeing respectively. This can be interpreted differently, with one argument potentially being that the pupils enjoy completing exercises involving numbers in comparison to the numerous strands in the maths curriculum that may not encompass numbers. As can be seen from Table 2, these findings have a significant lower agreement rate as opposed to corresponding national and international averages from TIMSS 2015 (IEA, 2016). The researcher was surprised that the findings revealed that more females indicated that they liked mathematics as opposed to males.

The researcher was particularly interested in the statement *I like to solve maths problems* as it is crucial in investigating the attitudes of the pupils towards mathematical problem-solving. 54% of the participants agreed with this statement. Again however, this agreement percentage is substantially lower compared to national data (72%) and international data (75%) from TIMSS 2015 (IEA, 2016). It is noteworthy that there is no significant difference between fourth and fifth-class in response to this statement, with 52% of fourth-class agreeing and 55% of fifth-class agreeing. In-fact, the researcher was surprised by this as fourth-class have encountered mathematical problems on a more frequent basis this year than fifth-class.

Finally, the two remaining statements; *I look forward to maths lessons* and *maths is one of my favourite subjects* resulted in 38% and 36% of the participants agreeing with the statements respectively. These findings are consistent with the overall findings as they suggested participants have a negative attitude to learning mathematics as opposed to pupils that took part in TIMSS 2015.

Attitude to Mathematics

The researcher sought to acquire information about the participant's specific attitudes towards mathematics. The pupils were presented with seven statements (Appendix F). These statements were predominately based on the self-confidence and value of the pupils towards mathematics. The statements and findings are clearly presented in Table 3. Five statements (A-E) were taken directly from TIMSS 2015 and thus this enables a comparative analysis to be made. The remaining two statements seek to gain an insight into participant's value of mathematics in real-life.

Table 3 *Participant's attitude to mathematics*

Statement	% of Females that agreed	% of Males that agreed	Combined % agreeing	TIMSS 2015 Irish data	TIMSS 2015 Inter-national data
a) I usually do well in maths	65	67	66	91	86
b) I am just not good at maths	31	48	39	22	30
c) Maths is harder for me than any other subject	52	33	43	28	33
d) Maths makes me confused	52	52	52	32	31
e) I am good at working out difficult maths problems	55	45	50	71	68
f) Maths is only useful for me in school	3	15	9	N/A	N/A
g) Maths will help me get a good job	93	89	91	N/A	N/A

Note. % Agreeing = Agree a lot + Agree a little

Two thirds (66%) of the sample agreed with the statement that *they usually do well in maths.* The researcher found this interesting due to the negative attitude the pupils have towards learning mathematics and the fact that a high percentage of pupils selected mathematics as one of their least favourite subjects. The agreement rate for this statement is relatively low in comparison with TIMSS 2015, with 91% of Irish pupils agreeing and 86% of international pupils agreeing with the statement (IEA, 2016). In relation to gender differences, as shown in Table 3, males have a higher agreement rate as opposed to females however this difference is minimal. When participants were asked if they believed *they are just not good at maths,* 39% of the sample agreed. . In relation to national and international data, only 22% of Irish fourth-class pupils believe they are not good at maths, with 30% of international students agreeing with the statement (IEA, 2016). The findings from these two statements are consistent with each other and suggest that pupils in this sample claim to not do as well in mathematics as other Irish and international pupils.

Regarding the statement *Maths is harder for me than any other subject*, the researcher was not surprised with the agreement rate of 43%. This agreement rate is relatively close to data from TIMSS 2015 with 28% of Irish pupils agreeing and 33% of international participants agreeing (IEA, 2016). However, it is noteworthy the percentage of females that agreed with the statement. 52% of the females indicated that mathematics is their most difficult school subject. In comparison to males, only one third (33%) of the male sample indicated that mathematics is their most difficult school subject.

Over half (52%) of the pupils stated that *maths makes them confused.* There were no gender differences in this finding. Nevertheless, this finding is alarming when compared to national and international data from TIMSS 2015 with 32% of Irish pupils and 31% of international pupils agreeing with this statement (IEA, 2016). However, Burns (2007) argues that confusion is part of the process of mathematics, and in-particular when solving mathematical problems and therefore it can be argued that this confusion experienced by the

pupils is enhancing their mathematical development. Also, this confusion could develop pupil's growth mindset and engagement in productive struggles (Dweck, 2015; Granberg, 2016).

The researcher was surprised that half (50%) of the sample agreed with the statement *I am good at working out difficult maths problems.* When compared to findings from TIMSS 2015, the findings from this statement are relatively low as 71% of Irish pupils and 68% of international pupils agreed (IEA, 2012). However, when the researcher compared the fourth and fifth-classes responses to this statement, an intriguing difference was noted. 60% of the fourth-class pupils believe they are good at working out difficult maths problems with only 42% of fifth-class pupils agreeing. This is noteworthy as the fourth-class have engaged with problem-solving more frequently than the fifth class throughout this school year. These results support the view of Delaney (2012) who believes that the best way to learn to solve problems is through practise.

The remaining two statements sought to acquire information regarding the value pupils place on mathematics outside of the school setting. Overall, a high percentage of the pupils indicated that they value maths outside of their school life. Results revealed that only 9% of the pupils believe that *maths is only useful for them in school.* This finding suggests that pupils within this sample realise the usefulness and importance of mathematics in real-life. Their understanding of the value of maths is further indicated by 91% of the pupils agreeing that they believe *maths will help them get a good job in the future.* In summary, it is apparent that pupils realise the importance and value of mathematics outside of the school setting, however these findings are difficult to generalise due to the small sample size.

Attitude to Mathematical Problem-Solving

The final section of the questionnaire (Appendix F) required participants to respond to eight statements based on mathematical problem-solving. The statements sought to acquire information about the pupils' value set, enjoyment and self-confidence towards problem-solving and their motivation to engage with the mathematical process (Tapia & Marsh, 2004, 2005). The findings are presented in four tables and each finding is analysed and discussed.

Table 4

Participant's value set to mathematical problem-solving.

Statement	% of Females that agreed	% of Males that agreed	Combined % agreeing
It is important that we solve problems in class	97	85	91

The finding presented in Table 4 suggests that pupils value the process of mathematical problem-solving as 91% of the sample agreed with the statement *it is important that we solve problems in class.* This finding may suggest that pupils are aware and understand the importance of solving problems for their mathematical development. Therefore, an argument can be made that pupils should be engaged in the process frequently throughout their mathematics lessons. This is vital as a more problem-solving based approach to mathematical lessons could develop children as mathematicians and also allow pupils to develop their numeracy skills (DES 2011; Mann, 2006).

Table 5

Participants enjoyment of mathematical problem-solving

Statement	% of Females that agreed	% of Males that agreed	Combined % agreeing
I like maths problems	38	59	48
I like problems where you must read words	52	55	54
The math problems we do are interesting	38	44	41

48% of the pupils agreed with the statement *I like maths problems.* The researcher was surprised by this finding as he thought there would have been a higher agreement rate as pupils in this sample are familiar with the process. Interestingly, there was a major difference in the gender of the pupils that agreed, with 59% of males agreeing as opposed to only 38% of females. The researcher also noted an interesting difference in the class levels of the pupils that agreed. 64% of fourth-class agreed with the statement in comparison to 38% of fifth-class. As the fourth-class have encountered problem-solving this year more frequently than the fifth-class, this may have added to their enjoyment of the process. Also, the type of problems encountered in fourth-class may have been more effective than the problems in fifth-class, and therefore this may increase the enjoyment levels of the pupils.

It is noteworthy that more pupils agreed with the statement *I like problems where you must read words* (54%) as opposed to the statement *I like maths problems* (48%). This can be interpreted differently, with one argument potentially being that pupils are exposed to word problems frequently due to the predominance of word problems allocated in specific

sections in textbooks (INTO, 2013, p.42). Therefore, as they encounter a high number of word problems in the textbooks, there enjoyment of these types of problems may increase.

Only 41% of the pupils believe that *the math problems they do are interesting.* This finding surprised the researcher as the agreement rate is relatively low as opposed to other statements. There was very little difference in the gender of the pupils that agreed with this statement. However, a major difference regarding the class level of the pupils that agreed was noted. 60% of fourth-class agreed with the statement as opposed to only 26% of fifth-class. As the fourth-class complete a weekly lesson on problem-solving, this may suggest that the problems they are completing engage the pupils through interesting topics that relate to their experiences (Delaney, 2012; NCCA, 2016). Also, the fifth-class are mainly exposed to problems from textbooks. This use of textbooks may also support Delaney's (2012) view that problems in Irish text books are of a poor quality.

Table 6

Participants self-confidence towards mathematical problem-solving.

Statement	% of Females that agreed	% of Males that agreed	Combined % agreeing
Math problems confuse me at first	83	59	71
I am confident when I do math problems	45	63	54
Pictures help me understand maths problems	69	59	64

As shown in Table 6, 71% of the pupils indicate that *maths problems confuse them at first*. This finding supports the argument of Burns (2007) that individuals must realise that confusion is part of the process when solving problems. Interestingly, 84% of fifth-class

pupils indicated that problems confuse them at first, with only 56% of fourth-class agreeing with the statement. This is noteworthy as in this study, fourth-class pupils are more familiar with problem-solving as opposed to fifth-class pupils. This may suggest that the problems fourth-class complete do not provide a sufficient level of challenge in order for confusion to occur (Cai & Lester, 2010). However, it may also suggest that the fourth-class pupils are better at solving problems due to frequent practise and therefore they experience less confusion. This finding may support Delaney's (2012) view that the best way to solve problems is through practise.

54% of the pupils agreed with the statement *I am confident when I do math problems.* Interestingly, more males agreed with this statement as opposed to females with 63% and 45% agreeing respectively. The researcher was not surprised that almost two thirds (64%) of the pupils indicated that *pictures help them understand maths problems*. The researcher believes that this is important and that if pupils are assisted in their understanding of mathematical problems then it may then add to their enjoyment of and engagement with the process. The three findings displayed in Table 6 are consistent with each other regarding gender differences. The findings may suggest that males are more confident than females when completing mathematical problems. However, due to the small sample size it is difficult to generalise this statement.

Table 7

Participant's motivation to complete more mathematical problems.

Statement	% of Females that agreed	% of Males that agreed	Combined % agreeing
I would love to do more maths problems	34	48	41

Finally, as shown in Table 7 only 41% of the pupils claimed that *they would love to do more math problems.* It is noteworthy, that 60% of fourth-class pupils agreed with this statement, with just over one quarter (26%) of fifth-class pupils agreeing. This finding may suggest that the pupil's motivation to complete problems increases when they encounter problem-solving frequently and when they engage with interesting problems.

Conclusion

Throughout this chapter, the researcher presented the findings of this research study utilising a table or a chart. The findings were discussed and analysed with reference to national and international literature and research studies. First, the profile of the participants was discussed which outlined the class level, gender and age of pupils in this sample. The researcher then focused on the pupil's attitude to their school and school subjects. Discussion and analysis based on the findings of participant's attitudes to mathematics and problem-solving was then outlined. Regarding mathematics, participants displayed a negative attitude to the subject as opposed to their national and international peers. When analysing statements based on problem-solving, the researcher was surprised at the attitude pupils indicated they exhibit towards the process. Although a high percentage of pupils value the problem-solving, pupils lack self-confidence and motivation towards the process and more than half of the sample do not enjoy it. The next chapter will now summarise the key findings of the study and outline recommendations based on these findings.

Chapter Five

Conclusion and Recommendations

This concluding chapter is divided into four sections. First, the researcher will restate the research question which this research study was based on. Next, the researcher will summarise the key findings from the data analysis. Recommendations based on the findings will then be suggested. The final section will provide a summary of the research project.

Research Question

The research question that this study sought to address was,

What are the attitudes of fourth and fifth class pupils in one school towards the process of mathematical problem-solving?

First, the researcher explored pupil's attitudes towards their school and their school subjects. The pupils' attitudes towards learning mathematics and towards mathematics in general was then investigated. The researcher then explored the participant's attitude towards the process of mathematical problem-solving. This study considered the pupil's value set, self-confidence and enjoyment of mathematics and mathematical problem-solving (Tapia & Marsh, 2004, 2005). Furthermore, the dissertation investigated the pupil's motivation to engage with mathematics and problem-solving.

Summary of Key Findings

The key findings from the data analysis were as follows:

- 80% of the participants agreed with the statement *I like being in school.* Only one female disagreed with this statement while 37% (10) of the males indicated that they do not like being in school.
- A high percentage of participants agreed with the following statements; *I feel safe when I am at school, I feel like I belong at this school, I am proud to go to this school*

and I learn a lot in this school. The findings from these statements are consistent with findings from the Trends in International Mathematics and Science Study (TIMSS) at fourth-class level in 2015.

- A considerable number of pupils in this study appear to have a negative attitude towards the teaching and learning of mathematics with more than half of the sample (53%) selecting mathematics as one of their three least favourite school subjects. Almost one quarter of the pupils (24%) stated that mathematics is their least favourite subject.
- 27% of the participants selected mathematics as one of their three favourite school subjects but only 9% indicated that mathematics is their favourite school subject.
- Findings suggest that pupils in this sample have a more negative attitude to learning mathematics as opposed to their national and international counterparts that took part in TIMSS 2015 (IEA, 2016).
- Interestingly, 55% of the pupils indicated that they find mathematics boring, however 79% suggested that they learn many interesting things in mathematics.
- 43% of the sample agreed with the statement *maths is harder for me than any other subject*. This finding also revealed a major gender difference, with 52% of females and 33% of males agreeing with the statement.
- The findings reveal that the pupils may value mathematics in real-life as only 9% stated that maths is only useful for them in school and 93% agreed with the statement *maths will help me get a good job.*
- Regarding problem-solving, 54% of participants indicated that they like to solve mathematical problems and 50% claimed that they are good at working out difficult mathematical problems. The findings from this study suggest that pupils have a more negative attitude towards problem-solving as opposed to national and international data from TIMSS 2015 (IEA, 2016).

- Findings suggest that pupils in this study value the importance of problem-solving as 91% agreed with the statement *it is important that we solve problems in class.*
- It is noteworthy that pupils indicated that they prefer word problems (54%) as opposed to mathematical problems (48%). Also, only 41% of the sample stated that the math problems they do are interesting.
- Regarding pupils' self-confidence towards problem-solving, 64% of participants indicated that pictures help them understand problems, 71% stated that mathematical problems confuse them at first and 54% agreed with the statement *I am confident when I do mathematical problems.*
- Finally, 41% of the pupils claimed that they would love to do more mathematical problems. 60% of fourth-class pupils agreed with this with only 26% of fifth class pupils indicating that they would love to do more mathematical problems.

Recommendations

Based on the findings of the research project, the researcher has made several recommendations. The recommendations made by the researcher are outlined below, some of which include the adaptation of teaching methodologies, and the development of the already existing online platform by the Professional Development Service for Teachers (PDST) with a focus on problem-solving.

First, the researcher believes that a large-scale research project should be carried out on this topical mathematical process. The ability to solve problems is key to withstand the difficulties posed by society. Developing this skill and implementing it to life's problems will benefit individuals. The researcher acknowledges that significant research has been completed on pupils' performance and scores in mathematical problem-solving but insufficient attention has been given to the attitudes of the pupils towards the process. Also, The National Literacy and Numeracy Strategy (DES, 2011) identifies that positive attitudes

and motivation are crucial “for progression in literacy and numeracy” (p.43). Therefore, to obtain developments in this area, there is a need to investigate the attitudes of pupils towards problem-solving.

Another recommendation is the need for students to have a voice in their learning. For a positive attitude to be established and maintained, it is important that pupils have an input in the content they are being taught and the teaching methodologies employed. Fleming (2016) argues that students’ opinions have been ignored for too long and he outlines the need for students to express their feelings and thoughts. This could benefit the student’s development and enhance their attitude in the classroom.

The researcher recommends that teachers adapt their teaching methodologies to increase a problem-solving approach for primary mathematics education. A high percentage of the pupils (91%) stated that they value problem-solving and are aware of the importance of the process. However, only 41% indicated that they do interesting problems and 48% stated that they like mathematical problems. The value that the pupils ascertain towards problem-solving needs to be sustained and developed. Therefore, it may be necessary for teachers to adapt their teaching methodologies and include numerous different types of problems such as LTHC tasks and real-world problems that interest the learner (McClure et al., 2011; NCCA, 2016).

Finally, the concluding recommendation suggests that a suitable Irish website with a range of mathematical problems should be further developed by the DES and operated by the PDST. This website could act as an archive of mathematical problems which would enhance the teaching and learning of Irish primary school pupils. The researcher recommends the maintenance of this website as he believes it was difficult to source effective problems during his Advanced School Placement. In time, this website could give teachers the ability to develop their pupils as mathematicians.

Conclusion

Pupil's engagement with problem-solving will develop their higher order thinking skills while ascertaining their positive attitudes towards mathematics. While a high percentage of the pupils realise the importance of problem-solving, just under a half enjoy the process. Additionally, a high percentage of the pupils indicated that the problems they complete in school are not interesting. Thus, the researcher believes that the teaching methodologies employed needs to be altered with access given to teachers to an archive of effective problems. This would lead to a higher engagement level and positive attitude exhibited by pupils in the classroom. Implementing an eclectic method of a problem-solving based approach to numeracy lessons could be pivotal in children's mathematical development. Teachers who maintain a positive attitude in rectifying this issue is a stepping stone in eliminating negative attitudes towards problem-solving in the classroom.

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Appendix A Principal Information Letter

Date: 21/01/2019

Principal,

Scoil X

Dear X,

As part of my masters, I am required to complete a research dissertation. The focus of my research is on the attitudes of senior primary school pupils towards mathematical problem solving. I am writing to you as I would like to request your permission to use the fourth and fifth classes here as the sample for my research.

To complete my study, pupils in fourth and fifth class will be asked to complete a questionnaire based on their attitudes towards mathematical problem solving. The questionnaire will focus on areas such as: if they like/dislike mathematical problem solving, if they find the problems challenging, or if they think that mathematical problem solving is useful.

The data will be completely anonymous, and the data will be analysed in confidence. Myself and my supervisor Dr Ann Marie Gurhy will only have access to the data and I will store it safely and privately in my house. In my dissertation, the school, class teachers and children will not be identified. Participants have the right to withdraw from the study at any time. "Marino Institute of Education is committed to processing information in accordance with the General Data Protection Regulation (GDPR). Further information can be obtained from dataprotection@mie.ie.

I would greatly appreciate your permission to access the fourth and fifth classes for my research. Please do not hesitate to contact me if you have any further questions on X or by email at X. Please find attached a draft copy of the questionnaire.

Thank you for your cooperation,

Feargal Doherty

Appendix B Board of Management Information Letter

Date: 21/01/2019

Board of Management, Scoil X,

Dear members of the Board of Management,

My name is Feargal Doherty and I am currently studying to obtain a Professional Masters in Primary Education from Marino Institute of Education. My aim is to qualify as a primary school teacher in June 2019. I am currently completing my advanced school placement here in Scoil X. As part of my masters, I am required to complete a research dissertation. The focus of my research is on the attitudes of senior primary school pupils towards mathematical problem solving. I am writing to you as I would like to request your permission to survey the fourth and fifth classes here as the sample for my research.

To complete my study, pupils in fourth and fifth class will be asked to complete a questionnaire based on their attitudes towards mathematical problem solving. The questionnaire will focus on areas such as: if they like/dislike mathematical problem solving, if they find the problems challenging, or if they think that mathematical problem solving is useful.

The data will be completely anonymous, and the data will be analysed in confidence. Myself and my supervisor Dr Ann Marie Gurhy will only have access to the data and I will store it safely and privately in my house. In my dissertation, the school, class teachers and children will not be identified. Participants have the right to withdraw from the study at any time. "Marino Institute of Education is committed to processing information in accordance with the General Data Protection Regulation (GDPR). Further information can be obtained from dataprotection@mie.ie.

I would greatly appreciate your permission to access the fourth and fifth classes for my research. Please do not hesitate to contact me if you have any further questions on X or by email at X. Please find attached a permission slip and a draft copy of the questionnaire.

Thank you for your cooperation,

Feargal Doherty

I hereby give Feargal Doherty consent to survey the fourth and fifth class here in Scoil X as part of his research sample.

Printed Name: _____

Signed: _____

Date: _____

Appendix C Class Teacher Information Letter

Date: 05/02/19

Dear X,

As part of my course, I am required to complete a research dissertation. The focus of my research is on the attitudes of senior primary school pupils towards mathematical problem solving. I am writing to you as I would like to request your permission to use your class as the sample for my research.

To complete my study, pupils in fourth and fifth class will be asked to complete a questionnaire based on their attitudes towards mathematical problem solving. The questionnaire will focus on areas such as: if they like/dislike mathematical problem solving, if they find the problems challenging, or if they think that mathematical problem solving is useful.

The data will be completely anonymous, and the data will be analysed in confidence. Myself and my supervisor Dr Ann Marie Gurhy will only have access to the data and I will store it safely and privately in my house. In my dissertation, the school, class teachers and children will not be identified. Participants have the right to withdraw from the study at any time. Marino Institute of Education is committed to processing information in accordance with the General Data Protection Regulation (GDPR). Further information can be obtained from dataprotection@mie.ie.

I would greatly appreciate your permission to access your class for my research. I estimate that the questionnaire will take a minimum of twenty minutes or more to complete. Please do not hesitate to contact me if you have any further questions on XXX or by email at XXX.

Thank you for your cooperation,

Feargal Doherty

I permit Feargal Doherty to survey my class here in Scoil X as part of his research sample.

Printed Name: _____

Signed: _____ Date: _____

Appendix D Parent/Guardian Letter of Consent

Date: 06/02/19

Dear Parent/Guardian

My name is Feargal Doherty and I am currently completing my school placement here in Scoil X with the aim of qualifying as a primary school teacher in June 2019. As part of my course, I am required to complete a research dissertation. The focus of my research is on the attitudes of senior primary school pupils towards mathematical problem solving. I am writing to you as I would like to request your permission to allow your child to participate in my research.

To complete my study, I will complete a questionnaire with pupils in fourth and fifth class based on their attitudes towards mathematical problem solving. The questionnaire will focus on areas such as: if they like/dislike mathematical problem solving, if they find the problems challenging, if they think that mathematical problem solving is useful.

The data will be completely anonymous, and the data will be analysed in confidence. Myself and my supervisor will only have access to the data. The school and pupils will not be identified. The pupils can withdraw from the study at any time.

I would greatly appreciate your consent. Please do not hesitate to contact me if you have any further questions by email at XXX. If you consent to your child's participation, please sign the consent form attached and return it to school **on or before Friday 8th February.**

Thank you for your co-operation,

Feargal Doherty

I _____ give my child _____ permission to participate in this research project undertaken by Feargal Doherty in Scoil X.

- I acknowledge that I have read the letter explaining the purpose of the study and what is involved.
- I agree to my son/daughter completing the survey.
- I understand that it is entirely voluntary for my son/daughter to take part in the project and both myself and my child can withdraw consent at any stage.
- I understand that all information obtained during the study will be analysed in confidence.

Printed Name of Child: _____ Date: _____

Printed Name Parent/Guardian: _____

Signature Parent/Guardian: _____

Appendix E Student Assent Form: 4th/5th Class 2018-2019

I _____ agree to take part in Mr Doherty's project and I agree to:

- Answer questions about school, mathematics and problem-solving in the questionnaire.

Don't forget that I will keep all the information that you share with me in confidence. This means that I won't be telling anyone what you said in the survey or any other details.

Printed Name: _____

Signature: _____

Date: _____

Please sign the form and return it to me by the end of the day, thank you very much for your time.

Mr. Doherty

Appendix F Student Questionnaire

This questionnaire involves you answering questions about you and what you think. For each of the questions, you should choose the answer which you think is best. Let us take a few minutes to practice the kinds of questions you will answer in this booklet.

Example 1

Do you go to school?

*Circle **one** only.*

Yes

No

Example 2

What do you think? Tell how much you agree with these statements.

*Fill in **one** in each line.*

	Agree a lot	**Agree a little**	**Disagree a little**	**Disagree a lot**
Watching movies is fun	○	○	○	○
I like eating ice cream	○	○	○	○
I do not like waking up early	○	○	○	○
I enjoy doing chores	○	○	○	○

Example 3

From the list below select your three favourite hobbies

Reading	
Playing sport	
Watching Tv	
Video games	
Walking	
Shopping	
Running	
Dancing	

Write:

1 in the box beside your favourite

2 in the box beside your 2nd favourite

3 in the box beside your 3rd favourite

Read each question carefully and pick the answer you think is best. Shade your answer. If you decide to change your answer, draw an ✕ through your first answer. Then shade your new answer. Ask for help if you do not understand something or are not sure how to answer.

About you

G1 – General 1

Are you a girl or a boy?

*Circle **one** only.*

Girl Boy

G2 – General 2

When were you born?

Month _____

Year _____

Your school

S1 (School 1) **What do you think about your school? Tell how much you agree with these statements**

*Fill in **one** in each line*

	Agree a lot	**Agree a little**	**Disagree a little**	**Disagree a lot**
a) I like being in school	○	○	○	○
b) I feel safe when I am at school	○	○	○	○
c) I feel like I belong at this school	○	○	○	○
d) I am proud to go to this school	○	○	○	○
e) I learn a lot in school	○	○	○	○

Subjects in school

SS1 (School subjects 1) From the list below select your **3 favourite** school subjects.

English	
History	
Drama	
Irish	
Maths	
Religion	
Science	
PE	
Art	
Geography	
Music	
SPHE	

Write:

1 in the box beside your favourite

2 in the box beside your 2nd favourite

3 in the box beside your 3rd favourite

SS2 (School subjects 2) From the list below select your **3 least favourite** school subjects.

English	
History	
Drama	
Irish	
Maths	
Religion	
Science	
PE	
Art	
Geography	
Music	
SPHE	

Write:

1 in the box beside your least favourite

2 in the box beside your 2nd least favourite

3 in the box beside your 3rd least favourite

Maths in school

MS1 – Maths in school 1

How much do you agree with these statements about learning maths?

*Fill in **one** in each line.*

	Agree a lot	**Agree a little**	**Disagree a little**	**Disagree a lot**
a) I enjoy learning maths	○	○	○	○
b) I wish I did not have to study maths	○	○	○	○
c) Maths is boring	○	○	○	○
d) I learn many interesting things in maths	○	○	○	○
e) I like maths	○	○	○	○
f) I like any schoolwork that involves numbers	○	○	○	○
g) I like to solve maths problems	○	○	○	○
h) I look forward to maths lessons	○	○	○	○
i) Maths is one of my favourite subjects	○	○	○	○

MS2 – Maths in school 2

How much do you agree with these statements about mathematics?

*Fill in **one** in each line*

	Agree a lot	**Agree a little**	**Disagree a little**	**Disagree a lot**
a) I usually do well in maths	○	○	○	○
b) I am just not good at maths	○	○	○	○
c) Maths is harder for me than any other subject	○	○	○	○
d) Maths makes me confused	○	○	○	○
e) I am good at working out difficult maths problems	○	○	○	○
f) Maths is only useful for me in school	○	○	○	○
g) Maths will help me get a good job	○	○	○	○

MS3 – Maths in school 3

How much do you agree with these statements about maths problem solving?

*Fill in **one** in each line*

	Agree a lot	**Agree a little**	**Disagree a little**	**Disagree a lot**
a) I like maths problems	○	○	○	○
b) I like problems where you must read words	○	○	○	○
c) Pictures help me understand maths problems	○	○	○	○
d) It is important that we solve problems in class	○	○	○	○
e) Math problems confuse me at first	○	○	○	○
f) The math problems we do are interesting	○	○	○	○
g) I am confident when I do math problems	○	○	○	○
h) I would love to do more math problems	○	○	○	○

Thank you for completing the questionnaire