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IMPROVING MY TEACHING OF MATHS TO DEVELOP STUDENT ATTITUDES TOWARDS THE SUBJECT

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ABSTRACT

The skills and concepts that are developed in our primary maths education have a significant impact on our daily lives through our engagements with each other and our environment. Therefore, it is important to promote maths education and learning in a positive and engaging way. The purpose of this Action Research study was to improve my teaching of maths to develop student attitudes towards the subject. The research took place in a senior national school, located in suburban Dublin, amongst a sample of 27 fourth class children.

The research was designed to take place over a ten-week period. This was reduced to nine weeks, as a result of the school closures due to the Covid-19 pandemic. There were two interventions phased over this time period, the first was phased at the start of the data gathering period and involved the integration of subjects into maths lessons. The second intervention was phased into the research at the mid-point of data collection and involved implementing ICT as a resource for teaching and learning in maths.

The research uncovers three findings that I will integrate into my future practice to further develop student attitudes towards maths. The first finding from this study suggests that through developing an increase in children's confidence of their mathematical ability, an increase in performance of mathematical tasks and problems is offered. It was also suggested that using iPads as a tool for assessments in maths is effective when carried out using game-based applications. There was discussion around the positive impact of using meaningful maths games to stimulate motivation and engagement towards the subject. Through implementing the findings that are presented in this study, I believe my teaching of maths will be improved to support the development of student attitudes towards the subject. I have discovered that in doing so I my educational values of agency, communication and positivity will be a prominent feature of my own practice.

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ABBREVIATIONS

AR	Action Research
PC	Primary Curriculum
NCCA	National Council for Curriculum and Assessment
CPD	Continual Professional Development
FSMAS	Fennema- Sherman Mathematics Attitude Scales
MSES	Maths Self-Efficacy Scale
EVT	Expectancy-Value Theory
ICT	Information and Communication Technology
PLC	Primary Language Curriculum
SESE	Social Environmental and Scientific Education

CHAPTER 1: INTRODUCTION

Chapter one will provide an outline for this thesis. It provides the research question and the aims of the research along with the purpose of the study. I will outline my educational values and state my role as an educator through a personal position statement. The structure of the thesis is outlined, introducing chapter titles and contents.

1.0 RESEARCH QUESTION

How can I improve my teaching of maths to develop student attitudes towards the subject?

1.1 PURPOSE OF THE STUDY

The purpose of this Action Research (AR) study is to develop and improve my teaching of maths in the classroom to support and develop student attitudes towards the subject in a positive and constructive way. The study begins by outlining my desire to assist children in their maths development. Through discussion with my critical friend, thesis supervisors, peers, colleagues and family members I decided that the study would be better positioned analysing an aspect of my practice of maths in an attempt to improve it, and better support and develop student attitudes for a subject that I feel great passion for.

The Irish Primary Curriculum (PC) for Mathematics states in its aims that the curriculum should enable children "to develop a positive attitude towards mathematics and an appreciation of both its practical and its aesthetic aspects" (NCCA, 1999:12). This is just one of the five aims outlined in the curriculum documents. Wilkin and Ma (2003) suggest that for most students, as they progress through school, their attitude towards maths education becomes increasingly negative. This discovery was eye opening for me as it allowed me to review my teaching of maths using elements of Brookfield's (2006) reflective lenses, paying careful

attention to the student's lens and my own perspective. In comparing the two, I decided that I would use this research study to develop and improve my teaching of maths in the classroom in order to support and develop student attitudes towards the subject in a positive and constructive way.

1.2 VALUES AND PRACTICE

Throughout the process of this AR Study there has been a development in my engagement with my educational values. The educational values that I regard as integral to my own personal beliefs and practices are agency, communication and positivity. In my value statement submitted to Maynooth University at the beginning of this study I outlined the importance of these values and documented

> *'that my values are interlinked and work in allegiance with each other to help me live a life that is close to my values and one that enables me to explore them through my practices and pedagogies as a primary teacher'* (Values Statement, 2019).

This was something I made a mental note of at the beginning of the research process as I wanted to find out if the study reflected my belief that my values are linked and work in allegiance with each other.

Agency is a value that I believe should be an important feature of primary classrooms. The National Council for Curriculum and Assessment (NCCA) (1999) discuss the importance of developing mathematical knowledge, skills and procedures through meaningful experiences. The value of agency is a central aspect of my teaching practice in the classroom as it enables children to have a voice amongst other children in the class and emphasises the importance of their right to a voice. It provides a motivation for learning through activities that are meaningful

to children. Elliot et al. (2000) supports this in suggesting that the learner employs a constructivist approach of knowledge acquisition through their own experiences.

Communication is a value that I believe is important in my own practice. Effective communication between a teacher and students will promote a communicative form of teaching and avoid the didactic style, that has long been associated with dated practice (Easingwood & Williams, 2004). The value of effective communication in the classroom has benefits for the children and class teacher. An example of this is when children experience agency in the classroom through effective communication, enabling them to discover their voice and its value in the context of their class. Personally, the main benefit of using effective communication as a class teacher, is its ability to enable me to explore practice in accordance with my educational values. There is growth in a person's ability to dilute what Apple (2015) describes as 'power in education', in allowing a communicative dialogue between the children to naturally occur. Through this, there is opportunity to adapt a developed view of 'self-image and self-esteem' (Kelchtermans, 2018; 230) into my future practices across the curriculum.

Positivity is a value that I aim to model in the classroom consistently. Dweck (2017) suggests that positivity and self-belief are fundamental components of developing a positive and healthy growth mindset. Therefore, by providing lessons that enable children to develop an increase in confidence and ability, a foundation for the potential of a growth mindset is developed. Children can constructively build on this over time, so that if presented with failure in maths, the probability of children categorising themselves into what Elliott et al. (2000) describe as a 'fixed mindset' is minimised.

In conclusion, the educational values that I regard as integral to my beliefs and practices are Agency, Communication and Positivity. It was my intention to carry out this AR study, improving my teaching of maths in order to develop student attitudes towards the subject, while practicing in accordance with my educational values.

1.3 PERSONAL POSITION

As a lover of maths, I embarked on my teaching journey with aims to instil my own passion and motivation towards maths onto the children that are enrolled in my class. I have engaged in Continual Professional Development (CPD) within the discipline of maths completing a course on effective numeracy assessment in the primary classroom, as well as actively trying to acquire new knowledge from my colleagues around the subject area. Through the implementation of newly discovered strategies I was able to see a meaningful development of my practice and its impact on the children in my class. My realisation of the positive impact CPD has on a teachers practice inspired me to complete a Masters programme in the area of attitudinal development towards maths.

In 2013, I began studying to become a primary school teacher in Marino Institute of Education. My desire to become a teacher stems from work experience that I completed in the primary school I attended as a child. The experience of facilitating children with facets of the maths curriculum that provide a foundation for future learning and development was a fundamental factor in my choice to study primary education. I graduated from Marino Institute of Education in 2017 and have taught at a variety of class levels since.

I have worked as a primary school teacher in a mainstream classroom for the past 3 years. In this time, I have worked in both junior national schools and senior national schools, which have varied in their socio-economic status. I am currently a full-time mainstream class teacher in a

primary national school located in suburban Dublin teaching fourth class children. The school features a Catholic ethos and is co-educational. I felt that the school offered a supportive structure and environment from which I could carry out the research necessary for the purpose of this study.

In conclusion, there is an intersection of my ambition to further my professional development and practices and my desire to develop student attitudes towards maths. It is my belief that through improving my practice I can provide meaningful development of student attitudes towards maths.

1.4 JEAN PIAGET

"It is with children that we have the best chance of studying the development of logical knowledge, mathematical knowledge, physical knowledge, and so forth." (Jean Piaget)

As a primary school teacher, much of my practice to date has been influenced and informed by the works of the Swiss psychologist Jean Piaget. I have developed my own educational values of agency, communication and positivity through studies of Piaget's works and philosophy. The principle of Piaget's theory of cognitive development enables teachers to view students as individual learners who develop personal understanding using previous related knowledge to construct and build an understanding for themselves (Isaacs & Lawrence, 2015). The nature of this constructivist approach to learning is learner-centred and involves children becoming active agents in their own learning. I believe that agency is an important value and one that I aim to provide to children as an educator. Piaget's theory supports agency in the classroom, promoting constructive learning through activities that are

meaningful to the children. I aim to bring these elements into my practices and develop my teaching to align with my values.

1.5 ORGANISATION OF THE THESIS

Chapter One

An overview for this thesis is presented in Chapter One. The research question, aims of the research along with the purpose of the study were discussed. It provided an outline of my educational values and an account of my role as an educator is furnished.

Chapter Two

There is an examination of the literature pertaining to attitude and maths education in Chapter Two. The literature examined in this chapter looks at maths attitudes and maths self-efficacy in relation to the research question. There is a review of maths anxiety and implementing a growth mindset. The areas of assessment of maths and ICT in mathematics are examined.

Chapter Three

The research methodology of the study is outlined in Chapter Three which includes an overview of the methods used for the purpose of this study. The aim of the research is to improve my teaching to develop student attitudes towards maths. The design of the research is outlined and the data gathering instruments are provided. There is discussion around the role of the researcher in this chapter.

Chapter Four

This chapter includes the analysis of the data collected during the research process. The findings are theorised and presented in Chapter Four.

Chapter Five

There is a summary of the main findings presented in Chapter Five. The limitations of the study are outlined and future recommendations are made in relation to the findings. Implications for practice are discussed and a final summary is drawn.

1.6 SUMMARY

This chapter outlined the overall purpose of this thesis. It provided the research question and the aims of the research along with the purpose of the study. It offered the reader an insight into my educational values and my role as an educator through a personal position statement. The organisation of the thesis is outlined introducing chapter titles and contents.

CHAPTER 2: LITERATURE REVIEW

2.0 INTRODUCTION

This chapter seeks to review literature in relation to attitudinal change and development within the domain of maths education. There will be an outline of maths attitudes and maths self-efficacy change at a fundamental level, which will be related to maths anxiety and examined in relation to attitudinal change and the development of a growth mindset. Assessment in maths is discussed in relation to enacting a development towards an educational discipline, such as maths. The research aims to provide an overview of the comprising elements of maths attitude and review the implementation of a growth mindset in relation to this. The literature review will provide an in-depth examination of literature in relation to the context of this study. The research question will be placed into context and supported throughout the literature review.

2.1 MATHS ATTITUDES AND MATHS SELF-EFFICACY

Maths Attitudes: Research has suggested that it is difficult to accurately define an attitude, but rather, attempt to understand why attitudes matter and the characteristics that shape them (Maio & Haddock, 2015). Hannula (2002) presents the theory that math attitudes are influenced by emotion, expectations and values, which implies that a person's attitude towards maths can change dramatically in a relatively short time. This theory is supported through McLeod's (1992) belief that mathematical attitudes are determined through an individual's positive or negative emotional disposition toward maths. Tocci and Engelhard (1991) identified a positive relationship between students' maths attitudes and subsequent academic achievements. Further studies have suggested that for a majority of students, as they progress through school, their attitude towards maths education becomes increasingly negative. It is suggested that through the negative perception of the social implications of maths in everyday life student attitudes become increasingly negative (Wilkins & Ma, 2003; Jackson, 2015).

In 2004, Tsao conducted a study making a comparison of math attitudes amongst ten and eleven-year-old students from Denver, Colorado with students in Taipei, Taiwan to determine if math attitudes affected students' mathematical performance. A sample of 21 American students and 37 Taiwanese students responded to an attitude survey, which revealed the Taiwanese students having a more positive perception towards maths than the American students. The emphasis placed on studying maths in the Taiwanese culture is outlined in the study, which discuss the initiatives carried out by the Ministry of Education in Taiwan towards maths learning at a national level. It is primarily evident in the area of curriculum development and practice, where the Ministry of Education in Taiwan 'publishes all textbooks.… with every school using the same textbook' (Tsao, 2004: 149). In contrast, the mathematics curriculum in the United States varies from state to state, providing inconsistencies in standardisation of maths teaching and learning. Therefore, there is a great deal of variation in the publication of maths textbooks for schools in the United States (Stigler, Lee, Lucker and Stevenson, 1982). This is further evidenced through the importance the American students place on memorisation of methods and formulae, where the understanding of methods and formulae is less important than achieving a high-test score. In contrast to this the Taiwanese student's belief that maths is a 'creative discipline where one can discover and learn to be logical' (Tsao, 2004: 151).

The Fennema-Sherman Mathematics Attitude Scales (FSMAS) are used to measure maths attitudes. It uses a 5-point scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). There are ten items on the scale, all of which pertain to math confidence/ anxiety, perceptions of mathematical applications in real life settings and motivation in maths (Betz & Hackett, 1983; Hackett & Betz, 1989). Higher scores on the scale indicates a positive attitude towards maths, a lower tendency towards maths anxiety, a perception that maths skills, knowledge and procedures are applicable and important in real life settings and an increased motivation

towards the subject. In contrast, lower scores on the scale imply a negative attitude towards maths, characteristics of maths anxiety are displayed, a perception that maths skills, knowledge and procedures are not important and a decrease in motivation towards the subject (Fennema & Sherman, 1976). A sample of the FSMAS can be found in the appendices. Although an effective tool for assessing mathematical attitude, the FSMAS should be altered for the participants in attempt to gain responses that correlate with current thinking (Ren, Green & Smith, 2016). Measuring children's attitude towards maths provides important information to the teacher about individual children's outlook of maths, assisting the teacher in understanding the mathematical journey of each child and enabling the teacher to develop student attitude towards maths.

Maths Self-Efficacy: Bandura's (1977) theory on self-efficacy was developed through the belief that an individual possesses the innate characteristics necessary to exercise control over their own feelings, thoughts and actions. Hackett and Betz (1989:262) support this theory through their definition of self-efficacy within the context of maths as "a situational or problem-specific assessment of an individual's confidence in his or her ability to successfully perform or accomplish a particular mathematical task or problem". Thus, the innate characteristics necessary for enacting change in our feelings, thoughts and actions are driven by personal engagement with success/ failure in maths. If the individual has a lack of belief in his/ her ability to achieve a desired goal or aim, then the incentive to act towards the task is minimised (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). Bandura et al. (1996) further suggest that children's personal beliefs in their efficacy may affect academic motivation, interest level and academic performance. Therefore, it is important that a teacher establishes a positive development of maths learning in early maths learning (Kaskens et al., 2020). Pajares (1996) discusses a variety if motivating factors within self-efficacy, the relationship between

success and failure, theory of self-concept, attainable goals and expectancy value. It is further suggested in his thinking that through evaluating both the decisions that are made and the knowledge gained from the engagement of a task, individuals are more likely to feel competent and confident in the area, while in avoiding this form of self-evaluation these feelings of success are denied. Individuals who experience high levels of self-efficacy tend to display a deeper interest in problems, tricky problems as puzzles that they can solve and are less effected by failure in the area, recovering from mistakes with the intention of developing growth in confidence and ability (Zimmerman & Martinez-Ponz, 1990; Dweck, 2017; Kaskens et al., 2020). In contrast to this, those who experience low levels of self-efficacy, particularly children who experience negativity towards maths from an early age, tend to develop low self confidence in ability, while avoiding tasks that they feel are difficult due to a doubt in their own ability (Bandura et al., 1996; Bhowmick, Young, Clarke & Bhowmick, 2017).

In an attempt to measure self-efficacy within the discipline of mathematics the 52- item Math Self-Efficacy Scale (MSES) has been developed and implemented by a variety of researchers (Hackett & Betz, 1989; Betz & Hackett, 1983). The assessment involves the analysis of the participants confidence levels when engaging with a maths problem and the subsequent mathematical performance generated from this. Participants are required to rate their level of confidence in solving mathematical problems and subsequently solve the same or similar math problems. Their confidence levels were drawn from a detailed analysis of these results (Pajares & Miller, 1994, 1995). Bandura et al. (1996) indicate that ascertaining an understanding of an individual's self-efficacy is important. It enables practitioners to create a foundation of knowledge from which academic motivation, interest level and academic performance can increase. The aim of this study is to improve my teaching to develop student attitudes towards maths. The review of literature around self-efficacy suggests that development of children's

self-efficacy within the discipline of mathematics is in correlation with their development of attitudes towards maths.

2.2 MATHS ANXIETY IN EDUCATION

Maths anxiety is defined as "a person's negative affective reaction to situations involving numbers, math, and mathematics calculations" (Ashcraft & Moore, 2009: 197). Guay et al. (2003) suggest that achieving an objective through the positive completion of a task enables the participant to develop confidence in a specific area or field. Furthermore, this enhances the probability that the participant will endure a positive and confident approach in future engagements with the subject or topic through a constructive form of self- development. In support of this, it is debated that negative experiences of a topic or subject contributes to an increase in anxiety and lowered performance level in the area (Dweck, 1986; 2017). Therefore, it is important that children experience a positive exposure of maths learning from a young age.

The Expectancy-Value Theory (EVT) of achievement motivation was initially developed by Eccles et al. (1983). The theory describes various cultural, social, interpersonal, and individual factors that influence children's motivations, task values, expectations for success, and achievement related choices (Linnenbrink-Garcia et al., 2018; Wormington & Linnenbrink-Garcia, 2017). As previously mentioned, it is important that a teacher establishes a positive development of maths learning in early maths learning (Kaskens et al., 2020) in attempt to influence children's motivations, task values, expectations for success, etc. from an early age. Included in the cultural milieu factors are cultural stereotypes about the subject and occupation and socialisers' beliefs and behaviours, as well as children's own perceptions of socializers' beliefs and society's stereotypes about the domain (Cased et al, 2015:2). Studies of the theory has yielded results that show the effect of parental role in their child or children's maths values,

performance, expectations and beliefs as pivotal for the child's success in the chosen subject or domain (Fan, 2011). Teachers and parents share a common role in socialising children's academic attitudes and values from an early age through providing positive mathematical experiences for children and modelling competency and enjoyment in procedural application (Cased et al, 2015). However, there is a "need for continued investigation of the role of parents' anxiety in children's anxiety in various developmental stages to determine when this effect begins" (Beilock et al, 2010: 2; Cased et al., 2015).

The classroom is an important place as an environment for learning. It should offer a variety of stimuli and create a space that is safe, fun and engaging for children to learn and express themselves (NCCA, 2019). Rubinsten and Tannock (2010) suggest that although a stimulating environment should encourage children to participate and engage with lessons, there will be children who will continue to experience high levels of anxiety when speaking out in group settings, irrespective of their environment. Children often present themselves confidently in the classroom when they may suffer from a mild, moderate or severe amount of anxiety within subjects that they feel less confident in (Bekdemir, 2010).

Jansen et al (2012) carried out a study investigating the effect of using a computer adaptive programme on maths anxiety levels of the children. Assessments were carried out around maths anxiety, perceived competence, and math performance were performed before and after the practice period. Performing assessments at these stages ensured a fair and accurate test (Jansen et al, 2012: 196). The research subsequently found that the initial prediction of using a computer adaptive programme to produce a reduction in maths anxiety was verified by the results. It was found that the computer programme expressed high success rates due to its tailoring and adapting of any problems to the individual participant. It offered feedback in a

way that was constructive and was given in a confidential manner in contrast to experiencing failure in front of a group of peers. The report mentions that children were inquisitive towards the results prior to the administration of the test. There were a number of inquiries relating to any effect the test would have on their individual academic grades that year, indicating a concern for achieving a test score rather than a meaningful learning experience (Jansen et al. 2012; Tsao, 2004). Jansen et al. further document that assurance was given to the participants stating the research being conducted would have no effect on their academic grading. It was expressed that the activity would only involve engaging with a computer application.

2.3 IMPLEMENTING A GROWTH MINDSET

Dweck (2017) believes that implementing a growth mindset is a beneficial skill in developing a positive and healthy growth in attitude towards a desired criterion. Dweck (2017) defines a mindset as a self-perception or self-theory that people hold about themselves. Believing that you are 'mathematically competent' or 'mathematically incompetent' is an example of this. According to Dweck, people can be 'aware or unaware' of their own mindset. This can have a profound effect on an individual's social development, acquisition of skills, professional success, as well as many aspects of life (Dweck, 2006; Oyserman, Sorensen, Reber & Chen, 2009). Children engage in self-evaluation as they progress through school life. It is suggested that as this process occurs, children can become afraid of challenges and may revert away from a growth mindset. There can be regression towards a fixed mindset, where children can experience comfort through familiarity. They can become anxious at not being considered smart or intelligent amongst their peers (Brock & Hundley, 2016; Dweck, 2017). Therefore, in order to improve teaching and develop student attitudes towards maths, it is important to encourage a mindset that promotes positive self-development. A growth mindset involves people believing that their most basic abilities and qualities can be developed through hard

work and dedication. Through enabling a growth mindset, a person creates a passion for learning and a resilience that is essential for great accomplishment (Dweck, 2015). Furthermore, through developing a growth mindset in a classroom setting the teacher can narrow the achievement gap between students and motivate those who underperform in the area of mathematics to persist (Elliott, Kratochwill, Cook & Travers, 2000; Chao, Visaria, Mukhopadhyay & Dehejia, 2017; Dweck, 2017).

A common misconception around the development of a growth mindset is the idea of success, which leads itself towards a fixed mindset rather than a growth mindset. The idea of having a growth mindset around a subject invites the participant to become open to the prospect of self-development within that discipline being explored (Oyserman, Sorensen, Reber & Chen, 2009). Implementing a growth mindset in the classroom will encourage children to believe that their mathematical aims and targets can be reached through hard work and dedication. This is assisted through teacher modelling of confidence and competence, the children may become motivated to employ strategies and elements associated with a growth mindset within their own thinking, ultimately having a positive effect on their learning and developing lifelong habits (Hymer & Hailstone, 2014; Brock & Hundley, 2016; Boylan, Barblett & Knaus, 2018). Implementing a growth mindset in a classroom will assist the development of children's agency for learning, further developing lifelong habits that can assist develop attitudes towards maths learning (Boylan, Barblett & Knaus, 2018).

2.4 ASSESSMENT OF MATHS

Assessment is a crucial element of teaching and learning. It allows teachers to ascertain an understanding of a child's previous related knowledge of a topic. The results are used to create a foundation of learning that can be built on through the careful planning and execution of lessons (Taylor-Cox, 2013). Through examining this it has been shown that "continuous

assessment is particularly useful for diagnosis and planning in mathematics" (NCCA, 1999: 5). It is important that teaching practitioners derive strengths and areas of development from their assessments, as they inform the teacher of any discrepancies in ability, learning styles and even delve into a deeper understanding of an individual child's mechanical process and thinking around a mathematical topic or concept (Steiner & Ashcraft, 2012). In understanding this, teachers are much better equipped to set out a plan that will enable them to create a learning environment that will assist children in their learning of the components of the maths curriculum as outlined above (NCCA, 1999).

It is outlined in the introductory chapters of the Revised Primary Mathematics Curriculum (1999) that continuous assessment is particularly useful for teachers as it provides the continuous development of children as they engage with a topic. Mathematics is built upon a foundation and information and mathematical strategies are layered on top of this foundation (NCCA, 1999). It is therefore important that teachers engage with continuous assessments of children's individual interactions with a concept or topic in attempt to ascertain a foundation for constructivist learning (Furnham et al, 2013). Furthermore, this enables children to experience their own development within maths learning, developing a growth mindset where they believe mathematical aims and targets can be achieved through hard work and effort (Dweck, 2015). There are different forms of assessment implemented by teachers in schools, particularly around the area of mathematics. It is documented that some of forms of assessment are more effective at deriving strengths and areas of development than others. An example of this is technology-enhanced form of assessment (Stickney, Sharp & Kenyon, 2012).

The assessment process facilitates the opportunity for teachers to provide feedback to children at various levels and at individual and group settings, which enables children to become active

agents in their own learning. This can allow children to foster a sense of responsibility for learning (Cook-Sather & Luz, 2014) enabling them to set mathematical targets and allow confidence to develop around their own ability to reach the targets. Brown and Glasner (2003) discuss the cycle of assessment as a process of self- discovery, analysis and evaluation. Firstone et al. support this in their views that children "are not simply passive recipients of knowledge" (2004: 19) but rather inquisitive and curious by nature. In the study carried out by Tsao (2004:151), as previously discussed, there is an emphasis placed on national mathematical development by the Ministry of Education in Taiwan with the aim of viewing maths as a 'creative discipline where one can discover and learn to be logical'. It is suggested by Brown and Glasner (2003) that the benefits of constructive feedback are heightened in stature when given on a regular basis. Regular feedback highlights areas of success/ difficulty across the spectrum of a subject. This is contrasted with the negative effects of a yearly test form of assessment, where the student receives only an overall grade. There has been a significant amount of research carried out in the area of assessment in recent years and it is worth noting the importance of individual personality traits when looking at the overall assessment of a student. The validity of the traditional methods of what is accepted as satisfactory scholastic achievement is brought into question as it does not include many external factors of a child's being such as emotional intelligence or even personal motivation (Ackerman & Heggestad, 1997; Laborde et al. 2010).

2.5 ICT IN MATHS

In recent years Information and Communications Technology (ICT) has become an important resource in the classroom across the spectrum of subjects. It shows an advancement in technology and willingness to transcend with current times and societal normalities (Hardman, 2019). Moreover, the advancement in digital literacy and technological use has proven to be a

useful tool in the classroom as a faculty of learning and assessment (Voogt & Pareja Roblin, 2012). Primary schools in Ireland have ICT policies that stipulate a variety of requirements. These policies can include areas such as safe search on the internet, acceptable ICT usage, restrictions placed on school-based IT systems and various other topics (Elliott, Kratochwill, Cook & Travers, 2000; Moreno, Egan, Bare, Young & Cox, 2013). Although ICT is commonly perceived as a positive modern addition to schools' researchers have formed a consensus that ICT use should be considered complex and multi-layered instead of a monolithic phenomenon (Vanderlinde, Aesaert & Braak, 2015).

Easingwood and Williams (2004) discuss the idea that maths is an easy subject to teach badly. They hypothesise that this is because most teachers themselves have a lack of in-depth knowledge of the subject coupled with a misunderstanding of the real-life application of the many mathematical skills and components and why they are there. Children respond to real life experiences, as they are able to relate to them on both a personal and cognitive level, which allows the learning of a topic to become meaningful (Garrick, Bath, Dunn, Maconochie, Willis & Wolstenholme, 2010). It is suggested that ICT will help teachers and children bridge the gap of creating and partaking in continuous, fun and engaging activities and assessments (Hardman, 2019). The first component of using ICT in the primary classroom is planning. An "important point to make about the use of ICT is that it cannot and should not replace the teacher. Excellent teaching and effective learning can only occur when a good teacher is present" (Easingwood & Williams, 2004: 9; Way & Beardon, 2003).

In 2010 Apple announced their first tablet computer, the iPad. Its popularity from then to the current day is unquestionably high. The application of tablet-based devices, particularly the iPad, into the school and classroom setting has increased year on year (Elyas & Al-Bogami,

2019). In their report of Tablet Based Maths Assessment Cayton-Hodges et al. (2015) outline the four key dimensions that they used in their mathematical review; "(1) the quality of mathematical content, (2) feedback and scaffolding, (3) richness of interactions, and (4) adaptability of the applications. These four areas were cultivated from prior research on digital tools in mathematics" (Cayton-Hodges et al, 2015: 3). The criteria were used on an initial sample of sixty-four apps that were available on the Apple App Store in 2015 and featured in different genres of mathematics. The results showed that although some apps took the form of eBooks and personal tutors, the vast majority came in the form of games. Primary schools in Ireland have made advancements in their engagements with digital technologies that promote mathematical learning through the medium of ICT. Advancements in this area provides a platform for CPD for teachers in the area of attitudinal development. In addition, it is documented that through a game-oriented app "the player needs to solve mathematics problems to earn points and achieve game goals" (Cayton-Hodges et al, 2015: 4). It was also found that there were no applications that claimed to be 'assessment apps' but rather a platform of exploring mathematical skills and concepts within a game setting. An example of this from the Apple App Store is 'Math Geometry: Learning 2D and 3D Shapes'. The app is designed for teachers and children and features informative shape related text, images and a multiple-choice quiz, where the user answers questions related to 2D or 3D shapes. It is suggested that iPads provide a great resource within the subject of math and the mathematics curriculum as they can be used as a resource to support various stages of a maths lesson. Apps such as 'Math Geometry: Learning 2D and 3D Shapes' support the learning of new mathematical skills and strategies in a way that is fun and engaging for children and is a valuable stimulus. When assessing children in these areas it is important that the teacher plans appropriately, to observe or make checklists that are completed to ensure an accurate gathering of the children's individual learning of a particular topic (Torrance, 2009).

2.6 SUMMARY

The Literature Review has identified and outlined some of the key insights, elements and challenges surrounding the development of student attitudes towards maths. The literature outlined in the chapter discusses attitudinal change at a fundamental level, where self-efficacy and maths anxiety are examined in relation to attitudinal change. The development of a growth mindset is discussed in relation to enacting a development towards an educational discipline, such as maths. From the literature reviewed it is clear that achieving a meaningful development of attitude towards maths is deeply complex and involves elements that are sometimes beyond the control of the teacher. The methods of teaching maths education are changing within the Irish context. The aim of this study is to improve my teaching of maths to develop student attitudes towards the subject. Engagement with this Literature Review has facilitated a deeper insight into the elements of maths attitude and its relationship with self-efficacy, anxiety and the development of one's mindset. It has outlined links between assessment of maths and the role ICT can have in future teaching.

CHAPTER 3: RESEARCH METHODOLOGY OF THE STUDY

3.0 PURPOSE OF THE STUDY

The purpose of this AR study was to examine how I can improve my teaching of maths to assist the development of student attitudes towards the subject for fourth class students in a senior national school. It was my aim to improve my teaching to enable children to develop a positive attitude towards maths, allowing students to enjoy the subject without hesitation around their ability.

3.1 RESEARCH QUESTION

- How can I improve my teaching of maths to assist the development of student attitudes towards the subject?

3.2 RESEARCH PARADIGMS

The definition of a paradigm is explored by (Cohen at al., 2007) when they outline the definition to be a way of looking at and researching phenomena. This is more commonly simplified as a world view. Kuhn adds to this definition when he states that it is often seen as a view of what counts as accepted, corrected scientific knowledge or a way of working. Ultimately an 'accepted model or pattern' (Kuhn 1962: 23). For the purpose of my study I have used the AR paradigm.

Action Research Paradigm

AR in the context of education has progressed over the past ten years (Bassey, 1990) and is regarded as a powerful tool for initiating change and addressing the need for continuous improvement in a specific area chosen by the researcher (Cohen et al., 2007). Bargal (2008:

25) suggests that the AR paradigm primarily 'deals with the creation of change in human systems.' Cohen, et al. (2007: 297) further explore AR as a method that can be used in most organisational environments 'where a problem involving people, tasks and procedures cries out for solution, or where some change of feature results in a more desirable outcome'. This is recently exampled in the Irish education system through the Department of Education and Skills development and integration of the (PLC) Primary Language Curriculum in schools. The PLC aims to 'develop children's lives through language development and improve connections and communications with others' (NCCA, 2019: 34). This is a constructivist approach which has a strong link with my own educational values. The constructivist approach to learning takes place when 'people actively construct or make their own knowledge and that reality is determined by the experiences of the learner' (Elliott et al., 2000: 256). It is suggested that prior knowledge influences what new or modified knowledge an individual will construct from new learning experiences and can assist shape a person's opinion or attitude (Phillips, 1995).

AR is a process that enables both the researcher and the participants to engage with a study that aims to upskill and develop the knowledge and understanding of all participants, primarily that of the researcher in a collaborative manner (McNiff & Whitehead, 2010: 20). Clear communication is an educational value that I bring into my teaching and practice. I believe that good communication is the foundation of good teaching practice. AR enabled me to explore positive and ethical practices of communication between the various participants of this research study. It provided a platform for discussion and feedback. Coghlan and Brannick (2009) support this idea by affirming AR as a collaborative problem-solving relationship between researcher and the subject of the research, with the objective of solving the problem while generating new knowledge through continuous improvement.

The AR paradigm allows the researching practitioner to respond to issues within the study using a cycle of inquiry (Glenn, Roache, McDonagh, & Sullivan, 2017). This enables the researcher to understand and intervene these issues in real time as part of a frequentative activity (Kuhne & Quigley, 1997). The participatory nature of AR (Edwards-Groves, Grootenboer & Wilinson, 2018) was an important feature of the research for me, as it allowed me to enhance my practice and understanding through a paradigm of research that is in direct accordance with my educational values.

3.3 RESEARCH DESIGN

Research Site

The research took place in a primary school classroom in a mixed gender senior school in Co. Dublin. A senior school is established when the number of students in each class stream exceeds a certain number and a school is split into separate junior and senior schools. For the purpose of this study the names and location of the school and its students have remained anonymous. The research was carried out in a fourth class where I was the class teacher. The members of the school community at the research site offered a supportive environment for the research to be carried out. Members of the staff gave their consent and approval for the research to be carried out in the school.

Research Participants

The opportunity for participation in the research was offered to all children in my fourth class. Parental consent forms and child assent forms were received from all of the children in my class to engage and participate. A sample of these can be found in the appendices. As the research progressed, I actively engaged with my critical friend. Through our partnered planning, discussions and observations, I structured planned maths activities that informed the

research and provided a representation of the children's attitudes towards maths at the various stages of data collection. Throughout the process, I used a reflective journal to document feedback. The staff members of the school were informed of my AR study through a presentation at a staff meeting.

Overall design

The overall design was through an intervention process that would cover a total of ten topics over the course of this study. Due to school closures nine topics were covered. In Table 3.1 below a list of topics can be seen.

Topics	
Week 1 – Symmetry	Week 6 – Perimetre
Week 2 – Long Multiplication	Week 7 – Fractions 2
Week 3 – Patterns	Week 8 – Decimals 2
Week 4 – Division 2	Week 9 – 2D Shapes
Week 5 - Length	Week 10 – Chance * Not covered due to school closures.

Table 3.1 List of Topics Covered During Data Gathering Period

Data collection took place on a weekly basis and was gathered during a specific time on the class timetable. This can be seen in the Table 3.2 below. Data was collected from the participants in the fourth-class room and the iPad hub located along the corridor on the same floor. It was made clear to children that I would collect data during this time. Each data gathering session was structured and involved planned maths-based activities. I recorded the data using my observational notes during teacher designed tasks, surveys and indicator charts, which were designed to show attitudinal changes of the children at various points of the process

and reflections from my own reflective journal. The collection of data using the data gathering instruments and is highlighted in the next section of this chapter. Each data gathering session was reviewed and discussed with my critical friend. The suggestions that were derived from our discussions were implemented into my planning to improve the efficiency and effectiveness of collection of data through the planned lessons. The children completed a survey that used a likert scale to determine their attitudes towards maths upon completing the activities on each topic. The surveys showed any changes in the children's attitude towards maths based on the activity completed. The children completed an indicator chart at three points of the data collection process. These were distributed during the first week, fifth week and ninth and final week of the process. The data was then analysed and findings were drawn from this analysis.

Friday								
9.00	9.50	10.40	10.55	11.35	12.00	12.30	1.00	1.45
Gaeilge (40 mins)	Maths (60 mins)	*Break*	SPHE	SESE	Music	*Lunch*	Art	Drama

Table 3.2 Allocated Time for Research on Timetable

Description of Intervention

The study was designed to feature an intervention at two points of the data collection process. The interventions involved integration of other subjects into my teaching of maths, as well as enhancing my use of ICT as a resource and its effective use in the classroom. The interventions can be seen in Figure 3.1 below, where the intervention is named and the week when each was phased into the research is outlined. The interventions were designed and developed through discussion with my critical friend, reflections from my journal and findings from a review of literature. The interventions were phased into the research at two points. The first point, which

was the integration of various curriculum subjects, was phased in Week 1. This initially involved the use of visual arts as a method of teaching mathematical topics and concepts. (SESE) Social Environmental and Scientific Education subjects, Science and Geography were further used to teach the topics outlined in the AR plan.

The second intervention was introduced in Week 5 of the data collection process. It involved using ICT to support lessons through tablet-based activities. IPads were available for each participant during the lessons from week 5 to week 9. The initial use of the iPads involved the children documenting data and using the camera feature to record their work. Progressing from this in week 6 the iPads were further used to enable the children to employ mathematical knowledge, skills and procedures through a range of applications and games. Cayton-Hodges et al. (2015) suggest that using game-based applications is beneficial as it provides a platform of exploring a variety of mathematical skills and concepts within the confines of a games setting. The integration of iPads in the lessons provided an opportunity to record and document work, explore mathematical language and skills and provided an alternative means of assessment.

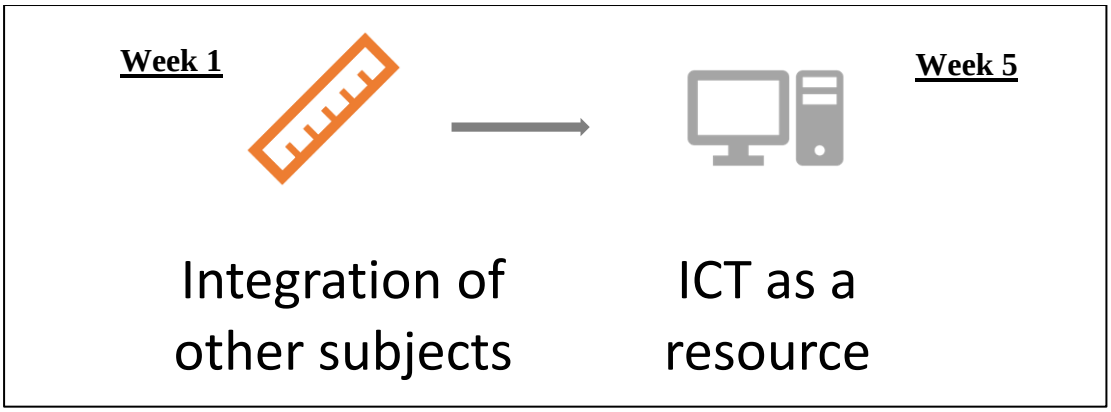

Figure 3.1 Phases of Interventions

3.4 DATA GATHERING INSTRUMENTS

Teacher Reflective Journal:

I made use of a teacher reflective journal during the data gathering period. In this journal, I engaged with reflection and meta-reflection around my observations of teacher-designed tasks. I made my reflections using elements of Brookfield's (2006) reflective lenses, paying careful attention to both the student lens and my own perspective. I decided to focus primarily on these two lenses as it provided an opportunity to examine both the student and my own engagement with maths teaching and learning, drawing comparisons between our experiences of the data gathering sessions. Doing this enabled me to gain an insight into thinking critically on my own planning from an alternate view. 'When we collect data from students we see the different ways they interpret what we say and do' (Brookfield, 1995: 8). It was my aim that my reflective journal would develop my learning and understanding of what was successful in each lesson and what I could change and phase into my future planning. The practice of reflection was a 'meaningful process of learning' (Moon, 2004: 100) that informed my teaching and helped me to improve my teaching and develop student attitudes towards maths.

Observations During Teacher-Designed Tasks:

I used observations during teacher-designed tasks to collect 'live' data during our weekly research time (Cohen et al., 2007: 398). I documented my observations in a notebook in-practice, writing any observations that I made pertaining to changes in the children's attitudes towards maths. The observations took place through a semi-structured process, where I used prepared prompt questions to elicit responses from the children around their engagement with the activity, while allowing the lesson to develop naturally, enabling children to generate their own responses mitigating external influences. Patton (1990: 202) suggests this process can be 'hypothesis-generating rather than hypothesis testing and will allow the observer to review the

data before suggesting an explanation for the phenomena being observed'. I began to observe the children completing specific tasks that were related to a topic outlined at each stage of the interventions. Using observations as a data gathering instrument enabled me to collect information that could not be detected by other data gathering instruments, for example, Morrison (1993: 80) 'formal and informal conversations, verbal and non-verbal interactions, etc'. Cohen et al. (2007) discuss the value of using observation in this way as it enables the teacher to focus on different events as they happen and unfold naturally in the classroom. Using a semi-structured observation approach allowed me to additionally document live peer interactions during the research time. This was a prominent feature throughout the data collection process and through my practice of reflection both in and of my own teaching I was able to record and document the various situations and responses in a manner that would provide a variety of perspectives (Brookfield, 2006) of attitudes towards maths. These were further reflected upon using my reflective journal. A sample of my observational notes from week 7 (Fractions 2) can be found in the appendices.

Surveys and Indicator Charts:

I used both surveys and indicator charts as data gathering instruments. I used indicator charts at three points during the data collection process. These points were Week 1, Week 5 and Week 9 and the indicator charts were distributed at these varying points. The indicator chart used a word-based and numerical likert scale. The scale outlined if the children believe that maths is 'fun', 'some fun' or 'a lot of fun' using numbers ranging from 0 to 10, where 0 represented 'no fun', 5 represented 'some fun' and 10 represented 'lots of fun'. Mellor and Moore (2014) discuss the benefits of using words as well as numbers when creating a likert scale format for children, highlighting its ability generate a more accurate representation of the children's

attitudes. Figure 3.2 below displays the indicator chart that was used for the purpose of this research. A sample of the indicator chart can be found in the appendices.

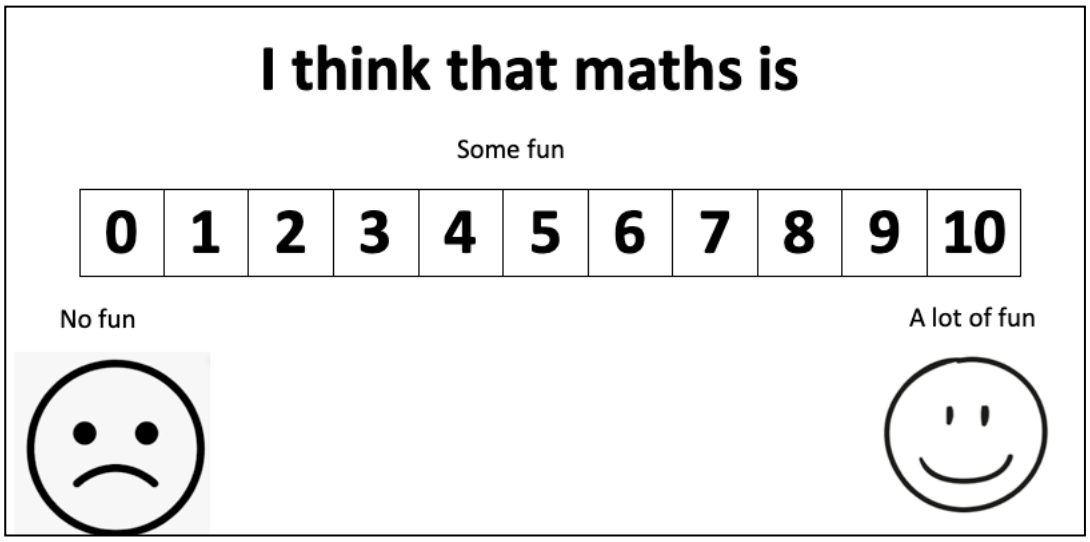

Figure 3.2 Indicator Chart

I used attitudinal surveys throughout the research. A sample of the attitudinal survey can be found in the appendices. They contained a series of statements that outline key elements of the children's attitudes towards maths. Similar to the indicator charts the attitudinal surveys featured a Likert scale graded from 0-10 where the children responded to the statements by selecting a number that represents their attitude or feelings towards maths. Sprato and Bandalos (2019: 3) outline the Likert scale as an effective method of data collection as it gives a precise numerical value rather than 'a more extreme response' that can be given in questionnaires. Using a Likert scale enabled the children to correlate their attitudes at the time of data collection with a number on the scale. Figure 3.3 below shows the attitudinal survey that was distributed amongst the children after each research session.

1. I find maths more enjoyable after today's lesson.

0	1	2	3	4	5	6	7	8	9	10

2. I think maths is much more fun when we do activities like we have today.

0	1	2	3	4	5	6	7	8	9	10

3. I think that doing maths is more fun now than I did at the start of fourth class.

0	1	2	3	4	5	6	7	8	9	10

4. My feelings towards maths is improving positively.

0	1	2	3	4	5	6	7	8	9	10

Figure 3.3 Statements from Attitudinal Survey

The attitudinal surveys were distributed on a weekly basis at the end of each data gathering session. Each data gathering session featured a single survey that was prepared for a total of 27 participants. However, due to absences from the class at the time of data collection each week, the number of completed surveys that were received fluctuated from the initial sample of 27 participants. There was a total of 219 of survey responses gathered over the course of the data collection process. A breakdown of a weekly amount can be seen in Table 3.3 below.

Week 1 – 22 Responses	Week 6 – 25 Responses
Week 2 – 25 Responses	Week 7 – 25 Responses
Week 3 – 23 Responses	Week 8 – 22 Responses
Week 4 – 23 Responses	Week 9 – 27 Responses
Week 5 – 27 Responses	

Table 3.3 Research Survey Weekly Responses

Group Conferencing:

The children were also invited to take part in group conferencing for the purpose of this study. I decided to use group conferencing as a data collection instrument because of its ability to draw oral responses from the children around their current attitudes and feelings towards maths in a small group setting. Larkin (2006: 25) discusses the benefits of collaborative group work and conferencing, its ability to assist metacognition through student-teacher interactions and its 'importance for academic achievement and for motivation'. The conference was semi-structured in nature and were led using specific prompt questions to elicit responses from the children. Group conferencing occurred each week after the research time had taken place with a random target group. I documented the responses in my notebook that is also used to observe the children as they complete teacher-designed tasks. This method of data collection enabled me to take direct quotes from the children's own discussions and reflections from the lesson and further link my own reflections which informed planning and teaching.

3.5 LIMITATIONS OF THE RESEARCH DESIGN

Limitations in an AR study enables the researcher to assess any external deficiencies that may impact the process and outcome of the study. Through identifying and acknowledging the limitations present the researcher is enabled to carry out one of two possible actions. They can adjust their planning and make changes to their research design before the data collection takes place or continue to complete the data collection without alteration, providing a justification for the research study as it is presented (Schanzenbach, 2012).

The following limitations were considered for the purpose of this study:

1.) The academic schedule of the school was a limitation of the study as certain children were scheduled to attend learning support/ motor skill groups at the time of data collection each week. Through working with learning support teachers at fourth class level, we were able to adjust the timetables and ensure that the children who wanted to participate were afforded the opportunity.

2.) Time was also a limitation. As aforementioned, the study was scheduled to take place over a ten-week process. Due to the Covid-19 and the subsequent school closures this data collection period was reduced to nine weeks. This put a strain on collecting the data for the ninth and final week as it had to take place earlier than planned on the timetable.

3.) The access and reliability of ICT equipment was a limitation of the study. There was a sample of 27 participants for the purpose of this study, with 30 iPads available at the time of data collection each week. There were instances when the iPads were late arriving to the room and some without a sufficient charge of battery. This was mitigated through discussions with teachers who would use the

iPads in the morning and ensuring that they were fully charged the evening before I was due to collect any data.

3.6 ROLE OF THE RESEARCHER

Credibility:

To ensure credibility throughout the data collection process and analysis, I used the triangulation method. The meaning of triangulation involves using more than one method to collect data on a topic (Stringer, 2020). The methods used to collect data for this AR study included indicator charts, attitudinal surveys, observational notes during teacher-designed tasks, teacher reflective journal and group conferencing. The indicator charts and attitudinal surveys were distributed at various points of the research, as mentioned above. These methods provided a quantitative approach to data collection. In contrast, the observational notes during teacher-designed tasks, teacher reflective journal and group conferencing provided a qualitative approach to the collection of data.

Validity:

Validity, 'depends on concrete examples of actual practices, fully elaborated so that members of a relevant research community can judge for themselves their "trustworthiness" and the validity of observations, interpretations' (Lyons & LaBoskey, 2002: 20). Validating is seen as a process of knowledge creation, in which establishing and judging the trustworthiness of a study is the key element (Sullivan, Glenn, Roche & McDonagh, 2016). When collecting data for this self-study I have documented quotes from children in my observational notes from teacher designed tasks and using prompt questions generated for group conferencing during the research time. These quotes have been recorded as a direct transcript of what the child said and I have not made any attempt to alter the wording or structure of the original quote. It is the

reader of the data who ultimately judges the validity of the study by considering whether it is informative, relevant or useful in his/her own setting (Hamilton & Pinnegar, 2009).

Methodological Assumptions:

As the class teacher I am aware that I have generated my own thoughts and opinions of each child's attitude towards maths in my class. This has come through personal observations, test scores, the children's previous engagement with other curriculum subjects and knowledge of children who attend learning support for maths. Therefore, during this study, I have made conscious attempts to mitigate bias I have around the aforementioned thoughts and opinions by documenting data accurately. All of the data that was gathered was anonymised to circumvent assumptions when analysing the data as well as adhering to ethical guidelines within the study.

Ethical Issues:

The issue of ethics is paramount within the discipline of education. Ethical conduct becomes even more important when conducting research as it pertains to the conventions of how we should approach and interact with each other (Eikeland, 2006). When explaining the purpose of the research to the various participants; critical friend, Board of Management, principal, teaching and non-teaching staff in the school, children and parents, I was clear in my explanations that I was not researching them, but rather using their data to research myself and improve my teaching around this area. A sample of the information letters and consent/ assent forms can be found in the appendices. At the beginning of each data gathering session the children were informed of the decision to participate in the research. On one occasion a child decided that he/ she would not like to be involved in the data collection during a research

session. This child was allowed to remove his/ herself from the data collection and his/ her data was rendered invalid and was not used as part of this research project.

The children were each invited to engage with the research and were encouraged to be honest in their feedback rather than providing answers that may be written for the purpose of pleasing me. This was reiterated when surveys and indicator charts were handed out during each data collection session. I was conscious at all times that when working with a vulnerable group certain discussion may arise. To ensure all children were protected, I made myself aware of the correct procedures outlined by the Maynooth University Research Ethics Policy, UN Convention of Rights of Child, Department of Child and Youth Affairs in the case that any disclosures that may have been made (Research Ethics Policy; 2015, UNCRC;1989, CCA; 1991). When collecting data over the research process I ensured that it was recorded, documented and secured in accordance with the guidelines highlighted above. Any digital files and assessments that were acquired on the iPads throughout the data collection process were stored remotely on an encrypted hard drive and stored in a locked cabinet within the confines of the school. The original files were deleted from the ICT devices. My written observations, reflective journal, indicator charts and attitudinal surveys were stored in a folder and placed into a locked cabinet also.

3.7 SUMMARY

The aim of this study is to improve my teaching to develop student attitudes towards maths. This chapter outlines the methodology used for the purpose of the research. The paradigm of Action Research is explored in the context of this study. There is a review of the research design, where the research site and sample are outlined and a description of the intervention is provided. The data gathering instruments are outlined and a rationale for their choice and adaptation for this study is furnished. The limitations of the research design are presented with

the aim of providing an overarching context for the reader. My role as the researcher is presented, where ethical considerations are made and the elements of credibility and validity are outlined.

CHAPTER 4: FINDINGS AND DISCUSSION OF DATA

4.0 INTRODUCTION

This chapter begins by presenting the data analysis procedures that were used when analysing the data collected for this study. There is an outline and presentation of quantitative and qualitative data that was collected during this time. The quantitative data includes indicator charts and attitudinal surveys which are represented as tables and further discussed, presenting emerging trends in relation to the charts and surveys. The qualitative data, which includes observational notes during teacher-designed tasks, teacher reflective journal and group conferencing are presented. Comparisons are drawn between the information outlined from the qualitative instruments and discussions of trends from the quantitative data.

4.1 DATA ANALYSIS PROCEDURES

The data analysis procedures for this self-study remained consistent with the proposal initially put forward prior to data collection in relation to the data collection tools which were divided into qualitative and quantitative methods of data collection. These data collection instruments are outlined below:

1. *Qualitative Data Collection Instruments*: Observational Notes from Teacher-Designed Tasks and Group Conferences and Teacher Reflective Journal.
2. *Quantitative Data Collection Instruments*: Indicator Charts and Attitudinal Surveys.

The process of analysing the qualitative and quantitative data was influenced by readings around the appropriate measures of generating codes and themes from my quantitative data using a thematic analysis, as documented by Braun and Clarke (2006) and using a case-based approach, as discussed by Kent (2015) to generate meaning from my quantitative data. Thus, enabling me to compare and contrast the qualitative and quantitative findings. The processes of analysis are discussed below.

Thematic Analysis

Braun and Clarke (2006) regard the process of Thematic analysis as a 'flexible technique that can be used in a wide variety of approaches to qualitative research' (Smith, 2015: 222). Thematic Analysis is completed in six phases which are outlined in Table 4.1 below.

Six Phases of Thematic Analysis
1. Familiarisation
2. Coding
3. Searching for Themes
4. Reviewing Themes
5. Defining and Naming Themes
6. Writing the Report

(Braun & Clarke, 2006)

Table 4.1 Six Phases of Thematic Analysis

The phases were carried out on the data collected from Observational Notes from Teacher-Designed Tasks and Group Conferences, which had been recorded each week during the data gathering sessions and my own Teacher Reflective Journal, which was documented and reflected upon in the days following the collection of qualitative data.

Quantitative Analysis

Kent (2015) discusses the benefits of using a variable and case-based approach when analysing certain types of quantitative data. Kent (2015) outlines the structures of these approaches documenting that a variable-based approach involves the analysis of two primary factors, numerical data and categorical data. In contrast, a case-based approach involves the analyst

relating a context to the numerical values presented. The quantitative data from this study was collected in the form of indicator charts and attitudinal surveys, both of which used a Likert scale grading from 0 – 10, where the numbers represented a respective given quantity. I decided that a case-based approach to analysing the quantitative data was favourable, as the number of attitudinal surveys collected each week varied and this would be represented more clearly through its acknowledgement along with the subsequent results achieved through the student responses. The results for the quantitative data have been represented in the form of tables for the purpose of this study.

4.2 PRESENTATION OF DATA

Indicator Charts

The indicator charts were distributed at the beginning, midpoint and end of the data collection process. The results for this have been represented as a table and can be seen in Table 4.2. Each child has been anonymised for the purpose of this study and are represented on Table 4.2 as Child (1-27). The Likert scale, used for the purpose of the indicator charts is represented by numbers ranging from 0 to 10, where 0 represents the children's view of maths education as 'no fun', 5/6 stipulates 'some fun' and 10 represents their view of maths as 'a lot of fun'. Mellor and Moore (2014) discuss the benefits of using both words and numbers within a Likert scale, highlighting its ability generate a more accurate representation of the children's attitudes. The data, that was collected over the course of nine data gathering sessions, shows an increase in positive responses between the first set of indicator charts and final set, with three exceptions, where Child 2, Child 8 and Child 26 gave a maximum score of 10, 'a lot of fun', for each of the indicator charts.

In some cases, there was a significant positive change in the children's response. Child 3 selected 3, 'no fun' in their first indicator chart and 8, 'lots of fun' in their final chart. This

shows an increase of five numbers on the Likert scale, moving from ‘no fun’ towards ‘lots of fun’. Child 5 and 22 made an increase from 1, ‘no fun’ to 8, ‘lots of fun’ indicating an increase of seven numbers on the Likert scale. Child 20 displayed a similar increase in their response moving from 4, ‘some fun’ to 8, ‘lots of fun’ showing a similar trend from ‘no fun’ towards ‘lots of fun’.

Child 13 presented the lowest rating at the final point of data collection. The context surrounding this response should be mentioned as it gives further meaning to the value of the numbers used to represent their attitude towards maths. Child 13 attends learning support for maths throughout the week in school. At the beginning of the academic year of this study, Child 13 struggled to engage with the maths curriculum and would often refuse to complete work in the subject. Over the course of nine weeks this child became more involved in maths lessons, showing a particular interest and excitement for the weekly research time. This is demonstrated in a note taken from my Reflective Journal on February 28th;

> “*Child X was asked if they would like to participate in a movement break during the research hour and was eager to stay and continue their involvement in the lesson. This behaviour towards maths is in contrast to comments made earlier in the month by Child X claiming they didn’t want to be involved in the lesson because they felt they were ‘not good at it’ and suggested that the subject ‘is boring’ in nature*”.

This is further demonstrated in the same child’s performance of the subject when Child 13 won the weekly maths tables competition during the seventh week of data collection. This was an accomplishment the child claimed would *‘never happen’* at the beginning of the data collection process. Therefore, when provided with the appropriate context, the value of Child 13’s numerical response represents a significant change in attitude towards maths education and learning.

In some responses the number value increased at the midpoint from the initial response and remained at the increased response for the final chart. Child 1 is an example of this where he/ she makes a response of 8, 'lots of fun' in the first indicator chart and further responds with 9, 'lots of fun' in the mid-point and final indicator charts. This is also displayed in the responses of Child 4, 7, 15, 16, 19 23, 24 and 27 respectively, where there is an initial increase in the value of the response from the indicator chart distributed prior to research and the indicator chart distributed at the mid-point, where the mid-point value is repeated on the final indicator chart. This suggests an initial development of attitude at the beginning of the research process that became stagnant in nature towards the later stages. In contrast, there is a change of this in the responses from Child 9 and 14. Child 9 responds with a value of 2, 'no fun' in the indicator chart distributed prior to research and indicator chart distributed at the mid-point, but increases his/ her response to 7, 'some fun, graduating towards lots of fun' in the final indicator chart. Child 14 responds with a value of 2 'no fun' in the indicator chart distributed prior to research and indicator chart distributed at the mid-point, but increases his/ her response to 7 'some fun, graduating towards lots of fun' in the final indicator chart. This suggests there was no initial development in attitude towards maths for these children.

The indicator charts display an overall increase in positive responses of children's attitude towards maths over the course of the data gather period. A number of points of discussion emerged from the indicator charts. These points discuss: 1.) Three children selected a maximum response of 10, 'lots of fun' for each of the three indicator charts given to them. 2.) Eight children provided a response in the first indicator chart which increased at the mid-point and remained the same for the final chart. This suggests an initial development in attitude towards maths, and one that remained consistent in its improvement of attitudes over the course of the data gathering period. 3.) Two children provided the same response in the first indicator chart and chart distributed at the mid-point. This response increased in the final chart, which

suggests a delay in the initial development of attitude towards maths. 4.) Child 13 responded with the lowest rating in the final indicator chart. However, the context surrounding his/ her attitude towards with maths suggests a meaningful development of attitude.

	Child 1	Child 2	Child 3	Child 4	Child 5	Child 6	Child 7	Child 8	Child 9	Child 10	Child 11	Child 12	Child 13	Child 14
Response before research started	8	10	3	6	1	4	6	10	2	8	7	4	3	8
Response at mid-point (Week4)	9	10	5	7	3	6	8	10	2	9	8	7	4	8
Respond at final point (Week 9)	9	10	8	7	8	8	8	10	7	10	9	8	5	9
	Child 15	Child 16	Child 17	Child 18	Child 19	Child 20	Child 21	Child 22	Child 23	Child 24	Child 25	Child 26	Child 27	
Response before research	8	8	2	3	5	4	7	1	6	8	5	10	8	
Response at mid-point (Week4)	10	10	4	9	8	7	8	6	9	9	7	10	10	
Respond at final point (Week 9)	10	10	7	10	8	8	9	8	9	9	9	10	10	

Table 4.2 Representation of Responses from Indicator Charts

Attitudinal Surveys

The attitudinal surveys were distributed amongst the children at the end of each data gathering session. A total of nine sets were collected. Each survey was structured with three statements; 'I think that today's activity was fun', 'I think maths is more fun when we do activities like we have today', 'I think that doing maths is more fun now than I did at the start of fourth class'. The Attitudinal Surveys were constructed using a graded Likert scale as a means of response for each statement. The scale ranged from 0 to 10, where 0 represented 'Strongly Disagree' and 10 represented 'Strongly Agree'. The intermittent values 1 – 9 were discussed as a graduation from 'Strongly Disagree' towards 'Strongly Agree'. The children were encouraged

to respond honestly in relation to the Likert scale provided. The results have been collapsed into three columns; 'High Rated', categorises responses which were made between 8 and 10, 'Mid-Rated', categorises responses which were made between 4 and 7 and 'Low Rated', categorises responses which were made between 0 and 3. The number of participants each week should be considered in relation to the analysis of trends that are discussed in each statement. These results are displayed in the subsequent figures associated with each statement below.

***Statement 1*:**

'I think that today's activity was fun'

In the first statement the children responded to the sentence 'I think that today's activity was fun.' The responses from this statement are outlined in Table 4.3 below. The 'Low Rated' column had the fewest number of responses in comparison to the 'Mid-Rated' and 'High Rated' columns. The 'Low Rated' column had 1 response in week three, 5 responses in week six and 2 responses in week seven.

The 'Mid-Rated' column fluctuates in responses over the nine weeks starting with 8 responses in week 1 and finishing with 6 responses in week nine. In week six the 'Mid-Rated' column received its highest number of responses with 10 children responding to this column. The number of participants each week should be considered in relation to the fluctuation of the 'Mid-Rated' column'. In week one and week five the 'Mid-Rated' columns received 8 responses respectively. However, in week one there were 22 participants in comparison to week five which featured 27 participants.

The 'High Rated' column had the largest number of responses in comparison to the 'Low Rated' and 'Mid-Rated' columns. The data suggests that there is a consistent increase in the

number of responses of the 'High Rated' column from week one, which received 14 responses to week nine, which received 21 responses. Week six features as an outlier in the trend of increasing responses in the 'High Rated' column. The trends from the data suggest an overall increase in responses in the 'High Rated' column, which implies a development in positive response towards the statement 'I think that today's activity was fun'.

	Week 1: Symmetry (22 Responses)	**Week 2**: Long Multiplication (25 Responses)	**Week 3**: Patterns (23 Responses)	**Week 4**: Division (23 Responses)	**Week 5**: Length (27 Responses)	**Week 6**: Perimeter (25 Responses)	**Week 7**: Fractions (25 Responses)	**Week 8**: Decimals (22 Responses)	**Week 9**: 2D Shapes (27 Responses)
High Rated (Responses in columns 8/9/10)	**14**	**16**	**18**	**18**	**19**	**10**	**21**	**20**	**21**
Mid Rated (Responses in columns 4/5/6/7)	**8**	**9**	**4**	**5**	**8**	**10**	**2**	**2**	**6**
Low Rated (Responses in columns 0/1/2/3)	**0**	**0**	**1**	**0**	**0**	**5**	**2**	**0**	**0**

Table 4.3 Number of Responses for Statement 1: I think that today's activity was fun

***Statement 2*:**

'I think maths is more fun when we do activities like we have today'

The second statement pertains to the children questioning if maths is more fun when we engage with activities like those during research time each week. The data is represented in Table 4.4 below. The 'Low Rated' column had the fewest number of responses when compared to the 'Mid-Rated' and 'High Rated' columns. The 'Low Rated' column had 4

responses in week six, which has been previously outlined as an outlier in the increasing trend of positive responses to the statements.

The number of responses in the ‘Mid-Rated’ column fluctuates throughout the data gathering period, with the lowest amount of responses, 4 responses, in week eight and the highest amount of responses, 8 responses, in weeks five and nine.

The ‘High Rated’ column had the largest number of responses in comparison to the ‘Low Rated’ and ‘Mid-Rated’ columns, with the highest amount of responses were given in weeks five, seven and nine. There were 19 responses given for each of those weeks. The lowest amount of responses was given in week six, were there was 15 responses given. This is consistent with the first statement, where week six featuring as an outlier in the increasing positive responses. The trends from the data suggest that there is an overall increase in responses in the ‘High Rated’ column, which implies a development in positive response towards the statement ‘I think maths is more fun when we do activities like we have today’. Similar to the first statement the number of participants that responded fluctuated over the course of the data gathering period, ranging from 22 participants in week one to 27 participants in week nine.

	Week 1: Symmetry (22 Responses)	**Week 2**: Long Multiplication (25 Responses)	**Week 3**: Patterns (23 Responses)	**Week 4**: Division (23 Responses)	**Week 5**: Length (27 Responses)	**Week 6**: Perimeter (25 Responses)	**Week 7**: Fractions (25 Responses)	**Week 8**: Decimals (22 Responses)	**Week 9**: 2D Shapes (27 Responses)
High Rated (Responses in columns 8/9/10)	**16**	**18**	**16**	**18**	**19**	**15**	**19**	**18**	**19**
Mid Rated (Responses in columns 4/5/6/7)	**6**	**7**	**7**	**5**	**8**	**6**	**6**	**4**	**8**
Low Rated (Responses in columns 0/1/2/3)	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**

Table 4.4 Number of Responses for Statement 2: I think maths is more fun when we do activities like we have today.

Statement 3:

'I think that doing maths is more fun now than I did at the start of fourth class'

The final statement of the survey was designed to enable the children to reflect on their own attitudes towards maths from the beginning of fourth class, contrasting it with their attitude at the time of completing the survey. The data can be seen in Figure 4.5 below. The 'Low Rated' column received a total of 18 responses throughout the nine weeks. There were 12 responses in the 'Low Rated' column from week one to week four inclusive. In contrast, there were 7 responses in the 'Low Rated' column from week five to week nine inclusive. This suggests a decrease in 'Low Rated' responses at the point where ICT as a resource is being phased into the research.

The 'Mid-Rated' column fluctuates over the nine weeks, ranging from a low of 2 responses in week four to a high of 9 responses in week five. The number of participants that responded to the surveys in the week ranged from 23 participants in week four to 27 participants in week

five, and may account for the fluctuating nature of responses in the 'Mid-Rated' column at this point.

The 'High Rated' column received the highest number of responses for this statement. There was an increase of 6 responses in the 'High Rated' column over the course of the data collection from week one, where there were 14 responses to week nine, where there were 20 responses. The increasing trend of responses in the 'High Rated' column suggests a development in positive response towards the statement 'I think that doing maths is more fun now than I did at the start of fourth class'.

	Week 1: Symmetry (22 Responses)	**Week 2**: Long Multiplication (25 Responses)	**Week 3**: Patterns (23 Responses)	**Week 4**: Division (23 Responses)	**Week 5**: Length (27 Responses)	**Week 6**: Perimeter (25 Responses)	**Week 7**: Fractions (25 Responses)	**Week 8**: Decimals (22 Responses)	**Week 9**: 2D Shapes (27 Responses)
High Rated (Responses in columns 8/9/10)	**14**	**15**	**16**	**19**	**17**	**15**	**17**	**18**	**20**
Mid Rated (Responses in columns 4/5/6/7)	**6**	**6**	**3**	**2**	**9**	**6**	**7**	**4**	**6**
Low Rated (Responses in columns 0/1/2/3)	**2**	**4**	**4**	**2**	**1**	**4**	**1**	**0**	**1**

Table 4.5 Number of Responses for Statement 2: I think that doing maths is more fun now than I did at the start of fourth class.

Development of Confidence in Mathematical Ability

In a reflection written in my reflective journal on 14th February I documented that

> *"Child A and Child B gave interesting responses in feedback during the group conferencing at the end of the data gathering session on length. The teacher asked the*

question 'What did you think was good about today's maths lesson?' Child C was quick to respond stating that 'Today's maths didn't feel like maths. I was able to finish everything today and it was fun getting to measure the astro pitch'. Child D interjected saying 'Yeah today wasn't like maths. It was actually fun. I never thought I'd be able to work out the perimeter of the astro pitch but it was actually easy. I even tried the world problems in the book when we got back.' Having a pre-existing knowledge of the attitudes displayed by Child E and Child F when engaging with maths activities, there is a significant improvement in their positivity and engagement towards the subject."

To give further context to the perspective of Child E and F, it is important to document that both children previously displayed negative attitudes towards maths learning. This is demonstrated through verbalisations where Child E and F describe maths as 'boring and difficult'. Teacher observations document the disinterested body language that these two children have previously display during maths lessons in the classroom. The contrast in attitude shows a shift from a negative to a positive perception of what maths learning could be in future engagements. This is supported by the responses in the third statement of the attitudinal survey, which states: 'I think that doing maths is more fun now than I did at the start of fourth class'. The 'High Rated' column increases from 14 responses to 20 responses. The 'Mid-Rated' column received an initial amount of 6 responses, featuring some fluctuation but remaining on 6 responses. The 'Low Rated' column featured a decrease in its amount of responses overall, beginning with 6 responses in the first two weeks of data collection and finishing with 1 response in the final two weeks of data collection. There is an increasing trend of children who think that doing maths is more fun now than they did at the start of fourth class. Considerations are made for the number of students present for the data gathering sessions.

The development of confidence in mathematical ability was evidenced in my observational notes where I document 'Child G expressed a willingness to participate in the warm up game

today'. This is further explored in a reflection written in my reflective journal on 28th February where I record:

> "*Child G expressed a desire to compete in the maths warm up game today. This is in contrast to previous weeks where he/ she refused to participate due to his/ her belief that they would never get to the final two of the game. In today's group conferencing session, the children discussed any changes in their attitudes towards maths from the start of fourth class to this point. Child G openly discussed his/ her ability to compete in the 'maths game' at this stage of the year, compared to earlier in the year, where he/ she felt that the possibility of achieving a high placement in such a game would be very unlikely. Child G continues to discuss his/ her development of attitude towards maths in a positive way, as he/ she feels a high level of confidence when completing maths activity now, where Child G has stated that he/ she 'is not as rubbish… or likely to get it wrong'."*

Child G demonstrates a critical reflection of his/ her development of confidence in maths. This is further supported by indicator chart responses from Child G, where he/ she is represented as Child 5 on table 4.2 above. The responses show an increase in the attitude of Child G over the course of the data gathering period. Child G responded with 1 on the first chart, 3 on the second and 8 on the final chart. Brookefield (2006) outlines the benefit of viewing development through the lens of the student, suggesting that it helps the practitioner make sense of the student's experience. The student's lens is evident in this reflection and supports the idea that the study has enabled children to experience a development in confidence around their mathematical ability.

Using ICT as a Resource for Maths Learning in the Classroom

The use of ICT as a resource for maths learning in the classroom was a significant feature of the data analysis process. ICT as resource for learning was introduced into the research as an intervention in the phase 2 of the data gathering process. Its effect as a resource is evidenced in a documentation from my observational notes and in my reflection on them in the quote below from my reflective journal. To provide a context, it is important to note that Child H has a moderate autism diagnosis and experiences difficulty writing due to sensory needs.

> *"The children are responding positively to using iPads in the classroom in conjunction with their maths lessons. Child H is benefiting greatly from this as it provides an alternative to writing with a pencil. He/ she is developing a motivation towards engagement with maths learning through the use of the iPad as an instrument for recording his/ her work. By observing the iPads being used as a support at various stages of the lessons I feel they are most effective when dispersed towards the end of the activity as a means for assessment. This provides less distraction for the children when trying to complete other non-IT based activities. However, when used as a primary resource in the patterns lesson some weeks back, they were quite effective and did not pose any distractions as they were in use" (Reflective Journal, February 14th).*

The use of iPads is discussed in this quote, where connections are made towards their positive impact as a resource for learning. Using iPads as an effective tool for assessment became evident throughout the data analysis process. It is noted that Child H used the iPads as an alternative instrument for recording written work. Though the discovery of this, Child H became motivated to engage with maths learning. This is supported by the positive responses in the first statement of the attitudinal survey, I think that today's activity was fun, where there are 19 responses in the 'High Rated' column, '8' in the 'Mid-Rated' column and 0 in the 'Low Rated' column.

This idea is further supported in the following reflection that was recorded in my reflective journal, involving a conversation between two children in the class who displayed enjoyment as they engaged with the various lessons. I have recorded that

> *"Child I & J mentioned how much they enjoyed today's maths lesson as they were exiting onto the yard. I asked what it was they liked about and they both agreed that it was fun using the iPads to learn about fractions unlike just doing it in their copies like previous years. Child K continued to note that they found it much more fun and would have completed all of the fraction problems, especially the difficult ones, set out on the iPad if the bell did not ring for break" (Reflective Journal, March 6th).*

Analysis of the data suggests that iPads are considered a fun resource for children. I document in my observational notes from the final data gathering session, week 9, that 'the children displayed enjoyment during the conclusion of the lesson, which used the "Math Geometry: Learning 2D and 3D Shapes" application on the iPads.' In the group conference that proceeded this Child J disclosed

> "*that the iPads made it so much more fun to learn about shapes…. The games and quizzes are way better than a boring workbook*".

Child K is represented as Child 25 on table 4.2, which presents the number of responses from the indicator charts. Child K responds 9 to the chart on this week. This is the final stage in the trend of increasing responses to the indicator chart, with a response of 5 in the first chart and 7 in the second chart. This further supports the idea that ICT can be used as a useful resource for maths learning and development of positive attitudes towards the subject in the classroom.

Stimulating Student Motivation Through Meaningful Maths Games

Comments were made each week in my Observational Notes and Reflective Journal relating to the warm up game which was used to introduce each data gathering session. The weekly maths

warm up game involved the children standing in a line in pairs, where I would ask a multiplication or division table and the child who answered quickest went to the back of the line and the other child would sit down in his/ her chair. This process was repeated until two children remained in the competition and the winner was awarded a trophy to keep on their desk for the remainder of the day. I documented in my reflective journal

> *"the children are responding positively to our self-titled 'maths game'. Child L asked several times today when we would be playing the game. This is in contrast to Child L refusing to participate in the game three weeks ago. His/ her performance in the game last week appears to have instilled confidence and they are generating a much greater level of enjoyment from reciting number facts"* (Reflective Journal, February 2nd).

This reflection highlights elements of Chid L's attitude towards maths as a transition from negative to positive. This is reflected in Child L's responses of the indicator charts. Child L, who is represented as Child 22 on Table 4.2, displayed an increase in his/ her response towards their belief that maths is fun. In the first chart, Child L gave a response of 1, which increased to a response of 6 in the second indicator chart, which was distributed at the time of the above reflection. Child L gave a response of 8 to the final chart, highlighting the trend of increasing responses. I found that through Child L's engagement with the warm up game they have become more receptive to continued participation within weekly maths lessons. I further note in my journal

> *"The children have become infatuated with a game that promotes speed and accuracy of number facts and tables. Today Child M refused to speak or do any work when they were withdrawn from the class by their learning support teacher. I discussed this with my critical friend at lunch as it was particularly unusual for Child M to act in this way. My critical friend, who is a support teacher at my class level withdrew Child M in an attempt to draw out why they acted in this way. It was later revealed that the reason*

> *Child M refused to speak or do work was because they were being withdrawn as the class was about to practice for our maths game. Child M disclosed that they have been practicing at home and reciting their tables every night to try and win the game and became upset that they couldn't take part in the practice. I was astonished at the level of engagement and meaning that the maths game had projected amongst children in the class"* (Reflective Journal, February 28th).

I believe this highlights a positive use of active games to stimulate children within maths learning. In opening the dialogue and conversation between Child 11, my critical friend and myself, clarity and reason for this adverse behaviour was brought to the situation. A result of this involved the child feeling satisfied through the use of effective communication. This was an isolated incident that links directly with communication as one of my educational values. However, when analysing the meaning behind the actions of Child M, it is apparent that the active warm up game holds a significant value to him/ her and possibly others in the class.

I record in my Observational Notes during a Group Conferencing session at the end of Week 8; "When I asked the children was there anything in today's lesson that made them find maths more fun, Child N promptly responded, 'I beat Child O in the maths game today and got into the last eight which I never thought I could do, it made me so happy." I further reflected on this in my Reflective Journal when I wrote

> "*As Child N announced that he/ she had got to the final eight children in the warm up game, it became apparent that it was something that I had never noticed. This provided a profound insight into the value that this child places on succeeding in the game and the effect that the subsequent success has for his/ her confidence and performance.*" (Reflective Journal, February 28th).

4.3 THEORISING THE FINDINGS

Finding 1

An Increase in Confidence of Mathematical Ability leads to an Increase in Performance of Mathematical Tasks and Problems

An increase in confidence of mathematical ability leading to an increase in performance of mathematical tasks and problems was a finding from the research process. It has been documented that an increase in confidence around a subject invites the participant to become open to the prospect of self-development within the discipline being explored (Oyserman, Sorensen, Reber and Chen, 2009). This links with my educational value of positivity, as it enables the child to generate and develop their mathematical knowledge and skills in a positive way. Teachers and parents share a common role in socialising children's academic attitudes and values from an early age through provided positive mathematical experiences for children and modelling competency and enjoyment in procedural application (Cased et al, 2015).

The research found that children who developed in confidence displayed a deeper interest in the maths lessons. Kaskens et al. (2020) support this suggesting that individuals who experience high levels of self-efficacy have a greater ability to deal with a situation without becoming overwhelmed and are less effected by failure in the area, recovering from mistakes with the intention of developing growth in confidence and ability. Agency in education plays an important role for this development of a deeper interest in maths education. As one of my personal educational values, I believe agency enables children to become active agents in their own learning.

Developing an increase in confidence enabled the children to further explore a growth mindset in the context of maths education. Enabling a growth mindset allows a person to create a

passion for learning and a resilience that is essential for great accomplishment (Dweck, 2015). Through implementing a growth mindset into the classroom setting the teacher can narrow the achievement gap between students, motivating those who underperform in the area of mathematics to persist (Elliott, Kratochwill, Cook & Travers, 2000; Chao, Visaria, Mukhopadhyay & Dehejia, 2017; Dweck, 2017).

To conclude, the research suggests that children who experience an increase in confidence around their mathematical ability also develop in their performance of mathematical tasks and problems.

Finding 2

Using Game-Based Applications on iPads can be an Effective Tool for Maths Assessment

The enjoyment of using of ICT, particularly iPads, as a tool for learning was a finding that has emerged from the nine-week data gathering process. It became known to me that the iPads were most effective when used as a tool for assessment in the lessons. Stickney, Sharp and Kenyon (2012) discuss the power of using technology as a form of assessment as it provides a dimension of familiarity for children. Cayton-Hodges et al. (2015) further discuss the positive elements of using ICT to disguise assessments as a game, enabling children to employ knowledge, skills and procedures on a platform that is stimulating for the user. This relates to my educational value of agency, where I, as a teacher aim to provide meaningful learning experiences for children. Throughout the research process I observed the children engaging with iPads in the classroom. My observations of the children's enjoyment towards using iPads as a resource links directly with my belief that agency should be a prominent value in the classroom setting.

The iPads offer a versatility during lessons and have a bank of resources and games that can be used to motivate children to engage with the maths curriculum. Hardman (2019) has suggested that ICT has become an important resource in the classroom in recent years and can be used to make maths fun and engaging for children. Similarly, my experience of using ICT, in the form of apps using iPads, throughout the process of this study has given rise to the belief that with effective planning and use of digital resources, maths can be assessed in a positive and meaningful way.

To conclude, the research suggests that through using game-based applications on the iPad, children will experience enjoyment and perform mathematical skills and procedures within a platform that is familiar and enjoyable to them.

Finding 3

There is a Positive Impact of Using Meaningful Maths Games to Stimulate Motivation and Engagement Towards the Subject

Comments were made each week in my Observational Notes and Reflective Journal relating to the warm up game which was used to introduce each data gathering session. The weekly maths warm up game involved the children participating in a knockout-style game that involved the repetition of multiplication and division tables. An analysis of the data found that through using meaningful maths games in the classroom, student motivation and engagement can increase. Agency features a prominent education value in this finding through the importance of using a maths game that is meaningful to the children. Eccles et al. (1983) support this through the development of the Expectancy-Value Theory of achievement motivation. The theory describes various cultural, social, interpersonal and individual factors that influence children's motivations and task values, as well as expectations for success and achievement related to

choices. Focusing on student motivation, the EVT suggests that student motivation depends on the expectation of being able to solve a task and the value that this task has for the individual (Linnenbrink-Garcia et al., 2018; Wormington & Linnenbrink-Garcia, 2017).

Modelling confidence and competence as a teacher is an important role and can be achieved through providing positive mathematical experiences for children and modelling competency and enjoy in procedural application (Cased et al, 2015). Children may become motivated to employ strategies and elements associated with a growth mindset within their own thinking, ultimately having a positive effect on their learning and developing lifelong habits (Hymer & Hailstone, 2014; Brock & Hundley, 2016; Boylan, Barblett & Knaus, 2018).

To conclude, the research suggests that through implementing meaningful maths games into the classroom, student motivation and engagement can increase in a positive way. This can allow for a more meaningful engagement with maths learning.

4.4 SUMMARY

The Findings and Discussion of Data outlined the process of how the data was analysed and interpreted. The quantitative data was represented in tables and there was discussion around the emerging trends from the data. The qualitative data was presented and points of discussion were reviewed from the analysis, using the trends that were presented from the quantitative data to support the points. The data was theorised and three main findings from the research were deduced.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.0 RESEARCH QUESTION AND SUMMARY OF FINDINGS

The research question that was proposed at the beginning of this Action Research study was '*How can I improve my teaching to develop student attitudes towards maths*?' The purpose of the research was developed through my intention to transcend my own positive outlook of maths, enabling children to experience enjoyment from study and application of mathematical concepts and skills. Thus, developing their attitude towards the subject. This research question aims to improve my practice and develop my teaching of maths. There were three findings generated from the analysis process. These findings are outlined below.

Finding 1: An Increase in Confidence of Mathematical Ability leads to an Increase in Performance of Mathematical Tasks and Problems

The first finding from this research study was that children who experience an increase in confidence around their mathematical ability, also develop in their performance of mathematical tasks and problems. It was documented that an increase in confidence around a subject invites the participant to become open to the prospect of self-development within the discipline being explored (Oyserman, Sorensen, Reber & Chen, 2009). This finding links with my personal educational values of positivity and agency, enabling children to develop in confidence through positive and meaningful experiences of maths education.

The research found that children who experienced an increase in confidence of their mathematical ability further displayed a deeper interest in maths, showing a desire to develop a growth mindset. Encouraging a growth mindset in the classroom enables teachers to improve student motivation, especially with children who underperform in the area of maths (Elliott, Kratochwill, Cook & Travers, 2000; Chao, Visaria, Mukhopadhyay & Dehejia, 2017).

Finding 2: Using Game-Based Applications on iPads can be an Effective Tool for Maths Assessment

The second finding documents that through using game-based applications on an iPad, children experience enjoyment and can perform mathematical skills and procedures within a platform that is both familiar and enjoyable for them. In using game-based applications as a tool for assessment, children are enabled to experience an assessment without the knowledge they are being assessed (Cayton-Hodges et al., 2015). It is suggested that using technology as a form of assessment provides a dimension of familiarity for children (Stickney, Sharp & Kenyon, 2012) enabling them to employ knowledge, skills and procedures on a platform that is stimulating and meaningful to them. This relates to my educational value of agency, where I, as a teacher aim to provide meaningful learning experiences for children. Throughout the process of this study my observations and analysis of data has given rise to my belief that with effective planning and use of digital resources, maths can be assessed in a positive and meaningful way.

Finding 3: There is a Positive Impact of Using Meaningful Maths Games to Stimulate Motivation and Engagement Towards the Subject

The third finding produced from the analysis of the data was that through implementing meaningful maths games into the classroom, student motivation and engagement can increase in a positive way. Eccles et al. (1983) support this through the development of the Expectancy-Value Theory of achievement motivation which describes the various cultural, social, interpersonal and individual factors that influence children's motivations. This can allow for a more meaningful engagement with maths learning, promoting agency in the classroom. Throughout this self-study I implemented a weekly maths warm up game involving the children participating in a knockout-style game where the repetition of multiplication and division tables were recited.

Modelling confidence and competencey as a teacher is an important role and can be achieved through providing positive mathematical experiences for children and modelling competency and enjoyment in procedural application (Cased et al, 2015). Children may become motivated to employ strategies and elements associated with a growth mindset within their own thinking, ultimately having a positive effect on their learning and developing lifelong habits (Hymer & Hailstone, 2014; Brock & Hundley, 2016; Boylan, Barblett & Knaus, 2018).

5.1 LIMITATIONS OF THE STUDY

Limitations in an Action Research study provide the researcher with an opportunity to assess any deficiencies that may impact the process and outcome of the study. There are a number of limitations that occurred during the process of this Action Research Self Study. In identifying and acknowledging these limitations the reader is able to gain a greater understanding of the external factors that were present during the research process. It also provides a rationale for decisions that were taken by the researcher to use specific strategies in moments of my discretion (Schanzenbach, 2012).

The limitations should be considered upon completion of this Action Research study:

1.) During the early stages of data collection, the children were informed that the research was solely an investigation of my own practice in an attempt improve student attitudes towards maths. They were subsequently encouraged to be as honest as possible when responding to Attitudinal Surveys, Indicator Charts and questions asked during Group Conferencing sessions. However, it must be considered that over the course of the nine-week data collection process children may have provided answers that they believe may please me. In an attempt to mitigate this, I reminded children at each point of data collection that the research was being carried out for the purpose of my development.

2.) Another limitation of this study was the way that the participants may view the numerical values on the Likert scale present on the Indicator Chart and Attitudinal surveys. The terms ‘no fun’, ‘some fun’ and ‘a lot of fun’ that were used on the Indicator Charts can be interpreted in different ways by students as they will have a variety of opinions and experiences with the term’ fun’. It is the role of the researcher to ensure credibility within the study (Stringer, 2020).

3.) The process of data collection was cut short by one week than initially planned because of the school closures caused by the Covid-19 pandemic. It was planned that the data collection would take place over a ten-week process, in shortening the process of data collection by one week and moving the day on which the final data gathering session was completed the responses may have varied in nature.

5.2 IMPLICATIONS FOR PRACTICE

The aim of this study was to improve my practice to support and develop children’s attitudes towards maths. The results have outlined areas of my practice that I believe will contribute to developing my practice for future teaching. Throughout the process of this study I have discovered the emphasis that I place on living in accordance with my educational values. Such values include agency, communication and positivity. The reflective process has helped me create a relationship between my educational values and my practice. Brookfield (1995) suggests that practitioners take a critically reflective approach in their practice towards continuous, formative evaluations.

The findings from this research suggest that an increase in confidence of mathematical ability leads to an increase in performance of mathematical tasks and problems. It has been documented that an increase in confidence around a subject invites the participant to become open to the prospect of self-development within the discipline being explored (Oyserman,

Sorensen, Reber & Chen, 2009). Bandura et al. (1996) further supports this indicating that in gaining the understanding of an individual's self-efficacy, practitioners are enabled to create a foundation of knowledge from which academic motivation, interest level and academic performance can become increased. This approach to learning is constructive in nature and promotes a positive increase of the children's confidence and performance of mathematical skills and concepts, which can lead to a development in their attitude towards maths. The features of this process are in accordance with my values and are a development that I personally aim to bring into my future practice.

Using iPads as a resource for maths assessment through game-based applications is prominent feature of this research study. Voogt and Pareja Roblin (2012) support this suggesting that iPads can be used as a tool for assessment of maths in a meaningful way for the children. Disguising assessments as game-based applications enables children to explore mathematical skills and concepts within a domain that is stimulating and enjoyable (Cayton-Hodges et al., 2015). Pajares (1996) discuss the motivating factors within self-efficacy, highlighting the relationship between success and failure. It is suggested that through disguising assessments as game-based applications, children who experience failure are less likely to diminish in confidence levels or attitude towards the subject. Looking towards my future teaching of maths I believe that game-based applications are an effective method of assessing maths learning in the classroom with children who display features of maths anxiety and have a negative attitude towards maths.

5.3 RECCOMMENDATIONS FOR FUTURE RESEARCH

The initial aim of the study was to improve my teaching of maths to develop student attitudes towards the subject. While literature is available within the area of 'Attitudinal Development Towards Maths' I would suggest that more extensive research should be carried out. This is

particularly important in the area of 'Attitudinal Change' amongst children in the primary classroom, where I feel there is a lack of current, published research around the area of attitudinal change towards maths within the Irish context.

The second recommendation for future research is for schools to become further equipped with appropriate ICT resources and training. A main finding from the study outlines the positive effects of using iPads as a resource for maths assessment through game-based applications.

There has been a significant amount of research carried out in the area of ICT and its role in the classroom. Hardman (2019) suggests that in recent years ICT has become an important resource in the classroom across the spectrum of subjects. It shows an advancement in technology and willingness to transcend with current times and societal normalities. The increasing use of ICT into primary schools has given rise for a required increase in the level of digital literacy amongst staff and students. In the Irish context, teachers have a mandate to implement the development of national literacy initiatives, such as the PLC into their teaching and training for CPD is provided for this. I would suggest that following the increasing implementation of ICT in primary schools, adequate CPD training should be provided for teachers in this area.

The third and final recommendation for future research is that schools carry out a regular review of student attitudes towards a variety of subjects. I have highlighted communication as one of my core educational values in earlier chapters of this study. Research suggests that through constructive communication teachers are enabled to become more involved in the students' learning process and better support them in areas where necessary (Lory, 2015). In carrying out a regular review of student attitudes towards subjects, schools may put themselves in a position of monitoring attitudinal change towards the subject.

5.4 END OF MY RESEARCH JOURNEY

As I reach the final stages of this self-study I reflect on my development over the course of the research. Although my engagement with AR in relation to this study is now finished I am inspired to continue improving aspects of my practice through the AR model. I began this research project with the aim of improving my teaching of maths to develop student attitudes towards the subject. I had a desire to discover areas of my own practice that I could develop in order to achieve this aim. Upon completion of the study, I find myself even more intrigued to discover elements of maths education and development. I now have a greater desire to share my findings and further improve my teaching of maths to develop student attitudes towards the subject beyond this study.

Reflecting on the outcomes of this self-study, I believe my practices have developed in many facets of delivering engaging and meaningful maths lessons. The school in which the research took place was a supportive environment throughout the process of this study. Members of the staff adopted an interest in my research and spoke about their experiences with maths attitude in the classroom. I delivered a presentation of my research to the staff, outlining my main findings from the analysis of the data. The school is currently developing initiatives to further support the development of maths attitudes amongst its students through surveys and continual review. I intend to further share my research across a variety of platforms and through presentations.

To conclude, the research is now finished for this study, but I am not finished in my desire to further improve my practice in the area of attitudinal development in maths.

5.5 SUMMARY OF THE STUDY

This research study set out to investigate:

How can I improve my teaching of maths to develop student attitudes towards the subject?

In Chapter One, an outline of the thesis is provided. The research question, aims and purpose of the study were discussed. My own educational values and practice are presented and my role as a primary teacher is discussed. An outline for the organisation of the thesis is furnished.

In Chapter Two an examination of the literature pertaining to this particular enquiry is presented. The methodology for research is outline in Chapter Three, it provides details of the Action Research paradigm, design of the research study, description of data gathering instruments and my role as the researcher.

Chapter Four outlined the thematic analysis of the data gathered from the primary research. Findings are developed through the analysis process and were theorised in relation to the study. The aim of Chapter Four was to create meaning from the data and provide an insight into the experiences of the participants (Flick, 2014).

Chapter Five includes a summary of the main findings developed from this study. Limitations for the research are outlined and implications for future practice are presented. Recommendations for future research are furnished. The study finishes with a review of my research journey

The aim of this study was to improve my teaching of maths to develop student attitudes towards the subject. I believe this was achieved through discovery of the findings outlined in this document. I have found that through developing an increase in children's confidence of their mathematical ability, an increase in performance of mathematical tasks and problems is offered. It was also found that using iPads as a tool for assessments in maths can be effective when carried out using game-based applications. Finally, it was found that there is a positive

impact of using meaningful maths games to stimulate motivation and engagement towards the subject. I have discovered these findings throughout the process of my research journey and through implementing them into my practice, I will improve my teaching of maths to develop student attitudes towards the subject.

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APPENDICES

Appendix A: Declaration by Researcher

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Declaration by Researcher

This declaration must be signed by the applicant(s)

I acknowledge(s) and agree that:

a) It is my sole responsibility and obligation to comply with all Irish and EU legislation relevant to this project.

b) I will comply with Irish and EU legislation relevant to this project.

c) That the research will be conducted in accordance with the Maynooth University Research Ethics Policy.

d) That the research will be conducted in accordance with the Maynooth University Research Integrity Policy.

e) That the research will not commence until ethical approval has been granted by the Research and Ethics committee in the Froebel Department of Primary and Early Childhood Education.

Signature of Student: Matthew Whyte.

Date: 10/12/19

Appendix B: The Fennema-Sherman Mathematics Attitude Scale

Item	Item description	Reverse coding	Keep/remove
Confidence in Learning Mathematics Scale:			
2	Most subjects I can handle O.K., but I have a tendency to mess up math.	Reverse	Keep
5	I don't think I could do advanced mathematics.	Reverse	Remove
8	I am sure that I can learn mathematics.	No	Keep
10	I'm not the type to do well in math.	Reverse	Keep
11	Generally I have felt secure about attempting mathematics.	No	Keep
14	Math was my worst subject.	Reverse	Keep
15	I have a lot of self-confidence when it comes to math.	No	Keep
16	I am sure I could do advanced work in mathematics.	No	Remove
18	I think I could handle more difficult mathematics.	No	Keep
24	I'm no good at math.	Reverse	Keep
27	I can get good grades in mathematics.	No	Keep
35	For some reason even though I study, math seems unusually hard for me.	Reverse	Keep
Effectance Motivation in Mathematics Scale:			
1	I like math puzzles.	No	Remove
4	When a question is left unanswered in math class, I continue to think about it afterward.	No	Keep
6	Mathematics is enjoyable and stimulating to me.	No	Keep
9	I don't understand how some people can spend so much time on math and seem to enjoy it.	Reverse	Keep
13	I am challenged by math problems I can't understand immediately.	No	Keep
17	The challenge of math problems does not appeal to me.	Reverse	Keep
26	Math puzzles are boring.	Reverse	Keep
29	Once I start trying to work on a math puzzle, I find it hard to stop.	No	Keep
30	Figuring out mathematical problems does not appeal to me.	Reverse	Keep
31	When a math problem arises that I can't immediately solve, I stick with it until I have the solution.	No	Keep
33	I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.	Reverse	Keep
36	I do as little work in math as possible.	Reverse	Keep
Mathematics Anxiety Scale:			
3	I almost never get nervous during a math test.	Reverse	Keep
7	My mind goes blank and I am unable to think clearly when doing mathematics.	No	Keep
12	I usually have been at ease during math tests.	Reverse	Keep
19	Mathematics makes me feel uncomfortable, restless, irritable, or impatient.	No	Keep
20	I don't usually worry about being able to solve math problems.	Reverse	Keep
21	I usually have been at ease in math classes.	Reverse	Keep
22	I get a sinking feeling when I think of trying hard math problems.	No	Keep
23	A math test would scare me.	No	Keep
25	Mathematics usually makes me feel uncomfortable or nervous.	No	Keep
28	It wouldn't bother me at all to take more math courses.	Reverse	Keep
32	Mathematics makes me feel uneasy or confused.	No	Keep
34	Math doesn't scare me at all.	Reverse	Keep

Appendix C: Indicator Chart

I think that maths is

Some fun

0	1	2	3	4	5	6	7	8	9	10

No fun

A lot of fun

Appendix D: Attitudinal Surveys

Research Survey

1. I find maths more enjoyable after today's lesson.

0	1	2	3	4	5	6	7	8	9	10

2. I think maths is much more fun when we do activities like we have today.

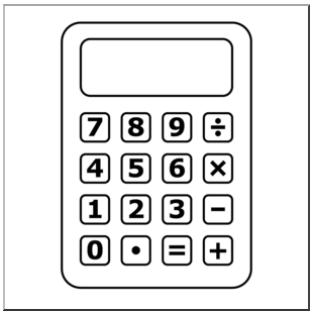
0	1	2	3	4	5	6	7	8	9	10

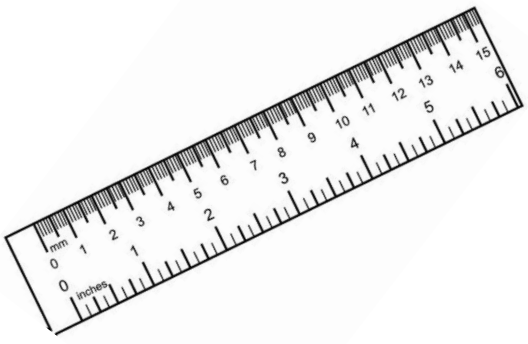
3. I think that doing maths is more fun now than I did at the start of fourth class.

0	1	2	3	4	5	6	7	8	9	10

4. My feelings towards maths is improving positively.

0	1	2	3	4	5	6	7	8	9	10



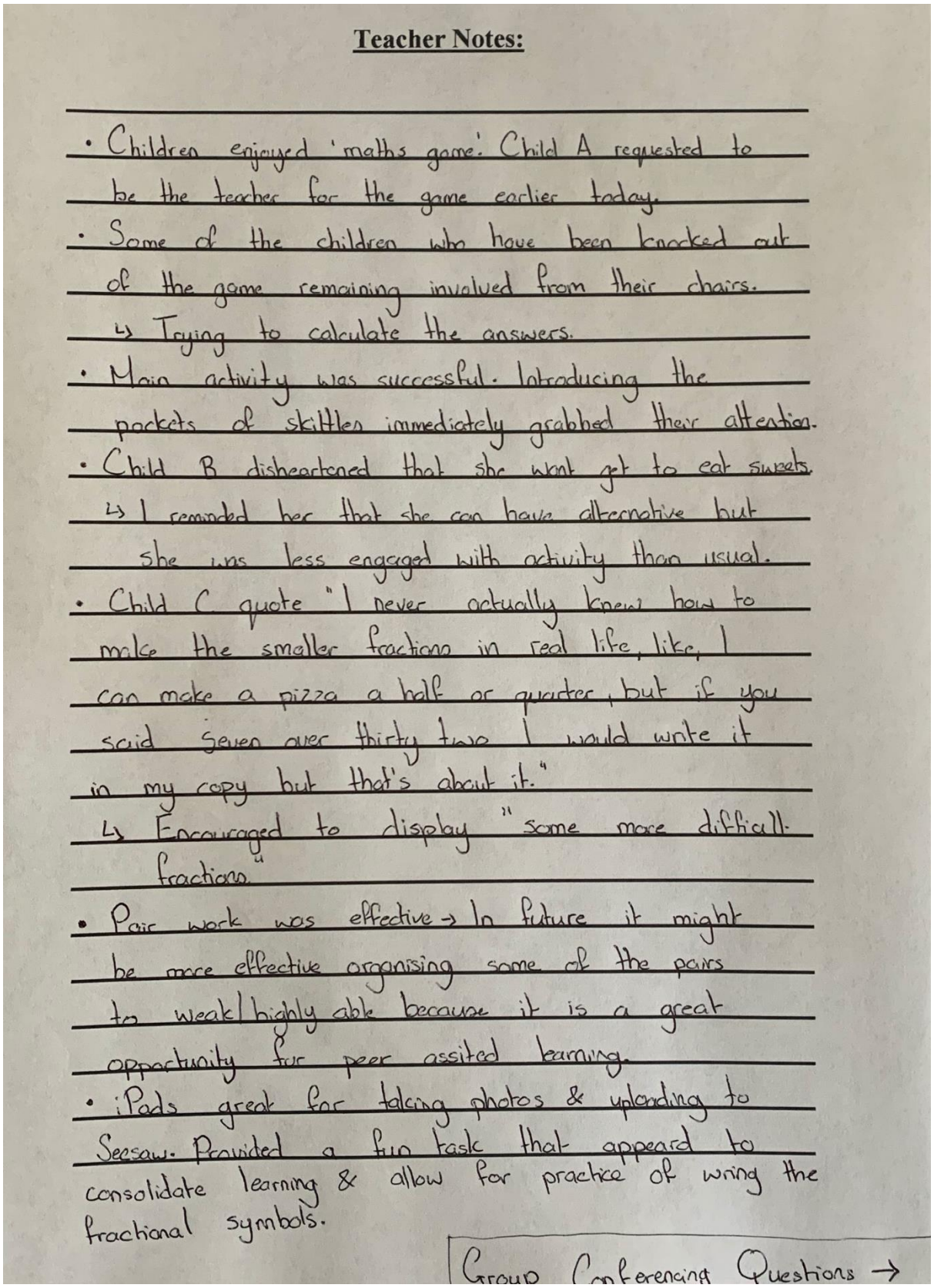


Appendix E: Template for Observational Notes

Topic: _____ Date: _____

Observational Notes:

Appendix F: Sample of Observational Note



Teacher Notes:

- Children enjoyed 'maths game'. Child A requested to be the teacher for the game earlier today.
- Some of the children who have been knocked out of the game remaining involved from their chairs.
  ↳ Trying to calculate the answers.
- Main activity was successful. Introducing the packets of skittles immediately grabbed their attention.
- Child B disheartened that she wont get to eat sweets.
  ↳ I reminded her that she can have alternative but she was less engaged with activity than usual.
- Child C quote "I never actually knew how to make the smaller fractions in real life, like, I can make a pizza a half or quarter, but if you said seven over thirty two I would write it in my copy but that's about it."
  ↳ Encouraged to display "some more difficult fractions."
- Pair work was effective → In future it might be more effective organising some of the pairs to weak/highly able because it is a great opportunity for peer assited learning.
- iPads great for taking photos & uploading to Seesaw. Provided a fun task that appeared to consolidate learning & allow for practice of wring the fractional symbols.

Group Conferencing Questions →

Appendix G: Parent/ Guardian Information Letter

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Dear Parent(s)/ Guardian(s),

I am a student on the Master of Education programme at Maynooth University. As part of my degree I am doing a research project. The focus of my research is based on teaching of mathematics in the classroom and whether this leads to a development in my practice of the subject and whether this leads to an improvement of the children's disposition towards the subject.

In order to do this, I intend to carry out research in the classroom through self-study action research and the collection of various forms of data.

The data will be collected using observations, student assessments, a daily teacher journal and the pupil's comments on maths. The children will be asked their opinions through discussing how they feel about the subject.

The child's name and the name of the school will not be included in the thesis that I will write at the end of the research. Your child will be allowed withdraw from the research process at any stage.

All information will be confidential and information will be destroyed in a stated timeframe in accordance with the University guidelines. The correct guidelines will be complied with when carrying out this research. The research will not be carried out until approval is granted by the Froebel Department of Primary and Early Childhood Education.

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

If you have any queries on any part of this research project feel free to contact me by email at matthew.whyte.2020@mumail.ie

Yours faithfully,

Matthew Whyte

Information Letter

Parents and Guardians

Who is this information sheet for?

This information sheet is for parents and guardians.

What is this Action Research Project about?

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

What are the research questions?

- How can I refine and develop my teaching of maths in the classroom?
- How can I develop pupils' attitudes and dispositions towards the subject?

What sorts of methods will be used?

- Observations
- Designed Activities
- Assessment Charts
- Reflective Journal

Who else will be involved?

The study will be carried out by me, Matthew Whyte as part of the Master of Education course in the Froebel Department of Primary and Early Childhood Education. The thesis will be submitted for assessment to the module leader Dr Bernadette Wrynn and will be examined by the Department staff. The external examiners will also access the final thesis.

What are you being asked to do?

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

Contact details: matthew.whyte.2020@mumail.ie

Appendix H: Parental Consent Form

Maynooth University Froebel Department of Primary and Early Childhood Education

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

PARENTAL CONSENT FORM

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

Parent / Guardian Signature_____

Parent / Guardian Signature_____

Date: _____

Name of Child _____

Child's signature: _____

Date: _____

Appendix I: Child Assent to Participate

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Child's Assent to Participate

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

I understand that I will be helping my teacher during research time when I am taking part in maths activities. Sometimes, my teacher might ask me questions about what I am doing and ask me to explain my thinking around an activity. I give my teacher permission to use my work for his project.

I know that if I do not want to take part in the research at any point I can opt out.

Name of child (in block capitals):

_____

Signature: _____

Date: _____

Appendix J: Critical Friend Information Letter

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Dear Critical Friend,
I am a student on the Master of Education programme at Maynooth University. As part of my degree I am doing a research project. The focus of my research is based on teaching of mathematics in the classroom and whether this leads to a development in my practice of the subject and whether this leads to an improvement of the children's disposition towards the subject.
In order to do this, I intend to carry out research in the classroom through self-study action research and the collection of various forms of data.
The data will be collected using observations, student assessments, a daily teacher journal and the pupil's comments on maths. The children will be asked their opinions through discussing how they feel about the subject.
Your identity will remain anonymous for the purpose of this study. The children's names and the name of the school will not be included in the thesis that I will write at the end of the research.
All information will be confidential and information will be destroyed in a stated timeframe in accordance with the University guidelines. The correct guidelines will be complied with when carrying out this research. The research will not be carried out until approval is granted by the Froebel Department of Primary and Early Childhood Education.
I would like to invite you to give permission to use and data gathered from our planning, discussions or observations in this project.
If you have any queries on any part of this research project feel free to contact me by email at matthew.whyte.2020@mumail.ie

Yours faithfully,

Matthew Whyte

Appendix K: Critical Friend Consent Form

Maynooth University Froebel Department of Primary and Early Childhood Education

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

CRITICAL FRIEND CONSENT FORM

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

Critical Friend Signature_____

Date: _____

Appendix L: Board of Management Letter for Permission

Maynooth University
National University of Ireland Maynooth

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Dear Board of Management,
As you may be aware, I am a student on the Master of Education programme at Maynooth University. As part of my degree I am doing a research project. The focus of my research is based on the teaching of mathematics in the classroom and whether this leads to a development in my practice of the subject.
In order to do this, I intend to carry out research in the classroom through self-study action research and the collection of various forms of data.
The data will be collected using observations, student grades, a daily teacher journal and the pupils test scores. The children will be asked their opinions through discussing how they feel about the subject.
The child's name and the name of the school will not be included in the thesis that I will write at the end of the research. Children will be allowed withdraw from the research process at any stage.
All information will be confidential and information will be destroyed in a stated timeframe in accordance with the University guidelines. The correct guidelines will be complied with when carrying out this research. The research will not be carried out until approval is granted by the Froebel Department of Primary and Early Childhood Education.
I am asking for your permission to complete this self-study action research project in the school.
If you have any queries on any part of this research project feel free to contact me.

Yours faithfully,

Matthew Whyte