OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND
MAYNOOTH

Froebel Department of Primary and Early Childhood Education
M.Ed. (Research in Practice)
2020 – 2021

Teaching and Learning Early Year's Mathematics in Irish Preschools

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

Date: 24/09/2021

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Bliain / Year group: 2020/21

Uimhir mhic léinn / Student number: 15757301

Ábhar / Subject: EDF689 THESIS

Léachtóir / Teagascóir: Lecturer / Tutor: Patsy Stafford

Sprioclá / Due date: 24TH September 2021

Teideal an tionscadail / Assignment title: HOW CAN I AS CURRICULUM LEADER ENHANCE THE TEACHING AND LEARNING OF MATHEMATICS IN THE ECCE CLASSROOMS IN MY EARLY YEAR'S SETTING FOR CHLDREN AGED 3-5 YEAR'S?

Líon na bhfocal / Word Count: __22,000____

Líon leathanach / Number of pages: 173

Aon ábhar eile sa tionscadal / Any other material in the assignment: Cover page, reference list, APPENDICES

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DECLARATION

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Student (Name) Lynn O'Dwyer

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ABSTRACT

The aim of this thesis was to find ways that I, as curriculum leader, could enhance the teaching and learning of mathematics for preschool children. The children involved attend the Irish Government funded Early Childhood Care and Education scheme at my Early Year's Care and Education setting. Underpinning this study was the desire to act in congruence with my epistemological and ontological values. I had observed and reflected upon the provision of early year's mathematics teaching and learning in the preschool classrooms in my setting, and had uncovered a problem area. I found there was very little mathematical play, and thus minimal mathematics teaching and learning occurring. This was disappointing, given my epistemological and ontological beliefs, which are firmly rooted in Froebelian values of mathematical concepts, collaborative play, and the joy of learning. I strongly believe that early mathematical confidence and ability is beneficial to later academic success for all children. Thus the concept for my study was generated – **"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?"**

The approach used was Self-Study Action Research. This study allowed me to observe and reflect upon my own practice as the curriculum leader of teaching and learning of mathematics for young children. The study was carried out within 3 preschool classrooms with the participation of 47 children in total, alongside their parents; and with assistance and input of 8 Early Year's Teachers. The interventions carried out included enhancing the mathematics learning environment across the 3 indoor classrooms and the communal outdoor play area; the training of the 8 teachers in the subject knowledge of mathematical play and learning for young children; and providing information and support for parents to include mathematics in their children's everyday lives. I also carried out a survey within the

wider community of Irish early year's educators to discover knowledge levels and attitudes regarding mathematics in the early years.

Findings suggest that in my setting the participating children benefitted from an enhanced and intentional emphasis on mathematical play in their preschool and home environments. The early year's teachers felt they learned a more intentional, informed and effective way to teach mathematics through play, without becoming too academic. Findings from the study include a need for a richly resourced mathematical environment to be in place; more focused and intentional learning about mathematics subject knowledge for early year's teaching students; the requirement for a knowledgeable and well qualified curriculum leader in all early year's' settings; and a mathematics curriculum to be written and followed in all early year's settings.

In summary, this study has enhanced the teaching and learning of mathematics in the 3 preschool classrooms in my setting. We have added to and enhanced our mathematics environments, indoors and outdoors. We have written a mathematics Curriculum Policy document for our centre. We are in the process of training all early year's' teachers in rich mathematical play environments and intentional teaching and learning of mathematics through play. These changes will benefit children of all ages who attend. I feel prepared to support my team to continue to enhance their mathematics teaching, and to review other curriculum areas which could benefit from the Self-Study Action Research approach. We have developed a bank of training and educational materials to support all parents whose children attend the setting. I also feel confident to share these findings with the wider early year's teaching community, and to potentially move the teaching and learning of early year's mathematics forward for the young children of Ireland.

ACKNOWLEDGEMENTS

I would like to firstly thank my supervisor, Patsy Stafford, for her constant guidance, feedback and thoughtful support provided whilst I have been writing this thesis. I must also thank the team of early year's teachers who became involved in the study, and my critical friends who assisted with the study and gave me invaluable insights. I would like to say a big thank you to all the children in my crèche, preschool and afterschool – you all make every day worthwhile. To my family, thank you for cooking the dinners, going to the matches, and taking the bus or bicycle, all of which have allowed me the luxury of time to complete and write up this research. Finally I would like to thank my parents, Sheila and Alan, who taught me the value of education, encouraged me to read voraciously, and who lit the fire of lifelong learning within me a long time ago.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF IMAGES

All photographs are authors own work

LIST OF ABBREVIATIONS

AMI	Association Montessori Internationale
AR	Action Research
ARC1	Action Research Cycle 1
ARC2	Action Research Cycle 2
ARC3	Action Research Cycle 3
CF	Critical Friend
CL	Curriculum Leader
CPD	Continuing Professional Development
DES	Department of Education and Skills
DCYA	Department of Children and Youth Affairs
DCEDIY	Department of Children, Equality, Disability, Integration and Youth
ECCE	Early Childhood Care and Education (specific to the Government funded Preschool Programme since January 2010)
ECEC	Early Childhood Education and Care (generic)
ECECS	Early Childhood Education and Care Setting
ECERS-R	Early Childhood Environment Rating Scale – Revised
ECERS-E	Early Childhood Environment Rating Scale – Extended
ELC	Early Learning and Care
EPPE	Effective Pre-school and Primary Education studies
ESL	English as Second Language
EY	Early Year's
EYT	Early Year's Education
EYTI	Early Year's Education Inspectorate
EYM	Early Year's Mathematics
EYMT&L	Early Year's Mathematics Teaching and Learning
EYFS	Early Year's Foundation Stage (England's EY Curriculum)
EYT	Early Year's Teacher
EYTT	Early Year's Teacher Training
EYMLEAT	Early Year's Mathematics Learning Environment Audit Tool

MA	Maths Anxiety
MEd	Master in Education (Research in Practice)
MKO	More knowledgeable other
MMR	Mixed Methods Research
NCCA	National Council for Curriculum and Assessment
OECD	Organisation for Economic Cooperation and Development
PISA	Programme for International Student Assessment
PMC	Primary Mathematics Curriculum
REMA	Research Based Early Mathematics Assessment
REPEY	Researching Effective Pedagogy in the Early Year's studies
SAC	School Aged Childcare
SSAR	Self Study Action Research
SST	Sustained shared thinking
STEM	Science, Technology, Engineering and Mathematics
STEAM	Science, Technology, Engineering, Art and Mathematics
TRJ	Teacher Reflective Journal
ZPD	Zone of proximal development

NB All children and teacher's names used in the thesis are pseudonyms.

CHAPTER 1 INTRODUCTION

1.0 INTRODUCTION

This chapter gives an introduction to this Self Study Action Research (SSAR) project. The overall research question is **"How can I as Curriculum Leader enhance the teaching and learning of mathematics in the ECCE classrooms of my early year's setting for children aged 3-5 year's?"** The focus and aims of the study are explained, as are the researcher's ontological and epistemological values as a basis. Research background, context and participants are described. Action research interventions and data collection are explained. Findings and recommendations are given. Further questions arising as a result of this study are posed.

1.1 FOCUS AND AIMS OF THE STUDY

In Ireland, the Department of Education and Skills, (DES 2011: 8) defines numeracy as encompassing "*the ability to use mathematical understanding and skills to solve problems and meet the demands of day-to-day living in complex social settings".* The aim of this research study was to discover how a curriculum leader (CL) in an early year's education and care setting (ECECS) could influence the early year's numeracy and mathematics teaching and learning (EYMT&L) in a positive way. After reviewing the literature and reflecting on numeracy in the setting, I identified several ways of enhancing the teaching and learning of early year's mathematics for preschool children aged 3-5 year's. This was approached via various interventions -the environment, continuing professional development (CPD) for the early year's teachers (EYT's); and by educating and supporting the parents.

This research study was carried out using the research paradigm of Self Study Action Research (SSAR). This is a critically reflective approach to one's own work based heavily on personal values (McDonagh et al, 2020). I am a scientist; my first Bachelor Degree was a BSc (Hons) and I followed a science and business career for 20 years before entering early year's education. My first exposure to education as an academic subject was in the Froebel Department at Maynooth University. Here I discovered I had an affinity with the teachings of Friedrich Froebel (1782-1852) and was drawn to his "gifts" of educational toys, which are very mathematic. I also value play, collaboration and social construction of knowledge, and this fits in with theories around how children learn mathematics. Hersh (1997) defines mathematics as being a human, social and cultural activity, with roots in our history. Zevenburgen et al (2004) see mathematics as a way of understanding our world, and a useful study for its own value. Dunphy et al (2013) believe young children learn mathematics through several social cognitive processes – connecting, communicating, reasoning, arguing, justifying, representing and problem solving. Importantly, mathematic skills and abilities predict later cognitive abilities (Duncan et al, 2007, Clements and Sarama, 2014). Early mathematics ability is a better predictor of later reading achievement than early literacy ability (Duncan and Magnusson, 2011).

1.2 Research Background, Context and Interventions

During the Covid-19 pandemic in the Summer and Autumn of 2020, I found I had to work in the ECCE classrooms in my setting as a teaching assistant, as we were short staffed. I had to get on the floor with the young children and teach. This is when I realised that I had been acting as a "living contradiction" (Whitehead, 1989). In the classrooms I found that the mathematics play and learning was not to a standard I wanted it to be, and had believed it to be. When I investigated, I realised the classrooms were insufficiently resourced for mathematics, and found the teachers were not confident in their subject knowledge of early

year's mathematics (EYM) to carry out early year's mathematics teaching and learning (EYMT&L) as part of the curriculum. The idea for my research was born. I noted in my Teacher's Reflective Journal (TRJ) in early September 2020:

"Another day working in the senior preschool; I am surprised today by the lack of mathematical displays in the classrooms, and when I asked Audrey why, I was told she didn't know why they weren't doing more maths artwork and displays, but that she didn't believe it was necessary. I was disappointed. I feel I will have to educate the teaching team on the importance of maths to children's overall learning and development" (O'Dwyer, 2020).

Qualitative and quantitative data was collected and analysed before and after the interventions were carried out. After analysis of all the data, the findings can be summarised:

- Children benefit from knowledgeable teachers guiding their mathematical play activities in a rich mathematical classroom environment.
- Currently, the training of mathematics subject knowledge for teaching mathematics in the early years is inconsistent to non-existent.
- Children benefit from everyday mathematics education in their home setting.
- A substantial proportion of early year's teachers (EYT's) still have maths anxiety from their own experiences of learning mathematics at school.

1.3 Potential Contribution of the Study

According to McDonagh et al (2020), by articulating findings of self-study action research (SSAR), teacher researchers can make a claim to new knowledge. By making meaning from the findings, and by garnering insights from data analysis, evidence is provided for this "new knowledge". This knowledge is important in the immediate context – where the research was carried out. As a result of this study, in my setting, we now have a bespoke mathematics curriculum. We have a body of training material for continuing professional development (CPD) of any new teacher's joining our team. We have a range of support materials we can use with parents to help them help their children learn. Thus the

potential of this study is to set the children attending the setting – now and in the future – on a positive course of mathematics skills, abilities, knowledge and confidence which will support success in later learning and life

However, it is also important to remember that teacher educators operate in a wider arena than their own immediate context, and should share new knowledge with the educational establishment, via publications; by speaking at relevant conferences. There is little published Irish research in the area of early year's mathematics. Timing is important when considering potential contribution of research. Currently the updated version of the original Primary Mathematics Curriculum (NCCA, 1999) is available in draft format (NCCA, 2020) for consultation, and is due to be launched in 2022. Aistear (NCCA, 2009) is about to be revised. The findings of this SSAR could add knowledge to the processes involved in reviewing these two important documents to support early year's mathematics teaching and learning (EYMT&L) for young children in Ireland.

1.4 FORMAT OF THE STUDY

This thesis is made up of 5 chapters. In Chapter 2, The Literature Review, there is critical analysis of Irish Policy for early year's mathematics. The chapter goes on to look at the importance of mathematics; how children learn; and the characteristics of quality early year's mathematics teaching and learning. There is some analysis of the Irish early year's teacher training, and a review of mathematics anxiety. Links are made between teacher knowledge, parental input and improved outcomes for children. The chapter finishes with a summary.

Chapter 3, Methodology, reviews research paradigms and explains my final choice; and outlines research carried out in the three action research cycles (ARC1, 2, 3). Methods of data collection are explained, and their choice justified. Quantitative and qualitative data

collection and analysis are discussed, and finally this chapter ends with a rigorous review of ethical guidelines followed.

Chapter 4 analyses the data collected and extrapolates findings attributable to the data. I analyse the new knowledge created by this piece of research; and how that has affected my practice and that of my early year's teachers involved, and how a change in our practice has positively impacted the children.

Chapter 5 is the final conclusions and recommendations chapter. This is where I relate my findings to the research question. I discuss transformative change within the setting; implications for the wider early year's sector, including for academia and policy writers involved in the setting of curricula for early year's mathematics, and finally ask further research questions that have arisen as a result of carrying out the study.

1.5 Summary of Chapter 1 - Introduction

This chapter has described early year's mathematics and the importance of this subject to cognitive development for all young children. It has outlined the study undertaken and the written thesis. The next chapter will review published literature, policy and research on the topic; how best to teach it; how to set up our classrooms; how we in Ireland train our early year's teachers, the value of knowledgeable educators and engaged parents for EYMT&L.

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews current literature to help answer my research question **"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?"** It examines Irish EYM policy, looks at what EYM is and why it is so important; investigates the research which explains how young children acquire EYM skills, processes and knowledge; and describes the characteristics of effective EYM teaching. It will continue by critiquing how EYT's in Ireland are taught to teach EYM. It will finish up considering research which demonstrates positive links between EYT subject knowledge and outcomes for children, the role of parents as primary educators; and concludes with a summary.

2.2 IRISH POLICY TO SUPPORT EARLY YEAR'S MATHEMATICS

In this section I will critique the Irish Policy landscape for supporting EYMT&L. Within Ireland, most policy documents guiding the care and education of young children arise from policy developed 30 years ago. These include ratification in 1992 of the *United Nations Convention on the Rights of the Child* (UN 1989); then Section VII of *The Childcare Act* (Government of Ireland, 1991) and the launch of the White Paper *Early Childhood Education, Ready to Learn* (Government of Ireland, 1999). In terms of our duty to care for young children, the Preschool Regulations were first introduced in Ireland in 1996; revised in 2006 and further revised in the *Child Care Act 1991 (Early Year's Settings) Regulations 2016* and the *Child Care Act 1991 (Early Year's Settings)(Amendment) Regulations 2016* (DCYA, 2016).

Regarding quality ECEC, two revolutionary sets of guidelines were then developed. The Early Childhood Quality Framework, *Síolta* (CECDE, 2006) was developed as a result of these earlier legislative measures and because of a growing need in society for quality childcare. Following on from Síolta was the introduction of *Aistear*, national curriculum framework from birth to 6 year's (NCCA, 2009). These two sets of guidelines hold a valuable and important position in the development of quality educational offerings in all settings educating young children in Ireland. They are world class and sit comfortably amongst similar offerings from many international countries, for example when compared with the English EYFS (Early Year's Foundation Stage curriculum) (DfE, 2008) or that of the Te Whãriki curriculum of New Zealand (Ministry of Education, 1996).

When we read these many Irish policy documents to discover where the EYMT&L policy guidelines are, they are hard to find. Within Regulation 5 of *The Childcare Act* (Government of Ireland, 1991) there are implicit teaching guidelines within section 3 and 4 of Regulation 5 - that young children in ECEC settings should be exposed to diverse and enriching play experiences leading to development of problem solving skills and abilities. No explicit EYM guidelines are given.

Looking at *Síolta* (CECDE, 2006), there are 12 Quality Principles which give the guidance for quality practice in ECEC in Ireland. These are broken down into 16 *Standards* and *Components*, which clearly define quality ECEC practice under each of the headings. The Standards related to EYMT&L include those of the Environment, Interactions, Play and Curriculum. Within these, there is reference to the environment being correctly set up for learning and development; to the types of interactions required for learning and development; reference to the quantity and quality of play engaged in by children in the ECEC setting; and to the requirement for a Curriculum Policy within the ECEC setting; which should follow the child's lead and inquiry in order to facilitate the individual child's

learning and development. There is, however, no explicit guidance regarding quality play related to numeracy and/or mathematics.

In the curriculum framework, *Aistear* (NCCA, 2009) there are more explicit curriculum guidelines, organised into curricular themes, aims and learning goals. The 4 over-arching themes are: Well-being; Identity and Belonging; Communicating, and Exploring and Thinking. The four themes have Aims and Learning Goals which relate to the teaching and learning of EYM, however are situated in the concept of learning and teaching holistically. The most explicit theme related to EYM is the Exploring and Thinking Theme, with 4 Aims, and several mathematically explicit learning goals. These are given in Appendix 1.

The next policy document reviewed results from Ireland's membership of the Organisation for Economic Cooperation and Development (OECD). Ireland helped found the OECD in 1961. As a member, we subscribe to be measured educationally as part of PISA (Programme for International Student Assessment) studies (OECD, 2021). The rationale behind these studies is to measure and record data allowing all subscribing countries rate their educational policy via children's educational outcomes. Assessment is done on 15 year old children, measured against previous year's' results, and against other countries results. This enables baseline, trend and policy data to be reviewed and acted upon. Literacy, mathematics and science knowledge skills and competencies are measured at every cycle (triennially since 1997).

As a result of poor academic results for Irish students in 2009 PISA (OECD, 2010), the Government launched a Strategy Document *Literacy and Numeracy for Learning and Life 2011-2020* (DES, 2011) - a national strategy to improve literacy and numeracy for children and young people. This document explicitly considered the teaching and learning of mathematics in the early years of children's lives. A claim was made:-

"Improving literacy and numeracy standards is an urgent national priority for the Minister for Education and Skills and the Government" (DES, 2011: 14).

The aim was to improve the communication and oral-language competence of young children in ECEC settings, and develop their readiness for early mathematical language and ideas. The strategy document set clear targets for raising national literacy and numeracy standards within the 6 pillars of the national education system:

1. Supporting parents/communities to support children's development across these 2 domains
2. Improving teachers and ECEC practitioners professional practice
3. Building capacity of school leadership
4. Improving curriculum
5. Helping students with additional learning needs to achieve to potential
6. Improve current assessment/evaluation

A review of this 2011 document was carried out – *The Interim Review 2011-2016, and New Targets 2017-2020* (DES, 2017a). This demonstrated that many of the literacy targets have been reached, and indeed surpassed, whilst several of the numeracy goals are still to be reached. Specifically for ECEC, the up skilling of EYT's was recognised as an issue in this review. The nature of ECEC provision in Ireland with a low paid workforce comprising 25% graduates only (POBAL, 2019) and the private provision of ECEC, alongside lack of non -contact time and low training budgets were seen as some of the concerns in the 2011 report. Many of these issues have still not been addressed in 2021 (SIPTU, 2021, Early Childhood Ireland, 2021).

It was recognised in the original 2011 publication and the later review of this policy document that a review of the Primary School Mathematics Curriculum (PMC) (NCCA, 1999) was long overdue. Two research reports were commissioned by the NCCA to address this required overhaul. The first was *Mathematics in Early Childhood and Primary Education (3-8 year's) – Definitions, Theories, Development and Progression Report no. 17* (Dunphy et al, 2013); and the second *Mathematics in Early Childhood and Primary*

Education (3-8 year's) Teaching and Learning - Report no. 18 (Dooley et al 2014). Both of these papers were strongly supportive of the importance of EYM in preschool settings; of the transition of this knowledge from preschool to primary school, and how that could be best achieved. The existing PMC (NCCA, 1999) has no mention of the importance of EYM in the preschool setting or the transition of that knowledge into the primary school setting for the child. There *is* mention of this in the new draft *Primary Mathematics Curriculum (for Junior infants to Second Class)* (NCCA 2020) – suggesting the new primary curriculum should build on what children bring to primary school from their Aistear experiences in preschool; and it foregrounds an integrated approach to all curriculum areas. It points to mathematics being treated as one of the 5 new curriculum areas alongside science and technology (a STEM approach) and that children should be encouraged to "be mathematical" in all aspects of life. This new draft mathematics curriculum is a framework with learning outcomes based on contemporary educational research unlike the detailed content objectives based PMC of 1999 (DES). There is a continuum based guide to assessment and teaching. It is a curriculum framework much more in line with Aistear, however does not seem to include the preschool years as part of the overall curriculum approach. This is a consultation document, and has been delayed by the Covid-19 pandemic.

Early year's mathematics and educational Policy in Ireland also continues apace - in 2015, a new Early Year's Education Inspectorate (EYTI) was set up within the DES. Their remit has been to develop and utilise inspection tools to assess the quality of early year's education that is being carried out in ECEC settings. The inspector observes the processes and practices relating to children's learning in ECCE classrooms in the ECEC setting. The associated documentation (DES, 2018) is completed and reported online for public access. Within this document, the quality of the educational provision is very much measured against guidelines from Síolta (CECDE, 2006) and Aistear (NCCA, 2009).

Also recently, the *STEM Education Policy Statement* (DES, 2017b) and the *STEM Education Implementation Plan 2017-2019* (DES, 2017c) have been launched. These arose as a result of an ambitious governmental target for Ireland to become the best education and training setting in Europe by 2026, articulated in the then governments *Action Plan for Education 2016-2019* (DES, 2016) by the Minister for Education, Richard Bruton. This policy foregrounds early year's education in the STEM subjects as essential to achieving the results we need to meet the technological requirements of a country performing in a technological world.

So where is Ireland now in terms of performance across the worlds' educational stage? The latest PISA test results from 2018, analysed by McKeown et al (2019) showed a return to our historical levels of educational results for mathematics, reversing the downward trend that had concerned academia and government in Ireland since the 2009 PISA results. In 2018 however, Ireland still only rated 16th out of 37 OECD countries for mathematics, with a lower percentage of high achievers than should correspond with this ranking. There is still work to be done if the PISA 2027 results are going to come up to Mr Bruton's high expectations of the best education and training system in Europe.

The most recent relevant policy document of note for EYM teaching is that of the newest early year's strategy document. This is the Government of Ireland (2018) *First Five: A Whole-of-Government Strategy for Babies, Young Children and their Families 2019-2028.* Within the implementation plans for 2019-2021 is an overarching goal of Positive Play-Based Early Learning across all settings used by children – home, parents, child-minders and both private and community ECEC settings. This contains some important action plans, including plans for aligning the new primary school curriculum with Aistear; developing consistency of curriculum and pedagogy between primary school and ECEC settings; higher level inter-departmental collaboration between DES and DCEDIY and NCCA; reviewing

Aistear and Síolta; aims for a graduate-led workforce made up of 50% graduates; and agreed criteria and guidelines for further and higher education ECEC qualifications.

Although all these policy and strategy documents have been important as drivers for the development of Early Year's curriculum, with the exception of Aistear, none of these documents have specific or *explicit* guidelines of how EYT's should actually teach early numeracy and mathematics to young children. McCauley Lambe (2021) argues for the inclusion of subject knowledge in initial early year's teacher training, similar to that of our primary teaching counterparts. Also of note – in Ireland, ECEC is chronically underfunded at only 0.2% of GDP against an OECD average of 0.8% (OECD, 2019). It will be interesting to discover whether Budget 2021/2022 allocates a more equitable and realistic amount of financing to the sector to really move the action plans within the 2018 First Five strategy document forward.

2.3 WHY IS EARLY YEAR'S MATHEMATICS IMPORTANT; AND WHAT EXACTLY IS IT?

There is a growing awareness of the importance of mathematics; for individuals; the economy and for society as a whole. In parallel, there is a developing realisation of the importance of the early childhood period for the acquisition of the foundations of mathematic skills, knowledge and abilities. Young children engage with mathematic principles every day, in their homes, their communities and their pre-schools. It is not something that is learned only when they reach school going age – young children are thinking mathematically from the moment they are born (Ginsburg, 2006).

There are political reasons why numeracy and mathematics have been placed high on government's agendas, in Ireland as well as many other countries. Mathematic success of the nation's citizens links to labour market success (Rose, 2006; Ritchie and Bates, 2013) and consequently economic success for the country. Ruairi Quinn, Minister for Education,

in his introduction to the *2011-2020 Literacy and Numeracy Strategy for Children and Young People (DES, 2011)* cited a social justice and equity rationale as a driver for the development of this mathematics linked strategy document. As discussed earlier, this policy document was developed as a response to poor PISA results (OECD, 2010). Dunphy et al (2013) agree, and argue that mathematical ability is powerful, and generally endows those who are good at it with financial success – in this report they cite studies which show that ethnicity, gender and social class can impact on mathematics success – or lack of – and thus many are denied this power (Secada, 1995; Ernest, Greer and Sriraman, 2009; Miller and Warren, 2014).

Importantly, mathematic ability has been demonstrated to be an important predictor for later academic ability – it appears to be a core component of cognition (Duncan et al, 2007). Mathematics skills and abilities predict later mathematics ability, AND later reading, whilst early literacy knowledge predicts later reading ability *only* (Duncan and Magnuson, 2011; Clements and Sarama, 2014). The mathematic abilities children have when they start formal school are the strongest predictors of later achievement in their school journey (Duncan et al, 2007; Claessens et al, 2009; Watts et al 2014; Watts et al 2016). These research findings have driven much of the policy and strategy behind development of many specific mathematic curricula for children of preschool age in the USA (NAEYC & NCTM, 2002; NMAP, 2008). In Ireland however, although cogniscence has been given to these studies (Dunphy et al, 2013; Dooley et al 2014), the direct development of an EY mathematically focused curriculum has not happened. In Ireland, the holistic nature of the curriculum framework, Aistear (NCCA, 2009) embeds mathematical teaching and learning within the entire early year's curriculum framework. It does however rely on the EYT having the subject knowledge and confidence to be able to extend a child's interests in order for the EYMT&L to occur.

Moving on to understand what actually EYM is, and indeed what numeracy is, and how the two are intertwined. There are various definitions of mathematics. If we use Hersh's (1997) definition, we find that he holds a socio-cultural, democratic view. He defines mathematics as a human, social, cultural activity with roots in our history. Zevenburgen et al (2004) see mathematics as a useful study in its own right, as well as a way of understanding the world. Mathematics is a great equaliser - all children have the ability to solve mathematic problems and think mathematically (Ginsburg, 2009). I agree with all these theorists that mathematics is all about democracy, equity, access and inclusion – mathematics is for everyone (Bishop and Forganz, 2007). These definitions fit in with my own values.

The UK National Numeracy charity states that numeracy skills are often not taught in the classroom, and numeracy relates to problem solving skills using numbers. It describes having numeracy knowledge as having the confidence and skills to use mathematical approaches, and that numeracy is equally important as literacy (NN, 2020). Education Scotland (2020) state that numeracy is a life skill and an area which supports all areas of learning. Young children need to begin to learn numeracy and mathematical skills for later life, when they will be expected to know how to use number processes, how to estimate, manage fractions and percentages, manage time and money, use measure, and gather data and information from charts. The South Australian Government Department for Education website (2020) gives a definition of how children become numerate – by exploring mathematical ideas, problem solving, investigating space, structure, pattern, number, measure, and data and its connections. A mathematical confidence is developed as children explore these concepts with parents, carers, families and friends.

In Ireland the DES (2011: 8) defines numeracy as "*the ability to use mathematical understanding and skills to solve problems and meet the demands of day-to-day living in complex social settings".* In order to do this, young children need to be able to think and communicate in number or quantity, often in the abstract; they need to learn how to

rationalise numbers and data; to be spatially aware, including shape recognition and use of measure; to be able to recognise sequencing and pattern; and to be able to readily understand and deal with data, using mathematical knowledge and logic to solve problems. This definition was broadened in the *DES Interim Review* (DES, 2017) to include knowledge of the use of estimation and prediction; ability to use investigating and reasoning skills, and use of digital technology to assist numeracy skills and understanding.

For the purposes of this SSAR project, I have alluded to all aspects of numeracy and mathematics as mathematics; which includes the content knowledge linked to the 5 domains (number and counting; geometry; measure; shape and space and pattern) plus the processes required for mathematical thinking. According to Dunphy et al (2014) this includes proficiency in conceptual understanding; fluency in procedure; competence in strategy; adaptive reasoning and productivity. They believe children learn mathematics through connecting, communicating, reasoning, arguing, justifying, representing, problem solving and generalising – all socio-cultural learning approaches. By engaging with these key processes, children interpret and express their everyday experiences in a mathematical way (Ginsburg, 2009).

2.4 HOW DO YOUNG CHILDREN LEARN EARLY NUMERACY AND MATHEMATICS?

There is evidence that humans as a species are born with innate mathematical capabilities including quantity and basic geometry (Geary, 1994; Gelman, 2000; Ginsburg, 2006). Starr et al (2013) agree - within the first few days of life and certainly within the first year, babies can differentiate between quantities; discriminate between shapes; show interest in solving problems; and seek out and enjoy looking at different patterns. These early

mathematics skills help with acquisition of numerical symbols, mathematic ability; and predate language ability.

Dunphy et al (2014) utilise insights from sociocultural, cognitive and constructivist theorists to explain both individual learning and group pedagogy for mathematics education. They take a stance that learning mathematics is an active process for young children, encompassing meaning making; understanding; an ability to participate in complex ways; and cite Lave and Wenger's (1991) theory of development of a person's mathematical identity, and the effective use of key mathematic tools – language; symbols; materials and images. They go on to describe how individual learning is supported by a community of learners, advocating for the use of small group and whole class activities, and that the EYT should proactively create a "Zone of Proximal Development (ZPD)" (Vygotsky, 1978); co-constructing meaning with the child – sometimes explained as sustained, shared thinking (SST) which emerged from the EPPE (Melhuish et al, 2008) and REPEY studies (Sylva et al, 2010) between child and educator. SST is defined as *"two or more individuals working together in an intellectual way to solve a problem, clarify a concept, evaluate activities or extend a narrative"* (Sylva et al, 2010 p157). Wood (2013) affirms that SST has developed into a recommended form of pedagogy which supports effective teaching and learning practice in the early years.

The cognitive, constructivist and sociocultural perspectives all recognise the importance of language for the development of numeracy and mathematical knowledge, and point to "mathematics talk" as a key tool to learn mathematics (Sfard, 2007). The quality and frequency of mathematics talk by carers, teachers, parents - "more knowledgeable others (MKO's)" - will improve children's mathematics development (Klibanoff et al, 2006). This includes using mathematical vocabulary at every opportunity; engaging in discussions about mathematical thinking, reasoning and logic, which can be planned or unplanned, and should include activities such as storytelling, using stories with mathematical ideas, reading (all

books but especially books with mathematical themes), reciting rhymes and poems, and singing mathematically related songs.

Piaget's (1952) ideas of stages in development of mathematical learning have been more recently replaced by ideas around developmental learning paths or learning trajectories (Sarama and Clements, 2009; Daro et al, 2011). Clements and Sarama (2014) have carried out much research into numeracy and mathematical teaching and learning in early education in the USA in the last 20 years in ECEC settings. They found that young children can engage deeply with mathematical concepts in a self-motivated and natural way; they love to think mathematically; and are excited by mathematics. Clements and Sarama (2014) strongly believe that to educate the whole child, we must educate the mathematical child. Importantly, a vast amount of young children's' mathematical knowledge is gained pre-Kindergarten (Kindergarten in the USA is equivalent to Junior Infants class in Ireland – children aged five year's old) which is also related to their mathematics learning for years hence (NMAP, 2008) which foregrounds the requirement for high quality numeracy and mathematics education in Irish early year's settings.

Clements and Sarama's trajectory theories (2009; 2014) state that children follow natural developmental progressions in learning and development. These developmental paths are a main component of a learning trajectory, and give educators a basis to measure mathematical development, and thus match children's learning needs to curriculum. A criticism of this type of theory is that they can be linked to "normative development" and it is now well known that there is no such thing. There is no "set" path – children develop their understanding of different mathematical concepts in a myriad ways. However these trajectories concepts fit in with sociocultural perspectives to the acquisition of mathematics related skills, knowledge and abilities, as children engage in sustained, shared thinking with their MKO's when engaged in mathematics and numeracy rich activities, and in mathematics rich environments.

Finally when looking at children's learning, we must look at assessment of and for learning. Formative assessment is seen as most useful to give a picture of young children's learning (Carr and Lee, 2012) and teachers can utilise these strong conceptual frameworks to support them recognising significant learning occurring. A range of methods can be useful – observations, interviews, conversations, learning stories, and use of digital technologies e.g. audio/video recordings are all helpful. Teachers should include children's own perspectives on their learning (Carr and Lee, 2012).

Thus the development of mathematics expertise starts in preschool, and this expertise develops over time in educational settings. EYT's need to be able to develop strong and effective pedagogical practice which engages young children in high quality mathematical experiences, within a clear curriculum, and be able to measure progress in the key areas (Dooley et al, 2014). Principles that underpin good mathematics pedagogy are discussed in the following section.

2.5 WHAT ARE THE CHARACTERISTICS OF EFFECTIVE EARLY MATHEMATICS TEACHING AND LEARNING?

Ginsburg (2009: 403) theorises there are 5 ways we can teach children the big mathematical ideas in the preschool setting for children aged 3-5 year's. These include:

1. Management of the environment
2. Playful teaching and learning
3. Making use of "teachable moments"
4. Using project based work in the classroom
5. Developing an effective mathematics curriculum

2.6.1 The environment:

The EYM environment must be well resourced, and importantly, accessible to children (Cotton, 2019; Ginsburg, 2006; 2009). Important equipment for mathematics learning environments include blocks, measuring equipment, water table, sand play, puzzles, counting and sorting equipment. Visuals of numerals and a number line are essential in a preschool environment (Stafford, 2012). Role play equipment allowing imaginative games around the concepts of shopping and other home-based and community role play ideas; as well as access to baking and cooking food, play dough, gloop, clay and other manipulative materials are all positive factors (Cotton, 2019). EYT's can assess various audit tools and measure the effectiveness of their classroom environment – for example, a tool provided by Northamptonshire County Council (2017) to their Early Year's centres; and the Aistear Síolta Self Evaluation Tool (NCCA, 2020).

2.6.2 Play:

We cannot discuss how children learn mathematics without discussing the learning that happens during play (Seo and Ginsburg, 2004; Ginsburg et al, 2008). Play is recognised as important for cognitive development as well as social and emotional regulation (Kernan, 2007; Milteer et al, 2012; French, 2013a). EYT's need to understand how engagement in play, in rich mathematical environments, supports mathematical learning for young children; and also how best to support this learning. There is much evidence to support playful learning and education for children of all ages, and especially in the early years (CECDE, 2006; French, 2007; Ginsburg, 2009; NCCA, 2009; Clements and Sarama, 2014). Early play experiences such as block play, imaginative role play, use of sound, pattern, rhythm and repetition; their awareness of numerical symbols, water and sand play, mark-making materials, manipulative materials, shape, space, pattern and difference, classifying, matching, comparing and ordering are important for the development of numeracy. A range

of skills are developed by exposing children to story books with mathematical themes, nursery rhymes, pictures, objects to compare, measure and count can all be playful, enjoyable and help children learn mathematical concepts. Through meaningful and timely interventions, the educator supports children to build their understanding of numeracy through natural play experiences in their day to day lives (McMonagle, 2018). Ginsburg (2009) cautions that EYT's must observe play carefully, to observe sophisticated mathematical concepts being used by young children, and need to "scaffold" children's learning in order to 'mathematise' the play – which requires recognition of the 'teachable moment'. This requires knowledge and confidence (Cotton, 2019) Activities should be spread across the entire play spectrum, and be led by the child's curiosity (NCCA, 2009). Attention should be given to the 5 mathematic content domains – number and counting; data; measure; shape and space; and pattern (Pound, 2006; Pound, 2008; Montague-Smith et al, 2018; Cotton, 2019).

2.6.3 THE TEACHABLE MOMENT:

Ginsburg (2009) argues that effective use of teachable moments (Copley et al, 2007) – observing a child's interest in mathematical ideas and capitalising on this interest to teach further mathematical knowledge – is actually very difficult to do in real world early year's settings. He also states, and I would agree, that many EYT's are just not trained to recognise these moments and/or have insufficient mathematical knowledge to capitalise further on them He feels these teachable moments are not viable educational strategies for teaching EYM.

2.6.4 PROJECTS:

Project based works, as favoured by the Reggio Emilia approach (Edwards et al, 1993) are an adult initiated and guided study of the everyday world, and can be seen as useful

vehicles to teach mathematic concepts and principles within the early year's classroom. I would argue they tend to be adult led, and therefore the rights of the children to follow their own inquiry led curriculum are impinged upon. EYT's need more guidance on how to fit their mathematics and numeracy teaching to the learning trajectories of the children in their class. Here is where a mathematics curriculum can be helpful.

2.6.5. Curriculum:

A curriculum is a written set of instructions and materials to guide students' acquisition of concepts. For mathematics curriculum, the sequence should be based upon the knowledge of children's mathematical learning trajectories. Dunphy et al (2013) argue that mathematics curriculum goals need to reflect the underlying theories, and reflect on processes which improve and develop children's mathematical knowledge, logic, and reasoning; and support children identifying as mathematicians (Perry and Docket, 2008).

2.6 Early Year's Teacher Training in Ireland

The EY workforce in Ireland is made up of variously qualified EYT's, and still some 6% are "non-qualified" practitioners (POBAL, 2019). These qualifications range from a QQI Level 5 (equivalent to a Leaving Certificate) to a Level 9 (Doctoral Degree). The makeup of the workforce by qualifications is as follows (POBAL, 2019):-

- EYT's educated to degree level (QQI Level 7 equivalent) or higher = 25%
- EYT's educated to QQI Level 5, 6 or no qualifications =75%.

For mathematical teaching proficiency, teachers need to be mathematically confident and proficient themselves (Dooley et al, 2014; Cotton, 2019). Dooley et al (2014) go on to

say that initial training courses should provide ways for EYT students to learn mathematics through collaboration, in rich mathematical environments; and practice placements which allow them experience of recognising children's mathematic engagement and concept development; mathematical and numeracy play; and practice at assessing mathematics learning in a formative way.

Early Year's Teacher Training (EYTT) courses vary in their coverage of teaching mathematics subject knowledge for EYT's. Within the Level 6 qualification there is an optional module in numeracy and literacy (Early Childhood Literacy and Numeracy, QQI specification 6N1935). Within this Module Component Specification set by QQI, only 50% of the requirement is numeracy based. It is hard to assess how many EYT's practicing in Ireland have studied this module. EYT's qualified through the graduate route only may well have studied numeracy as a module/part module – for example the BA Early Childhood Teaching and Learning (part-time) at Maynooth University includes a distinct Literacy and Numeracy Module. However, as McCauley Lambe (2021) argues, content knowledge is seen as essential to primary teacher training – why is it not seen as essential to EYTT? It would give EYT's the knowledge and confidence to extend children's learning and facilitate their development. The EYT needs content knowledge across all areas of the curriculum – literacy, numeracy, music, art, science, the environment, spirituality, physical play – EYTT should provide support for EYT students to access relevant content in order they can fulfil the highly skilled and complex task of meeting young children's varied learning needs (McCauley Lambe, 2021).

2.7 Mathematics Anxiety

I agree with Ginsburg (2009), who feels there is a fear of mathematics, and that many EYT's in the U.S. do not like teaching mathematics. Cotton (2019) feels that EYT's are not confident enough in their own mathematical knowledge to challenge young children's

mathematical thinking and/or understand mathematical development. I would agree there is a similar situation in Ireland, and that EYT's require to be further trained in this curriculum area. According to Hembree (1990), mathematics anxiety as a phenomenon is an adverse reaction to mathematics and the prospect of doing mathematics. The concerns compromise working memory which in turn stymie the focus on the mathematics task (Maloney and Beilock, 2012). The ideal solution is to improve basic mathematical skills in order to prevent maths anxiety from happening in the first place.

2.8 LINKS BETWEEN TEACHER KNOWLEDGE AND IMPROVED OUTCOMES FOR CHILDREN

Well educated EYT's enhance learning outcomes for children (Sylva et al, 2010; French, 2013b; Hayes, 2017). Hayes (2017) argues that only by striving to achieve our own full educational potential can we hope to help children develop theirs. Well educated, competent and professional EYT's form part of a competent ECEC system for the nation's youngest children (Urban et al, 2011). Staff qualifications are shown in many research studies (e.g. EPPE, REPEY, SureStart) to significantly impact on high quality educational outcomes for children; and quality ECEC relies on the EYT's knowledge and understanding of what they teach, alongside a holistic approach to teaching.

2.9 PARENTAL INPUT TO CHILDREN'S MATHEMATICAL EDUCATION

Young children's mathematics education should be in the classroom, within the home and within the child's wider community (Sheldon and Epstein, 2005). Bronfenbrenner's bioecological systems theory (1979) recognises the influence of the child's parents as well as the school on their academic and social development. Vygotsky's sociocultural theory (1978) recognises the importance of the MKO – a mentor - which is often the parents, although can be grandparents or an older sibling. Huntsinger et al (2016) argue that parental attitudes and parent-child experiences significantly affect academic

development. Research shows parent's home mathematics practices relate to children's mathematics outcomes (LeFevre et al, 2009; Kleemans et al, 2010; Hart et al, 2016). The parents' role is important in EYM.

2.10 SUMMARY OF LITERATURE REVIEW

Within this Literature Review I have reviewed current literature in order to help answer my research question **"How can I as curriculum leader improve the teaching and learning of numeracy and mathematics in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?"** Policy in Ireland affecting EYM is reviewed in detail, with a look at the latest STEM policies (DES 2017a; 2017b) and the imminent revamp of the PMC (DES, 1999) and Aistear (NCCA, 2009). I have explained what numeracy is and why it is so important. I investigated the research which explains how young children acquire numeracy and early mathematics knowledge, skills and abilities; and described the characteristics of effective numeracy and early mathematics teaching. I critiqued how Early Year's Educators in Ireland are taught to teach early math and numeracy, and the phenomenon of maths anxiety. Finally I considered the research which demonstrates positive links between teacher knowledge and educational outcomes for young children.

CHAPTER 3 METHODOLOGY

3.1 INTRODUCTION

This chapter outlines and explains the choice of methodology used to answer the research question **"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's setting for children aged 3-5 year's?"** It explains the study rationale; the choice of research paradigm and the use of mixed methods (MM) research. The research context and study participants are explained. The chapter then goes on to outline the overall design of the study; interventions made, and choice of research instruments used. There is an explanation on how collected data was analysed; and how validity and credibility were maintained. Finally, ethical issues considered throughout are explained, and the chapter concludes with a summary.

3.2 RESEARCH RATIONALE

I am a scientist first and foremost. In school I studied 3 sciences at A-level - Chemistry, Physics and Biology, and went on to 3rd level education to gain a BSc (Hons) in Dietetics. As a child and teenager, and even as a young adult, I always felt I was poor at mathematics, and was not confident using mathematic principles. I progressed into a science and business based career for 20 years, before entering early year's education. I am now a successful early year's educator and business woman, and have run an ECEC setting and business for 20 years, yet I still have maths anxiety.

I do not want my negative mathematics experiences to impact on any child or staff member in my setting. As explained in Chapter 1, during the Summer of 2020 as we reopened after the Covid-19 pandemic, I observed the EYMT&L and felt I was a living contradiction (Whitehead, 1989). Whilst I valued a strong mathematics education for all students attending, I was not facilitating the early year's teachers to be able to deliver on this

value. The classrooms were poorly resourced for mathematics teaching and learning; and the EYT's were not supported with mathematics content and process knowledge to be able to teach children. I recognised that I had not paid much attention to the mathematics teaching and learning in these preschool classrooms in recent times, and that I really needed to address this area, both as curriculum leader and as part of the EYT team in my setting.

Developing the rationale further, when I began to research the area of early year's mathematics, I read many studies which show that learning outcomes in later life can be predicted by mathematics and numeracy knowledge at pre-school age (Duncan et al, 2007; Cohrssen & Niklas, 2019). I also reviewed research demonstrating that mathematics knowledge is a better indicator for later positive academic and life outcomes than literacy knowledge (Clements and Sarama, 2014). Thus, the rationale for the SSAR was born - to investigate how I could enhance the teaching and learning of early year's mathematics in my ECEC setting for preschool children.

3.2.1 My value system and Self-Study Action Research

An aspect of SSAR that really resonates with me is that it should be focused on the self, on teaching practice of the self, and should relate closely to one's values (McNiff and Whitehead, 2005). Thus by carrying out SSAR, one researches oneself, and gains opportunity to reflect upon, and to really live out one's values (McNiff, 2013). This realisation was the first reflection I recorded in my TRJ during the first 2 days of the lectures on the MEd (Research in Practice) in Maynooth University. *"This seems like an ideal opportunity for me to do what I believe in, whilst creating positive outcomes for children in my care; and whilst educating, encouraging and empowering the EYT's who work with me – living my best life!*" (O'Dwyer, 2020). McDonagh et al (2020) describe this sense of balance, contentment, professional and personal fulfilment as teacher well-being. McCallum et al (2017) argue that teacher well-being is of the utmost importance to the future of

education. This is because teaching is a value-laden occupation (Rose, 2013). Society demands that education improves it is citizens in many ways. Teachers are expected to educate citizens with knowledge and facts; inspire them to be creative; successful; economically self-sufficient, and to behave in morally correct ways. Teachers teach, very often due to a desire to do good; to make future generations happier, more successful, and to make the society they live in more democratic and equitable (Brookfield, 2017). I as a teacher am no different than others. I carry with me a range of personal, embodied values which inspire and motivate me to do what I do every day in order to improve the lives of the children that are taught in my ECECS.

As explained earlier, one of my educational beliefs is mathematics. I believe in mathematics for all as a basic democratic principle. I think no child should be left at a disadvantage educationally by not having a firm foundation of basic early mathematic concepts on their transition from the ECECS to primary school. My epistemological and ontological beliefs fall in with many of Froebel's (1782-1852) theories on learning and education (as cited in Manning, 2005). Froebel believed, and I concur, that children gain knowledge about themselves and their world through play; and he famously gifted children with toys (for example crocheted balls, different sized wooden building blocks, sand, clay, and paper for folding and cutting) in order to challenge children to construct and to experiment. Many of Froebel's gifts are linked to discovery of mathematical concepts (See Appendix 2, Froebel's List of Gifts).

Like Froebel, I also believe that discovery and inquiry are central to the learning process, hence the curriculum I lead within my ECEC setting is play based and inquiry led. Froebel believed in the importance of an adult guiding children's exploration and discoveries. Within this SSAR, the EYT's and the children will be seen as co-creators of mathematical knowledge, and I will be encouraging the EYT's to develop collaboration and cooperation between children; and between the children and themselves; to promote strong

social relationships and concrete opportunities for mathematics teaching and learning. I will encourage democratic principles so all children are able to learn at their own pace, and that learning will be a positive and non-coercive experience.

3.3 Research Paradigms

According to Kivunja and Kuyini (2017) one's *axiology* – concerns around values and ethics – need to be considered when choosing the methodology for research. Cohen et al (2018: 29) suggest the choice of methodology should be "*a complex, deliberative and iterative process"*. Your way of being in the world (ontological beliefs) and your views of knowledge and "the knowers" (your epistemological beliefs) should influence this choice (McNiff and Whitehead, 2006; Hitchcock and Hughes, 2016). By reviewing different paradigms, one can clarify and organise thinking about one's research (Lather, 2006; Cohen et al, 2018). I will look at 3 such paradigms - those of Positivist, Interpretivist and Action Research (Candy, 1989, cited in Kivunja and Kuyini, 2017) and discuss my choice of SSAR as my methodology.

3.3.2 Positivist Paradigm

This is a traditional approach to research; useful especially for science based, factual studies and is sometimes called the scientific method (Kivunja and Kuyini, 2017). The data that is collected is quantitative and generally collected from an external perspective. It is objective, and the theory generated can be well tested and be replicated in other similar studies (Capra and Luisi, 2014). Ions (1977, cited in Cohen et al, 2018) criticises this paradigm as dehumanising. According to McDonagh, (McDonagh et al, 2020: 126) a positivist approach to research of teaching would work if the researcher was looking for

"*verifiable facts, objective realities and absolute truths".* These were not my goals in this SSAR.

3.3.3 Interpretivist Paradigm

Cohen et al (2018) refer to this as a post-positivist paradigm, and it is viewed by some as a practical (Carr and Kemmis, 1986) paradigm. Lather (2006) asserts it is a more humanistic approach than the positivist approach. The data generated can be subjective (McDonagh et al, 2020) and tends to be qualitative. This type of research is usually externally managed – data collected by the researcher as an observer, not a participant (McDonagh et al, 2020). Meaning making is developed cognitively and informed by interactions with participants. However the researcher is still viewing externally, and generally does not change anything during the research, merely observes and interprets the actions of the study participants. I am clear I wish to make a positive change in my practice as part of my research, and this points to a methodology where I can be part of the research myself.

3.3.4 Action Research Paradigm

This approach is useful for educational and social science research (Cohen et al, 2018). One studies a situation in one's own realm of practice, sometimes called a concern (McDonagh et al, 2020), with the purpose of improving outcomes for the students or the users of the social settings. It is very much an approach based in working with people; the researcher is involved within the research process; and the research involves collecting qualitative data, although quantitative data can be useful. This approach assists teachers to develop personally and professionally, and to build theories of their practice (McNiff and Whitehead, 2005; Feldman, 2017).

AR involves (sometimes repeating) cycles of planning, acting (doing), observing and reflecting. Models have been put forward by the following theorists - Lewin (1946); Kemmis and McTaggart (1988). I will follow an Action Research Model similar to that of Whitehead and McNiff's Model (2006).

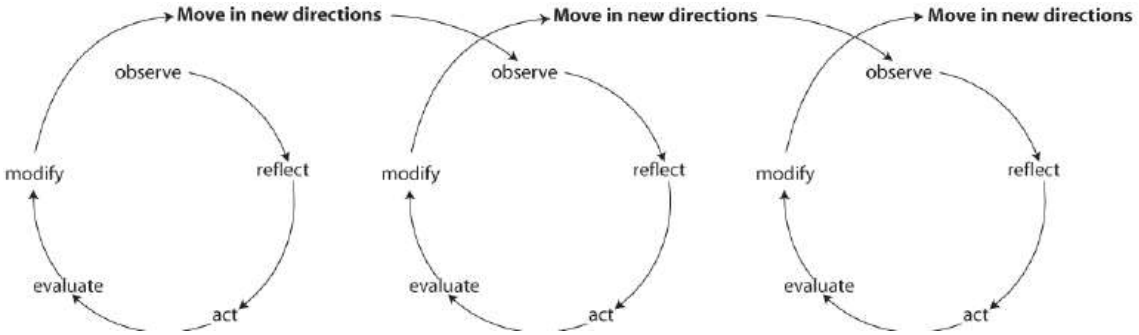


Fig. 3.1 Whitehead and McNiff Action Research Model (2006)

The findings of AR tend to be unique to the context of that research (Cohen et al, 2018). Because of this, according to McDonagh et al (2020) the results may often be unreproducible; the researcher will generate a theory or "new knowledge" based on findings within that context, which is a unique characteristic of the AR approach. There are several different AR methods – Narrative enquiry; Participatory AR; Practitioner Theory and the approach which I used, which is a Self-Study (SSAR) (Whitehead, 1989) approach. The researcher uses their findings to enhance their own future practice. Salient features of SSAR include that it involves research into one's own educational practice; is compounded in the desire for enhancing practice and includes the articulation of personal values as a starting point. The focus remains on the self in relation to others, and on one's own practice (McDonagh et al, 2020). As Whitehead explains it (2018: 1) *"How can I improve my practice (whatever it might be), and improve my own educational influence in my own*

learning and life, in the learning and lives of others, and in the social formations in which we live?" Thus researching our own practice using the SSAR method involves (Sullivan and McDonagh, 2020)

- Critically examining practice to discover where beneficial change is required;
- Developing plans to achieve the change
- Working methodically through the plan, keeping records of every stage
- Reflecting constantly on research process and documenting reflections
- Systematically collecting qualitative and quantitative data from a number of sources
- Analysing data through a number of lenses – personal, pedagogical, professional, political, those of colleagues (critical friend, literature review)
- Articulating findings as new knowledge
- Developing a new theory of practice
- Disseminating this new theory through publications, presentations etc.

Given my beliefs and values regarding mathematics education in the early years, and because I want to improve practice, SSAR is a solid choice of methodology to suit my piece of research, and will now go on to explain in detail how the research was carried out.

3.3.5 Collection of both Quantitative and qualitative data – Mixed Methods Research

Qualitative data, linked more to qualities, and quantitative data, linked to measure and numbers can both be useful (McDonagh et al, 2020) although in SSAR, qualitative data is usually the dominant type of data collected. In this SSAR, both quantitative and qualitative data were used – which is sometimes referred to as mixed methods (MM) research (Cohen et al, 2018). Quantitative data were useful to allow me to demonstrate a change in children's knowledge levels and a change in mathematics environment provision post-interventions. However, it was important to supplement this quantitative data with qualitative data from

surveys, semi-structured interviews and observations in order to give a full picture of rich mathematics teaching and learning in the classrooms. Check and Schutt (2012) argue that qualitative data is useful in gaining researcher credibility, as it prioritises the views of subjects over those of the researcher. This can help to reduce bias and minimise power concerns within AR.

3.4 Research Design

3.4.1 Research Site

The research site is a suburban ECECS in Dublin, Ireland. The setting provides for full day ECEC for children aged 12 months to 5 year's old, plus a sessional term-time ECCE preschool scheme. The participating children are taught in 3 ECCE classrooms. One classroom has 14 children who attend for the full day and ECCE is incorporated within that day; and 2 further classrooms facilitate 22 and 11 ECCE sessional children for 3 hours per day.

3.4.2 Research Context

The context for the research is the Early Childhood Care and Education (ECCE) classrooms within my setting. The children in these classrooms, aged between 2 year's 8 months and 5 year's 6 months, are funded by the government to attend 2 academic years of sessional preschool. Providers of these ECCE classes are contractually obliged to provide effective ECEC for all attendees, following Aistear (NCCA, 2009) to plan, implement and assess learning and development for children enrolled. This is inspected by the EYTI unit of the DES (DES, 2018), and to a certain extent by TUSLA (TUSLA, 2018).

3.4.3 Research Participants

In total 47 children and 8 early year's educators were sampled within these classrooms. All participants gave their informed consent and assent. Two children dropped out of the study due to relocation. Children involved were aged between 3 and 5 year's during the study. Some children in the group had experienced full day ECEC in the setting since they were 12 months old. Others joined the preschool classroom from the age of approximately 3 year's only, and may at the start of the study have been as young as exactly 3 year's 1 month old, having attended preschool for 4 months only. Out of the sample group of 47, 16 children did not speak English as their first language, with a mixture of languages spoken. As part of the intervention, parents of the 47 children were asked to be participants, and encouraged to help their child develop early mathematics.

I recruited 8 EYT's to participate, across the 3 classrooms. These teachers are also not a homogeneous group: with varying levels of experience and education in EY themselves. A separate part of the research was to sample a wider group of Early Year's Teachers by way of a questionnaire I designed using Survey Monkey©. This was distributed to a group of approximately 900 members of a private Facebook group, and 181 responses were received.

Throughout the study, I was the main researcher, investigating my own practice as curriculum leader for EYMT&L for the ECCE preschool classrooms; acting as curriculum leader, and mentor/trainer for the EYT's employed in my setting. I had a critical friend for the study, a senior EYT within the setting. I also asked 3 more EY professionals to assist me as critical friends.

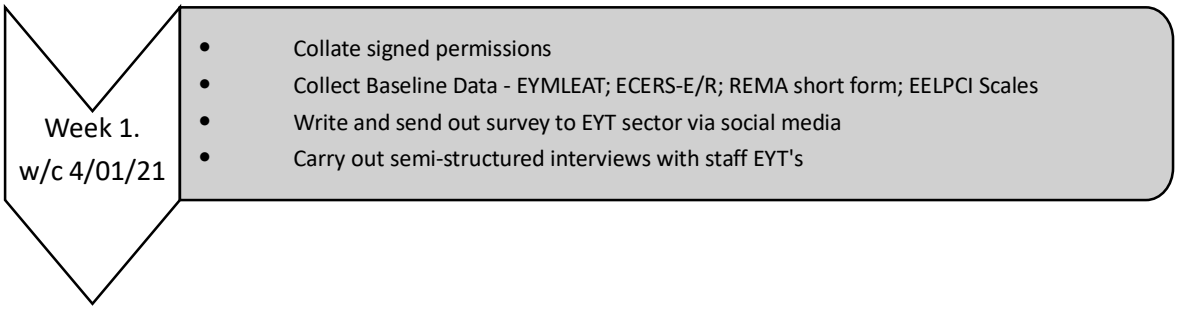
3.4.4 Overall design of Research

My overall research question is: **"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's setting for children aged 3-5 year's?"** In order to answer this overall question, I broke the study design into several smaller questions, and used mixed methods research over three AR cycles. The outline of the research timeframe and actions is given below, along with description of each of the research instruments and reasons why they were chosen.

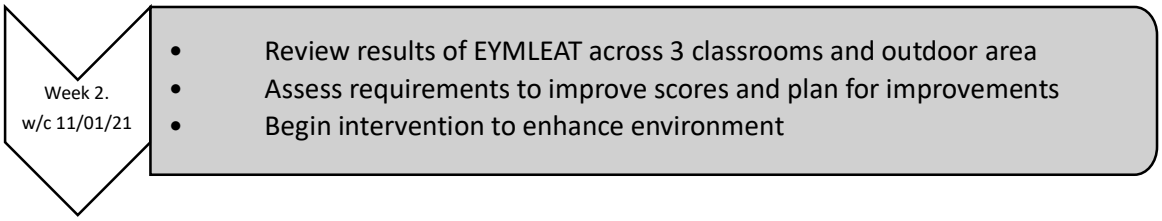
The research was planned to start w/c 4th January 2021 and initially planned to run for 12 weeks, until Friday 26th March, prior to the Easter holiday break. Part of the research was delayed as 2 of the classrooms did not re-open after the Christmas holidays until March 8th, due to Covid-19 restrictions. The same research protocol was carried out in the 2 late opening classrooms in the same way as in Classroom 1and finished 10 weeks later in these 2 rooms, towards the end of May.

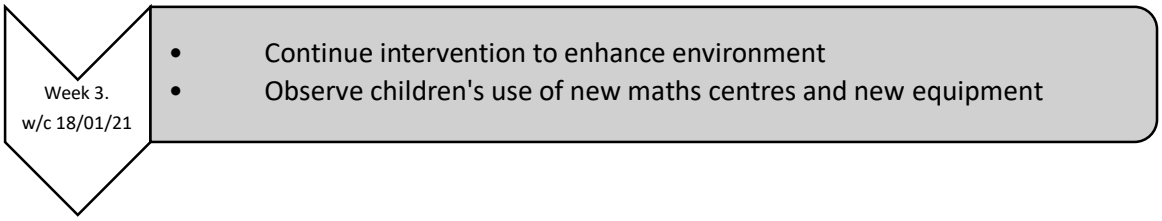
Three Action Research Cycles were carried out. The first ARC was to audit the physical mathematics environment, and then address the shortcomings of the results by adding in required materials, equipment, toys, games and displays etc. The second ARC involved carrying out CPD with the staff EYT's in the setting. The third ARC addressed communications and support for parents. Examples of mathematical activities within normal household routines were provided to support the parents in doing this, and included suggestions for reading books and apps that parents could further rely on, Appendix 3. For families where English is not the first language, I emailed the newsletters in a Word format and explained that they could easily be copied and pasted into Google translate to assist in translation. The outline of the research protocol and the data collection points was as follows:

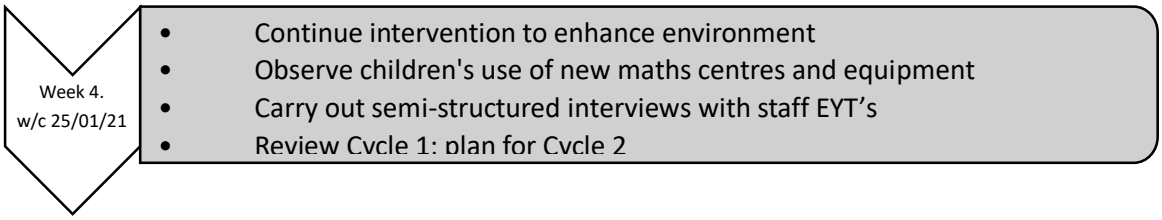
3.4.4.1 Baseline Data collection Week 1



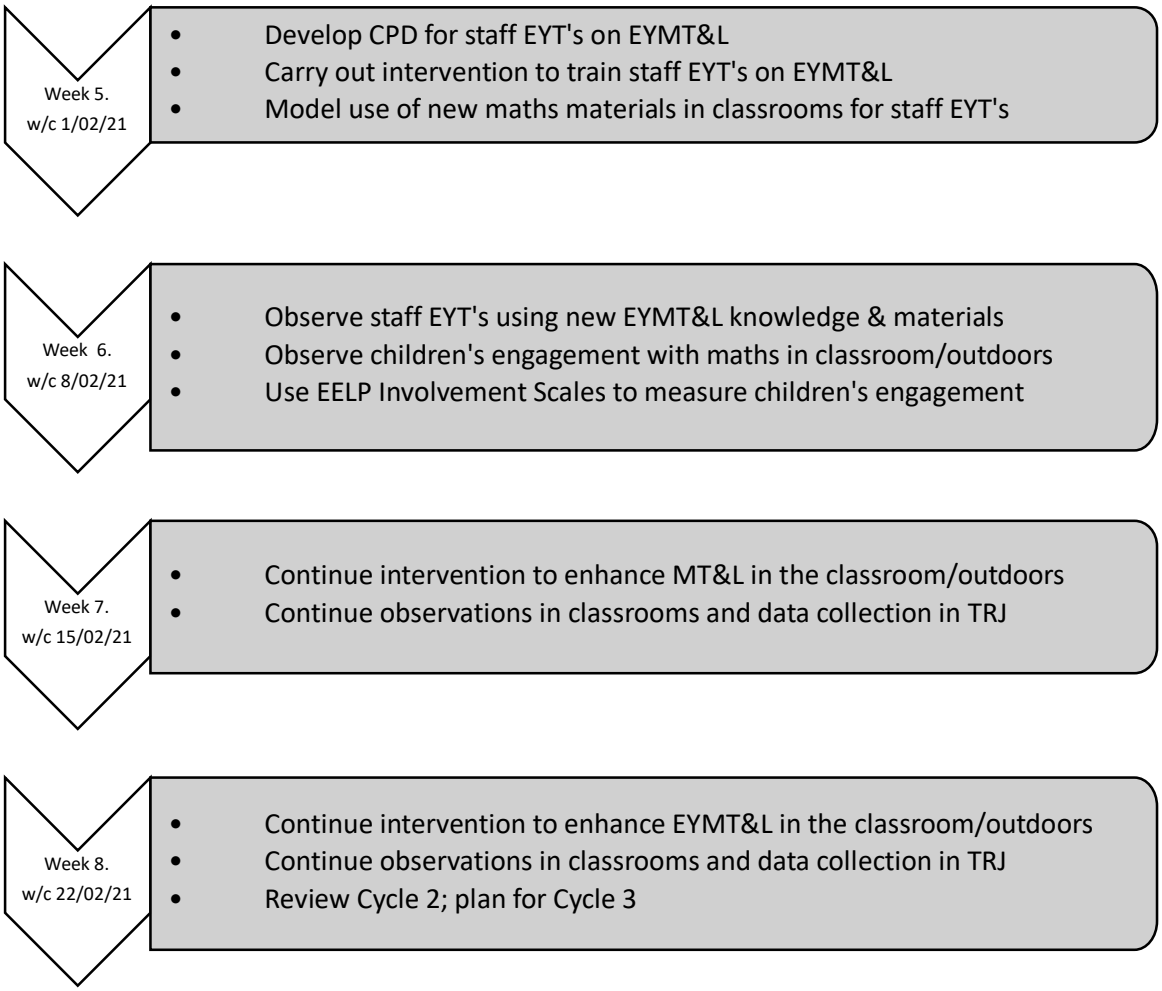
3.4.4.2 Action Research Cycle 1 Mathematics Learning Environment Intervention Weeks 2-4



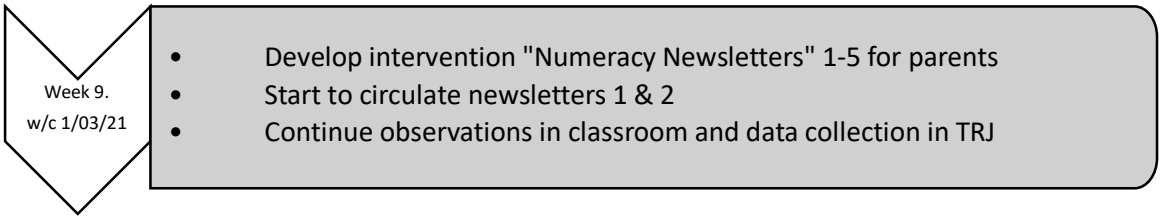


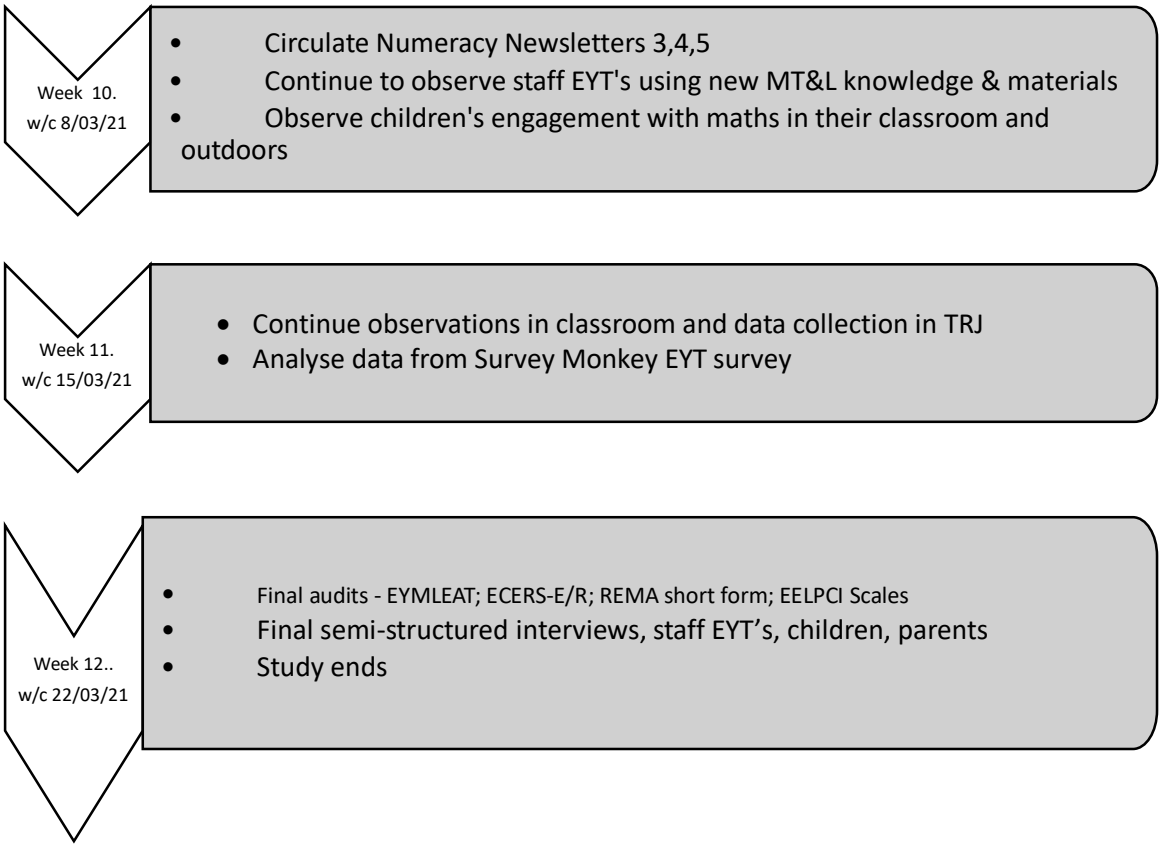


3.4.4.3 Action Research Cycle 2 CPD Early Year's Maths Teaching & Learning Intervention Weeks 5-8



3.4.4.4 Action Research Cycle 3 Parental Support Intervention Weeks 9-12





3.5 DATA COLLECTION INSTRUMENTS

All researchers must collect data and analyse it in order to demonstrate their research findings and make conclusions (McDonagh et al, 2020). Check and Schutt (2012) advise teacher researchers to harness a variety of data collection methods to give an accurate picture of what is happening in the classroom; add robustness (Campbell and Fiske, 1959) and reduce bias (Flick, 2018). Data can then be analysed and used by the researcher to make a claim to new knowledge (McDonagh et al, 2020). I used a range of qualitative and quantitative data, as described in the following sections. This approach is referred to as mixed methods research (MMR) and according to Fetters and Freshwater (2015) can often result in a body of data which is more than the sum of the whole; gives cognisance to the fact that the world is not exclusively quantitative or qualitative (Cohen, Manion and

Morrison, 2018: 31) and tends to give a greater understanding of the study question than would be given by concentrating solely on quantitative or qualitative data (Cresswell and Plano Clark, 2011). I chose these methods as pragmatic solutions in order to answer my research question.

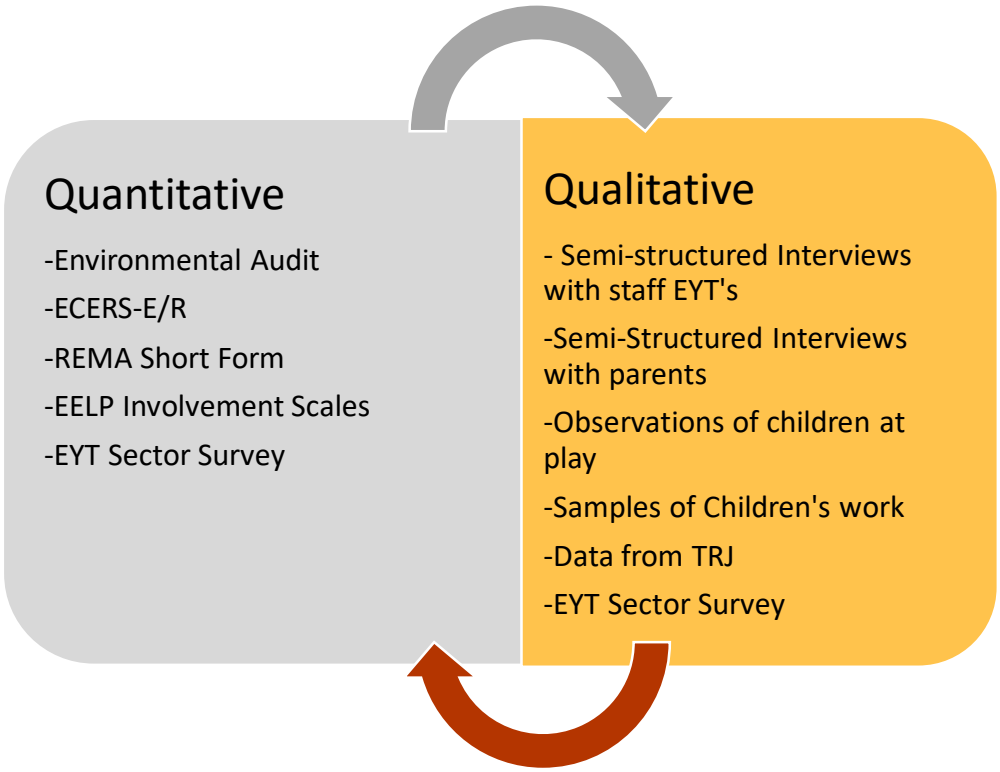


Figure 3.2 Data Collection Instruments used

3.5.1 Quantitative Instrument 1 – Early Year's Mathematical Learning Environment Audit Tool

The importance of the classroom mathematical environment - and provision within the classroom of mathematical equipment, toys, games and displays - was established in my literature review in Chapter 2. There are many classroom based mathematical environment audits available online, especially from UK early year's and primary school specialists,

designed to meet the needs of the Early Year's Foundation Stage (EYFS) Curriculum (DfE 2020) in England. In Ireland we have the Aistear Learning Environment Self-Evaluation Tool (NCCA, 2020) to support the Aistear curriculum. I chose not to use the Aistear tool, as on review I felt it was not mathematics specific enough for the needs of this study. I chose an audit tool from Northamptonshire County Council Early Year's Improvement Team (2017) called the Early Year's Mathematics Learning Environment Audit Tool (EYMLEAT). The reason I chose this tool was because it fitted with the ECERS-E/R audit tool (next section) also based on the English EYFS curriculum. I adapted it slightly to suit my study – what I wanted was a shopping list of what we should have on our classroom shelves to provide a well-resourced classroom for quality EYMT&L within a play-based, inquiry led curriculum– and this provided that for me -see Appendix 5.

3.5.2 Quantitative Instrument 2 – Early Childhood Environmental Rating Scale (ECERS-R/E)

I researched a proven audit tool which would give data on the quality of mathematics pedagogy happening in the ECCE classrooms. One of the most respected and robust internationally used auditing tools is the Early Childhood Environment Rating Scale – Revised (ECERS-R) (Harms, Clifford and Cryer, 2014). This tool is used as a measure of early year's classroom environment quality. A criticism when this was first published and used was that it did not measure specific curricular processes. Sylva et al (2011) as part of their landmark and long running Effective Provision of Preschool Project (EPPE) (Sylva et al, 2010) extended this ECERS-R rating scale to use in the EPPE study. They added in specific questions for measuring 4 curricular areas; Literacy; Mathematics; Science and the Environment, and Diversity, and named it *ECERS-E; The Four Curricular Subscales Extension to the Early Childhood Environment Rating Scale*. This audit tool focuses much more on the teaching and learning processes that are happening in a classroom, looking at interactions between EYT's and children, and audits the pedagogy that is apparent within

the classroom environment. I used this because it was important to add a process and pedagogy audit to the physical environmental audit, so adding a further layer to the data collected in the EYMLEAT.

I amalgamated mathematical subscales from both audit tools, using questions from the mathematics and science rating tools from ECERS-E and from the blocks, mathematical activities, mathematical daily events and understanding numbers from ECERS-R. See Appendix 6.

3.5.3 Quantitative Instrument 3 – Research Based Early Mathematics Assessment (REMA)

As the interest and concern regarding mathematics education for children in their earliest year's increases, so does the interest in assessing young children's mathematical capabilities. A research-based early mathematics assessment tool (REMA) was developed by Clements et al (2008) and is based on theory around learning trajectories in mathematics learning (Clements and Sarama, 2004). This tool has 125 questions, which was prohibitive for the scope of my SSAR, and tedious for young children. However a shortened version – REMA Short Form (Weiland et al, 2012) is also a validated tool and only has 19 questions. Most of the questions are around basic skills and abilities such as subitising, counting, adding on, taking away, shape recognition and shape properties - see Appendix 7. I created a game of the quiz– "Lynn's Buttons and Straws game" where I used a bag full of brightly coloured buttons for the subitising and counting/adding/subtracting tasks, and some pieces of plastic straw for construction of shapes.

3.5.4 Quantitative Instrument 4 – Effective Early Learning Programme Child Involvement Scales

This is a tool developed by Bertram and Pascal (1999) that was used in the Effective Early Learning Programme (EPPE) in order to measure children's engagement in various aspects of the EYFL curriculum, including mathematics. I adapted it to measure engagement

with mathematics only - see Appendix 8. The Leuven Involvement Scale for Young Children (Laevers, 1994) is the basis of this particular tool and measures levels of involvement. Involvement (Bertram and Pascal, 1999) is situated at the edge of a child's capabilities- in their zone of proximal development (Vygotsky, 1978). When heavily involved, children are fascinated, absorbed, engaged, motivated (Laevers, 1994). This tool was useful to assess interest in mathematical based play in the ECCE classrooms at various stages of the curriculum, for example during free play, small group and large group time, and as the study progressed.

3.5.5 Quantitative Instrument 5 – Early Year's Teachers Survey via Social Media

Surveys are useful to gather data at a particular point in time in order to analyse the current situation (Cohen et al, 2018). They can be used to mine data from a wide population to measure generalised features and attitudes of the population sampled, and can be efficient and economical. Internet based surveys are common in educational research (Denscombe, 2014) for these reasons. I used a template based system, Survey Monkey©, to design the survey and circulated it via a private Facebook Page of Early Year's Teachers. According to Dillman et al (2014) surveys can generate numerical data as well as descriptive and explanatory information, Appendix 4.

3.5.6 Qualitative Instrument 1 - Semi-Structured Interviews with Staff EYT's

Semi-structured interviews were used to gain information from the 8 staff EYT participants. This technique elicits concerns and interests of the research participants; non-standardised, personalised information about how the participants view the world (Cohen et al, 2018). I used a discussion guide to ensure a regularised approach - see Appendix 9. According to Patton (1980) the comparability of responses is enhanced as the interviewer

asks the same basic questions in the same order to each individual interviewed; and this approach assists data analysis and minimises bias. According to Roberts-Holmes (2014) there is more opportunity for the respondent to expand and talk more about areas which specifically interest them. The semi-structured nature of the interviews meant the discussions remained conversational, whilst following a clear discussion guide.

I did not record these interviews using written or audio recordings, in order to put my staff at ease as much as possible, and took time immediately after the interview to write down notes and reflections from each interview.

3.5.7 Qualitative Instrument 2 - Semi-Structured Interviews with Parents

A similar rationale as described above applied here; I was able to interview 11 parents representatives pre and post interview from across each of the 3 classrooms.

3.5.8 Qualitative Instrument 3 - Observations of Children

Children as co-participants in AR is an important concept (Clark, 2017; Sullivan et al, 2016). I collected data which recorded children's voice by observing, and taking notes within the classrooms. These notes recorded behaviours, engagement with mathematical play, vocalisations, actions, discussions of individuals, of small groups and of the whole class.

3.5.9 Qualitative Instrument 4 - Collection of Children's Work Samples

I photographed children's mathematically related artefacts – drawings, junk-art constructions, block constructions during the process and any final products - constructions, representations of patterns, mathematical shapes and symbols and mark-making attempts; and noted all observed mathematics related role play, number rhymes, stories and songs used

in the classrooms as part of my data collection. I was interested in engagement with mathematical concepts demonstrated within the children's work, and also whether there was an increasing quantity of such items as the interventions progressed through the 12 weeks study period. This is another method of listening to children's voice.

3.5.10 Qualitative Instrument 5 -Teachers Research Journal

McDonagh et al (2020) feel strongly that reflective writing is key to SSAR; and that it needs to be meaningful, motivated by a drive to research and improve practice. I have written about my practice in a reflective way on an almost daily basis (I used a pre-printed, dated diary to help me organise my thoughts). I recorded what was carried out, and reflected upon each aspect of the research process. This record is referred to as a TRJ – Teacher's Research Journal.

3.5.11 Qualitative Instrument 6 - Survey of EYT Sector

As discussed in section 3.5.5, the survey I used was able to capture quantitative data, which I have analysed statistically in Chapter 4, but also open ended questions were added in to the survey, to enable collection of qualitative data, and these questions were well responded to. I have analysed this qualitative data thematically as part of the overall data generated and these themes are discussed further in Chapter 4.

3.5.12 Critical Friends

Collaborative research methods in education add value to research (Samaras, 2011). For credibility and robustness, as well as triangulation, it is important during SSAR to share research, processes, thoughts and reflections with colleagues, and request that they critique your discussions and your thoughts, helping to form your ideas and research. The use of these critical friends adds to credibility and trustworthiness of the data, prevents bias and

reduces power dynamics (McNiff and Whitehead, 2010; Sullivan et al, 2016; McDonagh et al, 2020). I asked a group of 3 early year's colleagues whom I became friendly with during my undergraduate early year's studies to step into that role, and they were helpful in questioning my rationale, my values and my research. These telephone discussions were recorded and analysed as part of the qualitative data analysis. I also requested a senior EYT in the setting to fulfil the role of CF on site, as she was closer to the study and able to observe and give feedback directly on interventions in the classrooms.

3.6 DATA ANALYSIS

3.6.1 STATISTICAL ANALYSIS OF QUANTITATIVE DATA

The quantitative data was concerned with scores and test results, and some percentages. These were analysed using Excel spreadsheets and a variety of bar graphs and pie charts were used to represent the results visually for easier understanding.

3.6.2 THEMATIC ANALYSIS OF QUALITATIVE DATA

Qualitative data can be transcribed and collated by theme in order to garner meaning from large quantities of written data (Aubrey et al, 2000; Gibbs, 2007). I read and reread the written qualitative data, to become familiar with it. I then used Braun and Clarke's (2006) 6 stage thematic analysis model. I analysed the subject areas into various themes, by colour coding various portions of text that fitted into each theme – the most important themes were the ones that were mentioned most. This required reflexivity, which ties in with the reflexive paradigm of AR (Braun and Clarke, 2006). When analysing the children's work, I looked for examples of mathematics in play, and for trends in quantities/amounts of mathematic materials that were produced, and also any improvements over the time period, for example improvements in drawing shapes, or progression from tally counting to writing number symbols.

3.7 Role of the Researcher

3.7.1 Validity and credibility

It is important at this level of research that in order to make claims about new knowledge, the SSAR must be accurate and sound – it must be seen as having validity. McNiff and Whitehead (2010) would describe this as an outcome or change in practice which demonstrates that I am now living much more closely to my values in my everyday practice. SSAR needs to be to be credible – with integrity, to be robust, and through dissemination throughout the early year's academic community. I have provided a credible thought process from beginning to the end of the research, and by utilising peer reviewed literature to guide my actions, though processes and arguments.

3.7.2 Trustworthiness

In order for SSAR to be seen as trustworthy, it must be carried out ethically and reliably by the researcher, and the researcher must take all actions possible in order to remain credible through the research, not allow bias or personal opinions to sway the results, but to remain true to the actual data collected and analysed. Validity and credibility are part of this trustworthiness, as are results that could be transferable – produced again by a different researcher carrying out a similar study; and dependable – ensuring the research s consistent and reliable. This means allowing an outside party to be able to follow the research process and understand what was done, and why. All research tools and data are recorded in my SSAR, as is the rationale explained, which makes this study easy to follow and transparent to readers.

3.7.3 Triangulation

Triangulation means allowing more than one person's viewpoint within your study and on your outcomes, and within this study I have included the viewpoints of critical friends; of early year's teachers who have participated; and I have also elicited the viewpoints of the parents and the children themselves. I have used multiple data collection methods, including qualitative and quantitative data, in order to triangulate the data collected (Mukherji and Albon, 2009).

3.7.4 Knowledge Creation

McDonagh et al (2020) believe that by carrying out SSAR in our classrooms, we as teachers can create new theories of practice and generate new knowledge to be shared amongst our teacher colleagues. This ties in with Froebelian theories and my own epistemological beliefs that we are all knowledge creators, teachers and students together.

3.8 Ethical Considerations

I followed ethical guidelines from Maynooth University (Maynooth University 2020a) and guidelines for integrity (Maynooth University 2020b), and received ethical approval from the University to carry out the SSAR. I recruited participants from teachers and children (and their parents) within the ECCE classrooms in my setting. I will go on to discuss how I followed all pertinent ethical guidelines (DCYA, 2012; DCYA, 2018) particularly in the light of researching very young children.

3.8.1 Assent; Informed Consent; Confidentiality; Anonymity

I used a formal recruitment process – I wrote to all prospective participants, explained the research process and invited their participation. I have included the letters and consent/assent forms in Appendices 12-14; in this letter I also explained confidentiality,

voluntary participation, anonymity and withdrawal from the study at any stage in the process. I gained individual assent at every classroom session I carried out as part of the research, and respected their decisions for example if they decided that the timing was unsuitable to carry out any research on any particular day.

I formally invited the children's parents to participate themselves and to allow their child (ren) to participate. I invited all parents and children from all 3 ECCE classrooms. The invitation letter and consent/assent forms are included in Appendix 11. A total of 47 children, 41 families, gave consent to participate. In this letter I explained confidentiality, voluntary participation, anonymity and withdrawal from the study at any stage in the process. Two children from one family withdrew from the study due to family relocation.

Staff EYT's were invited formally and an information pack and consent form included – Appendix 12. For EYT's who completed the online survey, there was an informed consent statement at the beginning of the survey; by completing the survey it was assumed consent was given - Appendix 12.

Finally I invited each child individually to assent to participate by holding small group discussions in each classroom during circle time, and then asking them to make their mark next to a "thumbs up" symbol (yes I want to participate) or a "thumbs down" symbol (no I do not want to participate).

3.8.2 Power Issues/Dynamics

I as centre owner and leader am the gatekeeper. Ethically I had to remain aware of power issues that may have arisen because of this. It may be perceived by participants that because I am the owner and the leader of the setting, I may wield (consciously or unconsciously) certain power which might skew the results of the research. I am the employer of the EYT's, which adds another power dynamic. I pay their wages, book their

annual leave allowance, I am their boss. I made it very clear to them that participation is absolutely voluntary and would not impact on their employment or performance in their role in any way.

From the children's perspective, I was very clear that they were not forced into any numerical or mathematical play, teaching or learning. The numeracy environment changed, and the opportunity to get involved in numeracy activities increased, BUT they were not forced to participate at any stage. I certainly did not want to progress down the route of didactic teaching in our play-based, emergent inquiry, Aistear-led classrooms.

I remained cognisant of these power dynamics between myself, and adult and child participants throughout the study, and worked hard to reduce these issues to prevent bias/skewing of the data produced. I confirmed assent to carry out research in classrooms and with children both from the teachers and the children themselves at every opportunity; and monitored body language and discussions to ensure all participants didn't feel threatened by my powerful position as centre and curriculum leader in the setting. Teachers/parents and children were given several reminders they were able to withdraw at any stage if they so wished; and made sure other activities were available for children whilst interventions were taking place.

All groups of participants may have felt they had to give answers that I wanted to hear, so it was important for me to stress that I want honest opinion and responses. Anonymity at all stages of the study was assured in all consent/assent forms and information packs. Pseudonyms and numerical listings have been used throughout the study in data recording.

3.8.3 VULNERABILITY

The staff EYT's may have felt vulnerable if they did not believe they had a good grounding in teaching early year's numeracy, and perhaps if they felt they suffered from MA. I approached this sensitively and was clear what my expectations of them were regarding improving the teaching of numeracy; and taking them with me on this research and learning journey without threatening their self-esteem and confidence. In fact the aim was to increase their confidence and their mathematics content knowledge levels.

Parents and children who do not have English as their first language may have felt vulnerable if they did not understand the research proposal and informed consent forms. I suggested they use Google Translate and sent the documents in an easy format for them to copy and paste into this tool to try to prevent this language issue adding any additional concern to parents.

3.8.4 DATA STORAGE

Hard copies of data were stored under lock and key; soft data was stored electronically on the hard drive of a Desk-Top computer, and was encrypted before being saved. Once the research is completed and the thesis is written up, it will be published by Maynooth University. It may also be presented to a sector specific audience, for example at an Early Childhood Ireland Conference.

3.9 CONCLUSION TO CHAPTER 3 - METHODOLOGY

In this chapter, I have highlighted the research rationale; discussed the corresponding choice of research paradigm, and outlined the overall design of the research – including study site, context and participants. I have detailed the 3 ARC's that were undertaken, the data collection instruments used and the data analysis methods I chose. The role of the

researcher has been covered, and finally, important ethical considerations have been clarified. These include gaining ethical approval for the study, and gaining informed consent and assent from all participants, whilst guaranteeing them anonymity. The next chapter will give details of the data collected and discuss the findings deduced as a result.

CHAPTER 4 DATA ANALYSIS AND FINDINGS

4.1 INTRODUCTION

This chapter discusses data collected whilst carrying out SSAR to answer my research question **"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?"** I have analysed both quantitative and qualitative data collected during the three AR cycles I carried out. This chapter is concerned with reviewing the results of the research, the reasons behind these results, and the findings I concluded from these. At the end of this Chapter, I outline the findings that I have deduced, link the findings with research outlined in the Literature Review in Chapter 2, and discuss whether I have answered my research question.

4.2 BASELINE DATA

Baseline data was generated using mixed methods and the research instruments as explained in Chapter 3. The baseline data from Week 1 was used as a comparator to ascertain whether we enhanced EYM teaching and learning during the 3 ARC interventions by the end of the study period. The data collected is referred to in the following discussions as "pre-intervention" (or baseline) and "post-intervention" data. In deducing overall findings I have analysed research results as an overall body of data, and referred to research discussed in the Literature Review.

4.3 Quantitative Data

4.3.1 Early Year's Mathematics Learning Environment Audit Results

The Early Year's Mathematics Learning Environment Audit Tool (EYMLEAT) (Northamptonshire County Council, 2017; see Appendix 5) was used by the lead EYT in each of the 3 classrooms involved in the study; and my CF audited the outdoors area. Audits were completed in week 1 and week 12. One of the EYT's involved in the study commented on the audit tool after she carried out the baseline audit in week 1: -

> *"Definitely an EYT-opener… that I should be doing more mathematical displays for my classroom. Can you email me a copy of this audit so I can use it for ideas?" (EYT, Jan 2021)*

As you can see from Figure 4.1, the audit scores for the 3 classrooms and for the outdoors play area increased after the intervention. The average score across the 4 audited areas almost doubled.

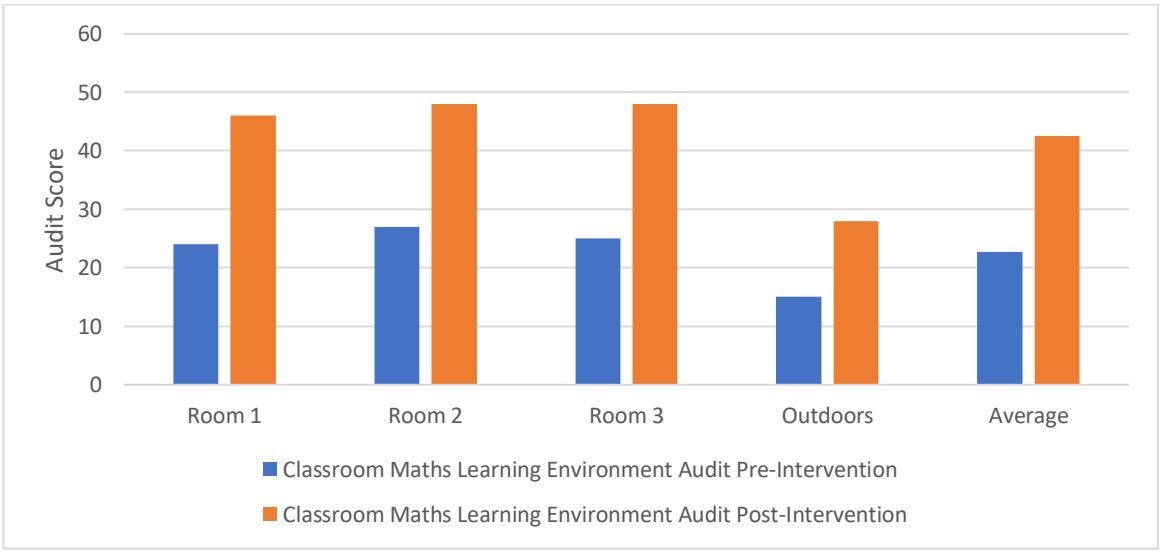


Figure 4.1 Results of Mathematics Environment Audit Pre & Post intervention

The interventions made to the environment were relatively simple, in order to enhance the quality of the EYMT&L that the EYT was able to provide. Ginsburg (2006, 2009) and Cotton (2019) contest that classroom environment stimulates children's EYM development. Stafford (2012) continues this line of argument - that the preparation of a mathematically rich environment is a key role of the EYT to aid the development of numeracy through everyday play and experiences. Obviously the EYT needs equipment and materials to be easily available in order to follow the child's lead when they are curious and want to further investigate EYM. EYT's also need the confidence and knowledge of mathematics and mathematics equipment in order to ensure the mathematics environment is properly resourced and laid out (NCCA, 2009; Ginsburg et al, 2008; Cotton, 2019).

Interventions carried out in ARC1 included enhanced mathematics displays in the classrooms- by adding in number lines, washing lines, posters, and using children's artwork as part of the displays. We set up a "mathematics centre" in each classroom to keep the mathematics materials together and easily to hand. We ensured there were materials for sorting and counting, measuring, weighing, telling time/measuring time and included plenty of games – Playing Cards, Snap, Dominoes, Lotto and counting/number games (See Appendix 15 for photographs of classroom environments after this intervention). We also added a large amount of mathematics related books to our setting library – see Appendix 16 – and shared these around the 3 classrooms. The children noticed all the new materials and books in the classrooms, and clearly showed interest with the new materials. This intervention alone stimulated more maths talk in the classrooms. An excerpt from my TRJ (O'Dwyer, 2021) when the mathematics centre was set up in one classroom. I introduced some small plastic 3-dimensional shapes in bright colours, which are very tactile and small enough to fit into a child's hand:

Child: "*Lynn, look, we have new stuff….mmm…why do we have these… errr…*

….thingies? They're amazing- they give us powers…colours powers…"

This interest simulated a discussion regarding the different 3-D shapes and then a comparison between 3-D and 2-D shapes ensued.

4.3.2 Early Childhood Environmental Rating Scale ECERS-E/R Results

As discussed in Chapter 3, these audit tools - ECERS-R (Harms et al, 2005) and ECERS-E (Sylva et al, 2011) are well-respected, and assess the provision of curriculum and early year's pedagogy, and the teaching and learning of mathematical processes. I adapted the tool (Appendix 6) to include mathematical elements from the original ECERS-R and the newer ECERS-E tool combined, in order to cover 7 areas (subscales) of mathematics pedagogy provision:-

1. Counting
2. Number
3. Shape
4. Sorting and Matching
5. Block Play
6. Daily Maths
7. Written Numbers

This audit was carried out twice, once in week 1 and once in week 12, and was done by myself and separately by my critical friend for validation. The scores we both allocated for each item in each classroom were then averaged to avoid any bias either of us may have had.

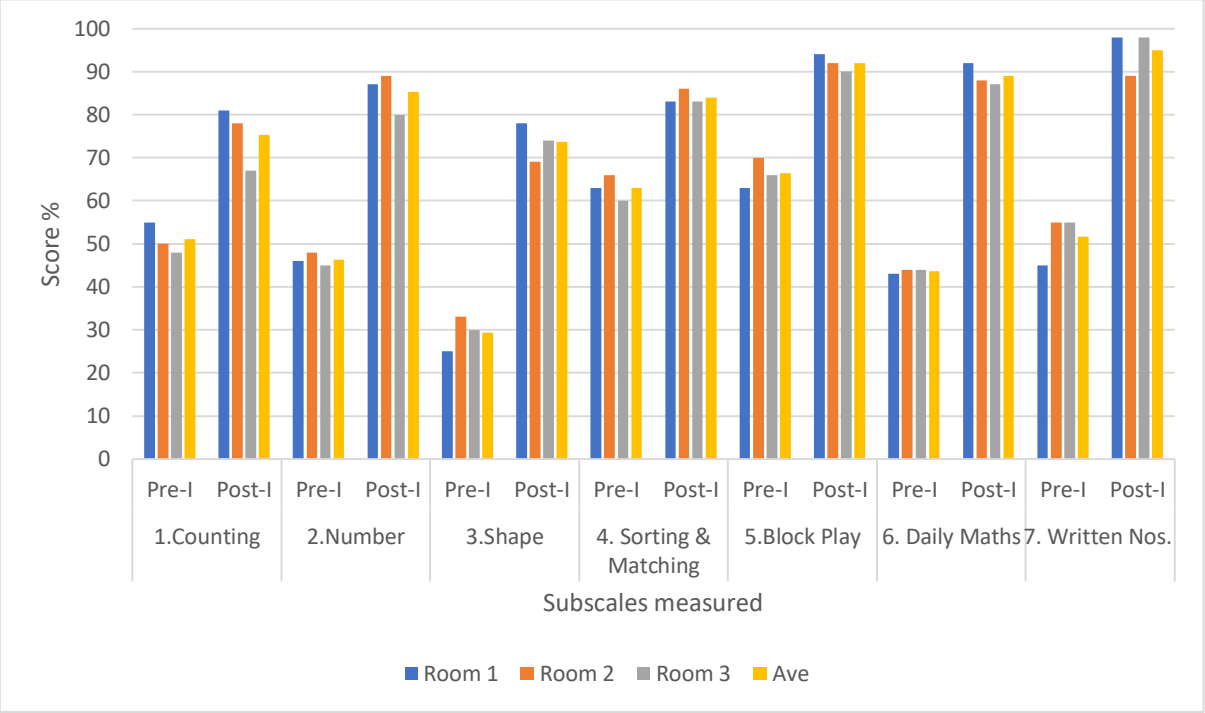


Figure 4.2 Results of ECERS-E/R AUDITS pre and post interventions

From the graph in Figure 4.2, all seven measured subscales demonstrated good score improvements post interventions, with the very strong improvement areas in the provision of daily mathematics, shape and in written numbers. To look into some of these results in more detail – it is interesting to note that all rooms scored poorly on the shape subscale initially, however all scored highly on block play. When you analyse the questions asked in those 2 subscale areas on the audit tool, it is clear there are very different aspects audited regarding the shape subscale than are audited in the block play subscale. We have been well resourced for block play as a Capital Expenditure Grant provided by the DCYA in 2017 (DCYA & POBAL, 2017) allowed us to purchase 3 expensive sets of blocks for the 3 ECCE classrooms, and the use of blocks and teacher-child interactions in block play has been strong ever since. This experience in our setting further demonstrates that a rich mathematics environment is important for EYMT&L (Ginsburg, 2006; 2009; Stafford, 2012; Cotton, 2019).

4.3.3 Research Based Early Mathematics Assessment REMA Results

As discussed in Chapter 3, this early mathematics assessment tool (Weiland et al, 2011consists of 19 simple maths questions (Appendix 7) and was carried out week 1 and week 12 with a simple score system to be as unbiased as possible. The child achieved the task (1 point) or did not (0 points). Figure 4.3 represents the results for 12 children from the full day care classroom (Classroom 1) who returned to the setting at the beginning of January. See Appendix 16 for scores for all child participants. All children tested across the 3 classrooms improved their scores over the 12 weeks of the interventions. This score improvement can be assumed to be as a result of the interventions, given that the interventions carried out were all closely linked to research demonstrating how we should teach EYM. We improved the EYM environment, both physical (Ginsburg, 2009) and pedagogical (Sylva et al, 2010; Stafford, 2012; Cotton, 2019). We carried out CPD for the staff team to enhance mathematics content knowledge, their mathematics confidence (Cotton, 2019) and to support and increase the use of maths talk in the classrooms (Klibanoff et al, 2006; Sfard, 2007).

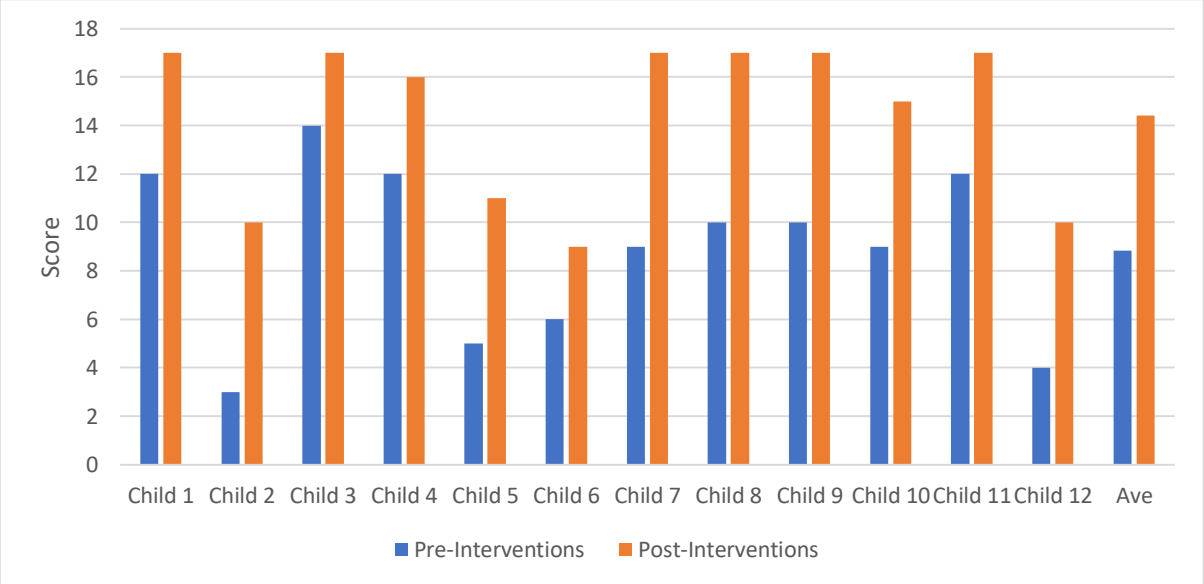


Figure 4.3 REMA short form test results pre and post interventions

When comparing the average REMA scores across the 3 classrooms (Figure 4.4) and comparing improvements in score (Figure 4.5) there is a clear pattern that the younger age group of children in Class 2 scored lower on average pre-intervention, and scores improved less than Class 1, but more than Class 3 post intervention. The children in Class 1 were aged from 3.3 years to 4.10 years at the time of the study, attending throughout the study for full day ECEC, most of them for 5 days per week. Class 2 children are all in the younger age bracket (3.3 years to 4.0 years) attending ECEC for 3 hours/day. Class 3 are an older cohort, aged 4.8-5.2 years, attending 3 hours/day. I would have expected that the younger group would have lower initial REMA scores than older children. These results could be indicative of the effect of the late return to the classroom for class 2 and class 3 due to the Covid-19 pandemic restrictions. They may have taken some time to settle back into ECCE routine. Class 3 performed better pre and post-interventions, and this may be a factor of their older age. This also ties in with Clements and Sarama's (2004) research regarding learning trajectories discussed in chapter 2; that as children mature, they are generally able to learn more sophisticated mathematics skills and to put these understandings into practice.

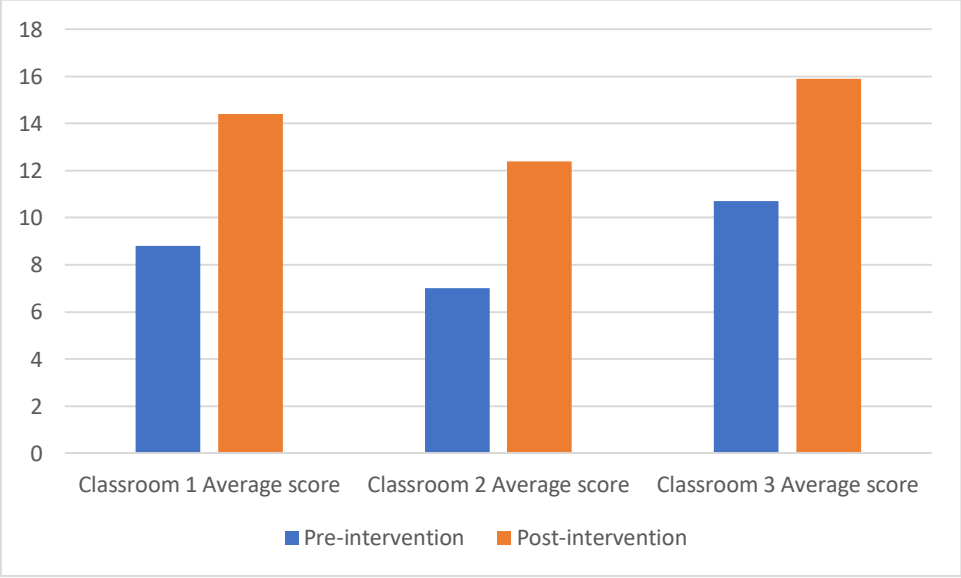


Figure 4.4 REMA short form Average test results by classroom

When looking at average score improvements by classroom, Figure 4.6, the REMA average score improvements are similar for the 3 classrooms. Class 1, full-time children, improved the most post-interventions. These children attend the setting for full day ECEC so there are many more opportunities for mathematical teaching and learning within their day. They are a slightly younger group than class 3, so I believe this extended day impacted their mathematics learning positively. I was pleased to see a strong improvement in Class 2 despite these children being younger, and perhaps less emotionally and socially secure than the children in the other 2 classrooms. Classroom 3 children started from a higher baseline so their improvement in this test seems less strong. Perhaps a more in-depth mathematics test may have shown different results for them, for example the extended REMA test, (Clements et al 2008) as discussed in Chapter 3. This could be investigated in further studies.

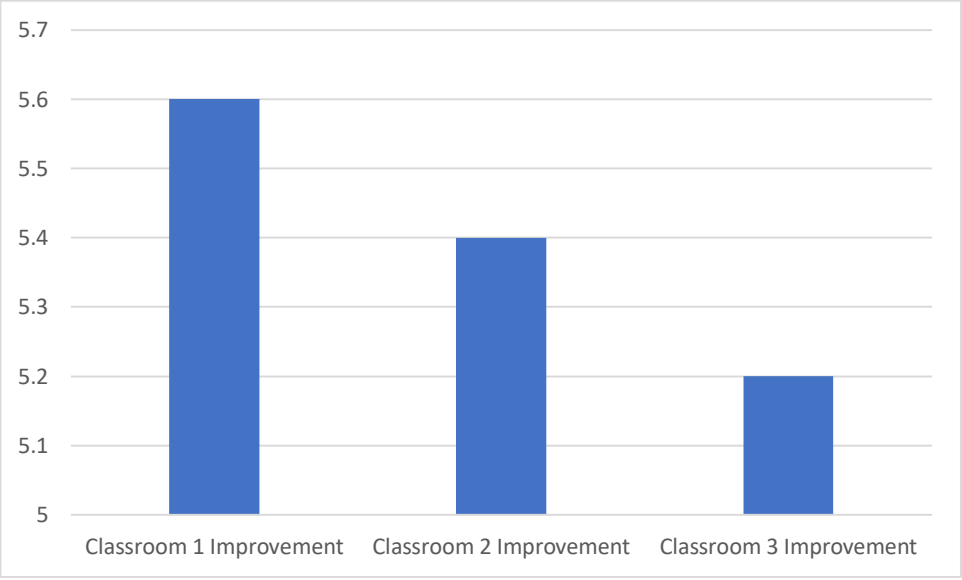


Figure 4.5 REMA Average score improvement by classroom

There are several children in each class with English as a second language (ESL) – 2 in Class 1 (17%); 11 in class 2 (46%) and 7 in Class 3 (64%); 42.5% of children

in the overall study have ESL. We currently only teach through English in this setting; this may well have an impact on the effectiveness of the teaching and learning (Toll and Van Luit, 2014) in many preschool classrooms in Ireland; and may have been a factor in this study. This prevalence of children with ESL points to another important reason to support and include parents in the education of their preschool child (Slusser et al, 2019). Work by Miller and Warren (2014) also demonstrates that disadvantaged students with ESL are at risk for lower mathematics performances but also stand to make the most gains with quality EYMT&L.

4.3.4 Effective Early Learning Programme Child Involvement Scales Results

Details of this assessment tool (Bertram and Pascal, 1997) are explained in Chapter 3, and Appendix 8. I and my CF assessed 6 children, 2 from each classroom for 6 x 2 minute observations (3 in the morning and 3 in the afternoon) across week 1, and repeated this testing protocol in week 12. A total of 72 x 2 minute observations of each child's engagement with mathematical materials; and with mathematical content guided by the EYT. This might have been during child guided (free) play; during circle time; small group or large group time. Level 1 shows poor involvement and level 5 shows keen engagement. Figure 4.6 shows the total number of observations where each different engagement level was demonstrated. It is clear from this graph that we observed a higher engagement with mathematics post-interventions across the 3 classrooms.

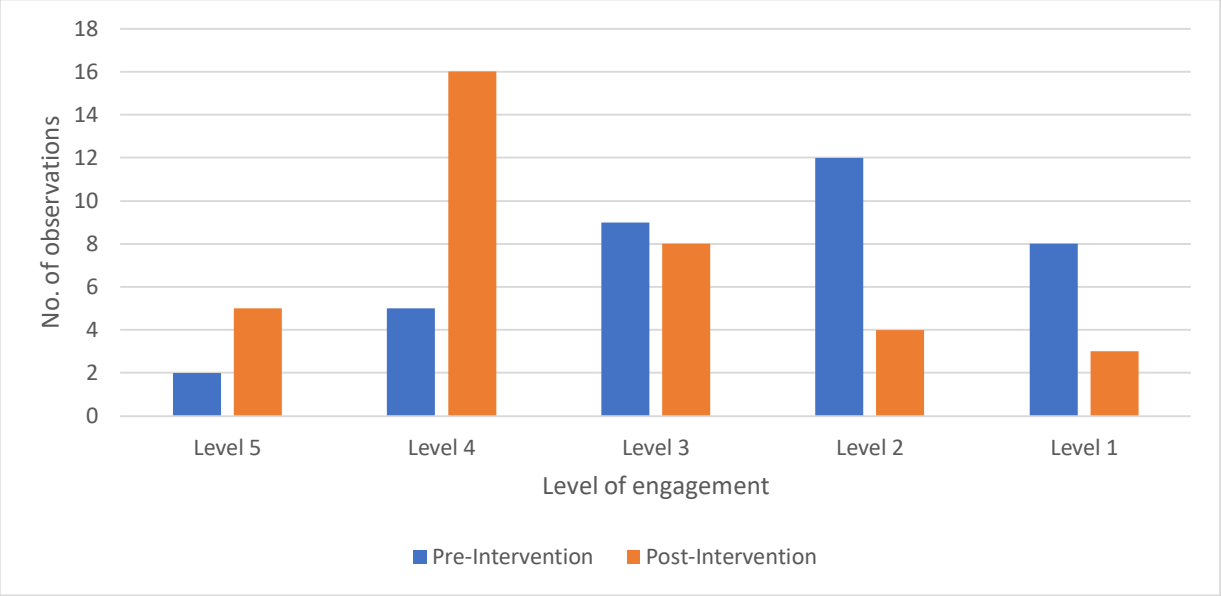


Figure 4.6 Effective Early Learning Programme Child Involvement Scales Results

According to Bertram and Pascal (1999) these higher levels of involvement are at the extent of a child's current capabilities and into the zone of proximal development (Vygotsky, 1978). Children are learning mathematics when involved to these levels, based on the work by Laevers (1994); and that social construction of learning (Dunphy et al, 2014) is taking place. The EYT and the child are involved in sustained, shared thinking (Sylva et al, 2010; Wood, 2013).

4.3.5 Early Years Teachers Survey via Social Media – Quantitative Results

See Appendix 4 for a copy of the survey questions. The survey was completed by 181 respondents from a sample size of 989- a good response rate of 18%. 70% of these EYT's who responded have worked for over 11 years in Early Childhood Education, Figure 4.7; and 92% work with children in the preschool age bracket of 3-5 year olds.

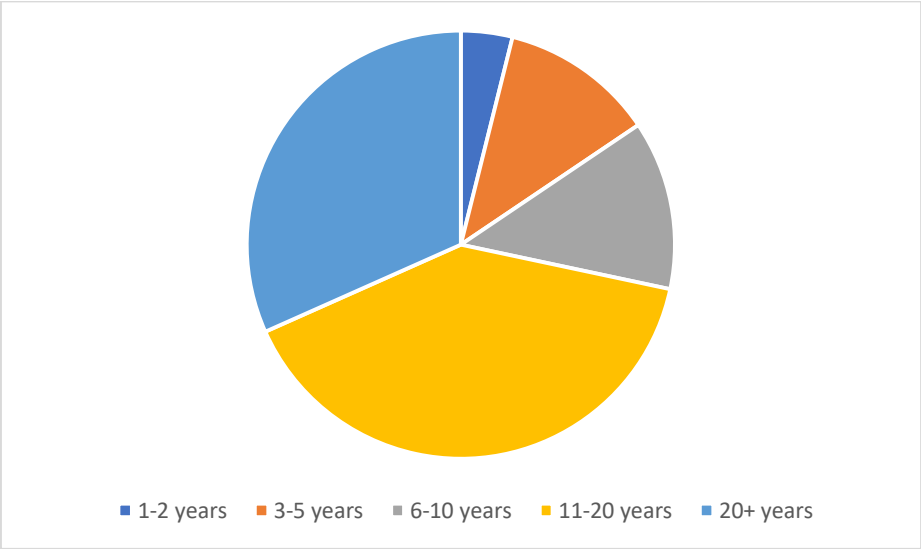


Figure 4.7 Years of ECEC Experience of Respondents (n=181)

Of all respondents, 66% worked with a play-based curriculum, and 44% with Montessori as their main curriculum. Almost 60% of the respondents group were graduates with level 7 or 8 qualifications, and a high level (14%) with Level 9 qualifications, Figure 4.8. The survey responses were heavily weighted towards graduates (74%) when compared with the overall sector of EYT's, where only 25% are graduates (POBAL, 2019) and the remainder in the sector are qualified to QQI Level 5 and 6. The survey should be repeated with a much wider spread of qualifications and experience at a future date.

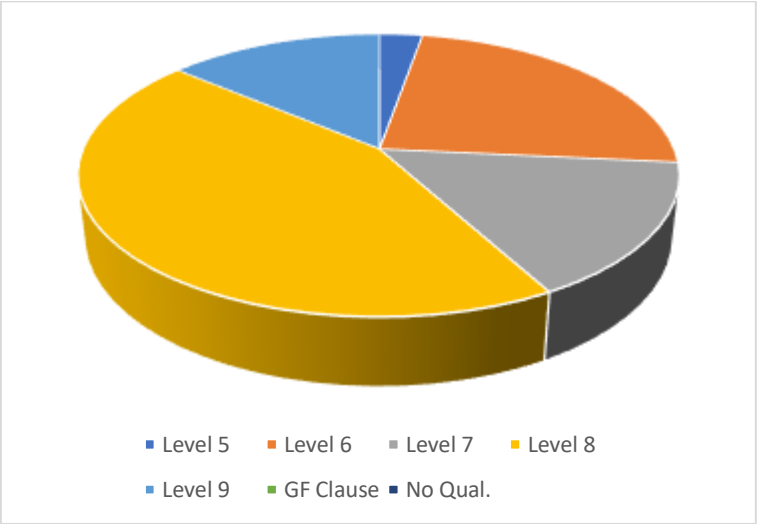


Figure 4.8 Qualification Levels of respondents (n=181)

Despite 72.2 % of EYT's surveyed reporting "*definite"* MA or suffering MA *"somewhat"* whilst at school, and only 26% reporting they were confident in mathematics whilst studying in school, almost 85% have passed mathematics at leaving certificate level, Figure 4.9

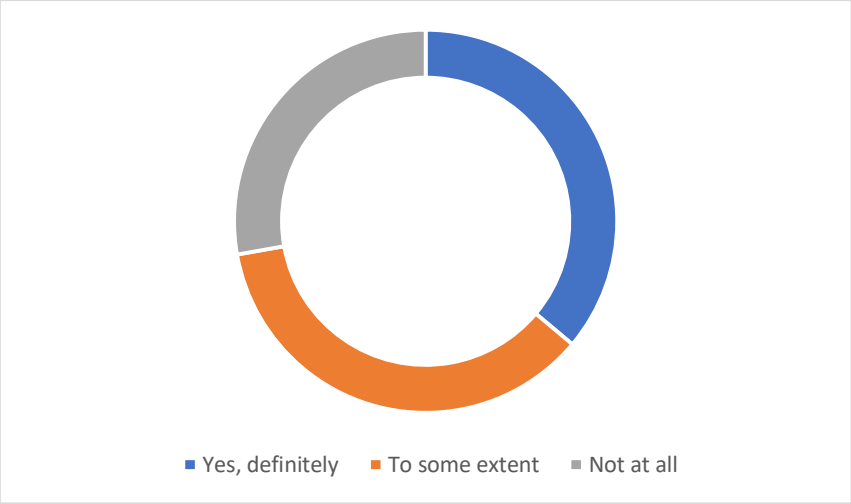


Figure 4.9 Maths Anxiety in own education as reported by respondents (n=181)

Worryingly, 29% of EYT's reported that their EYTT did not equip them to teach EYM, and a further 26% felt their training only prepared them somewhat, Figure 4.10. This is concerning, given the plethora of research that demonstrates well educated EYT's enhance learning outcomes for children (Sylva et al, 2010; Urban et al, 2010; French, 2013; Hayes, 2017). This is of concern against the background of a large amount of Irish Policy which commits to up skilling the ECEC workforce in the area of EYMT&L (DES, 2011; Dunphy et al, 2013; Dooley et al, 2014; DES, 2017; Government of Ireland, 2018). Additionally concerning is that 62% stated that their EY setting does not have a specific mathematics curriculum or policy for them to follow, which has been clarified as essential in Síolta (CECDE, 2006) and in work by Ginsburg (2009) and Dunphy et al (2013).

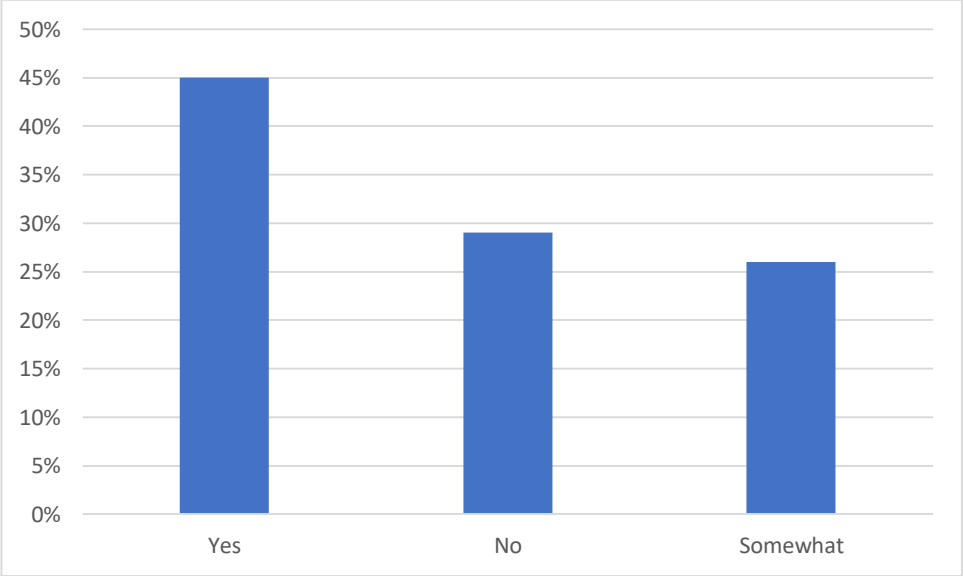


Figure 4.10 Teacher training included maths as reported by respondents (n=181)

Most respondents had a good grasp of mathematical content and processes involved in ETMT&L, Figure 4.11. Interestingly, Digital Technology scored low on this section, however this is becoming an area of increased focus in Ireland (DES, 2017a; 2017b, 2017c; NCCA, 2020). The reason for this low score for DT might be because respondents to the survey have worked in ECEC for many years – 72% of them for 11 years or more. I have

assumed that many EYT's of this level of experience are also an older age group, and may be cautious, or lack knowledge about how to teach this area of mathematics in the EY classroom. I am also assuming their EYTT was carried out some time ago, and possibly the use of digital technology may not have been included on older course materials. This is definitely an area that requires focus in EYMT&L going forward.

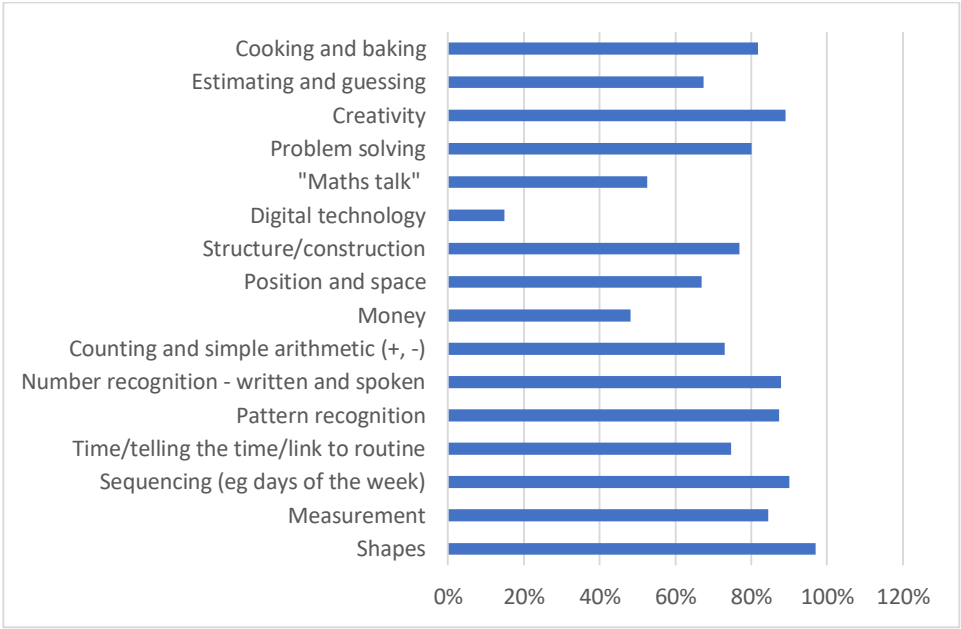


Figure 4.11 Maths content in classroom as reported by respondents (n=181)

Finally, in the survey I asked a question on the importance of mathematics in the overall cognitive development of the young child. The majority (85%) felt that mathematics was equal in importance to literacy; with only 8% believing that mathematics is more important than literacy in EYT. This shows a lack of awareness of research highlighting the importance of EYM for later outcomes (Duncan et al, 2007; Claessens et al, 2009; Watts et al, 2014) as discussed in Chapter 2.

4.4 QUALITATIVE DATA

Qualitative data was collected to add a richer layer of information to the stark numbers that were collected as quantitative data. According to Roberts-Holmes (2014) qualitative research is based in beliefs that the social world in continuously constructed; and can record some of the complexity and diversity of human interactions. Qualitative data is useful in recording children's opinions and experiences – their voice (O'Sullivan, 2016) and should be considered in any research involving young children (Clark, 2017). The voice of the EYT's and the parents is also important to record and reflect upon, in order to interpret the data and make findings, conclusions and recommendations (Roberts-Holmes, 2014). All the qualitative data was analysed thematically using the Braun and Clark (2006) 6 step method. Below I have discussed key themes arising from each research instrument, and given some examples. However I also treated all quantitative data together as a whole body in order to deduce themes arising for each group of participants-children, parents, EYT's and myself.

4.4.1 SEMI-STRUCTURED INTERVIEWS WITH STAFF EYT'S RESULTS

Semi-structured interviews were carried out with EYT staff pre and post interventions, see Appendix 9 for discussion guides. The data collected from this cohort of responders – 8 staff EYT's working in the setting – was recorded in writing by me, post interview. In the responses from the staff EYT's prior to the interventions, there was a level of maths anxiety uncovered – all 8 EYT's admitted to not particularly liking mathematics whilst studying it at school. Responses ranged from *"I was definitely under confident"* to *"I didn't like maths at school"* to *"I HATED it"*. This maths anxiety was tempered to a certain extent in that 5 of the 8 had passed mathematics at leaving certificate level, and one EYT said *"I like maths for the early years, because it is easy – simple maths".* These findings correlate with arguments made by Ginsburg (2009) and Cotton (2019) stating YET's need

to be knowledgeable and confident in EYM, and with data on the phenomenon of maths anxiety (Hembree, 1990; Maloney and Beilock, 2012).

A lack of specific EYTT for EYMT&L was uncovered through these structured interviews. Staff qualified at Level 5 (QQI, 2016) had not covered specific mathematic content, only a much more generalised look at curriculum through play based learning. Of the 5 staff EYT's who had qualified to Level 8 ECEC, 3 of them had covered specific numeracy modules/part modules as part of their degree; the 2 other graduates had covered mathematics as part of the play and learning or play and curriculum modules within their Level 8 qualification. According to Cotton (2019) EYT's require a good level of mathematic subject knowledge, as well as confidence, in order to be able to respond to children's mathematics questions and developmental needs. It seems this level of knowledge is not being imparted to EYT's during initial training consistently across the many routes to EYTT in Ireland. This correlates with comments from McCauley Lambe (2021) requesting that EYTT becomes more subject focused, in line with Primary and Secondary Teacher Training. This finding is reinforced by the wider EYT sector survey carried out in this study.

Although all staff EYT's felt that they covered EYMT&L with children in their classrooms, and most had a good understanding of the topics that were included in EYMT&L, none of the 8 intentionally planned to include mathematics in the daily curriculum – it was covered more on an ad-hoc basis, as and when children showed interest. There was concern shown by respondents that maybe they weren't teaching EYM as it should be taught, or as frequently as it should be included. There was a theme of "show us how and we are happy to cover it" in response to the semi-structured interviews. Content was also of concern. One EYT was very honest, saying:

"If you asked me now what I should be teaching and how I should be teaching it (maths) I honestly couldn't tell you what I should do - maybe I should go on a course."

Other respondents said that they didn't think they had enough mathematical toys, games, equipment in their classrooms. *"There isn't even a ruler if they (children) want me to measure their towers"*. Another comment was *"how can I teach them about time if the battery in the clock has gone?"* Overall, the theme I identified here pre-interventions was that the staff EYT's were confident to teach EYM, but wanted training, support, content and materials in order to do it right.

Another theme identified was that staff EYT's believe strongly in learning through play in the early year's. Several of the responders were adamant that we should *not* have an EY academic mathematics curriculum, akin to the PMC (DES, 1999). Concern was expressed about the study:-

> *"You're not going to…err…schoolify my classroom are you, you know, through this research?"*

Themes identified post-interventions were that the staff EYT's in general found the research study a positive experience. The new materials – toys, games, books, equipment – had refreshed their own interest in teaching mathematics as well as stimulating the children's curiosity and interest. EYMT&L was reported to have increased in quantity and quality since the interventions had been carried out, and benefitted children in the class. Overall, they appreciated the CPD on mathematics in which they all took part (Appendix 18). Some feedback on the CPD was that it had "*given me areas to focus on, like the maths talk – that's easy to do- all day every day in my class"*. Some of the responders said that the 5 CPD modules had been a good refresher of *"what early year's maths is"* and what mathematics content they should teach. All staff EYT's committed to including mathematical content into their curriculum every day.

Disappointingly, the Numeracy Newsletters had not really been discussed by staff with parents. I would blame this on a general lack of engagement between parents and EYT's

form January to May this year. Due to Covid-19 pandemic parents dropped and collected children at the external building door and did not come into the classrooms. Opportunities for discussion between staff and parents were reduced. This aspect of the study will be looked at again in the future, as the Numeracy Newsletters could be a useful piece to encourage cooperation between parents and EYT's to benefit children's mathematical education.

4.4.2 Semi-structured Interviews with Parents Results

Semi-structured interviews were carried out with 11 parent's (representatives from all 3 classrooms) pre and post interventions, Appendix 10. All parents interviewed were positive to a mathematics research study – in general, all parents wanted their child to get a good start at preschool, in order to be ready for school in 1 or 2 year's' time. Comments included *"all this play is OK but what (he) needs is some….lessons, some structure and some numbers and sums – not play all the time"* and *"at last, someone sensible in the school, to teach numbers".*

The pre-intervention interviews recorded a level of maths anxiety in parents, similar to levels seen in EYT's (about 35%). There also seemed to be a lack of confidence in some parents own ability as primary educator for their child. One parent went on to say *"I was never any good at maths at school …..so I really don't know how I'm going to help (child's name) when she's getting maths homework from school…it is a big worry of mine…I was so bad"*. Six of the 11 parents reported they did not actively discuss numbers or play any mathematics with their child before the study.

Most parents responded that it was the preschool or schools responsibility to teach their child mathematics, and that they agreed their child was at the right age to be learning mathematics now, in the preschool, at the age the child was at. There was recognition from some parents that card games, dominoes and other "family" games could be useful for

learning mathematics in the home environment, and that reading books was also important for general cognitive development, as well as mathematics learning. The responses I got from the questions asked lead me to believe that for most families, these types of activities may happen, but as an exception rather than the rule. This is definitely an area I would like to investigate further and improve going forward.

Use of tablets and phones in the home environment seem to have taken over from board and card games, and even from parents reading to children. This finding in the pre-intervention interviews compelled me to investigate Apps for phones/tablets that could be used at home to encourage some mathematical learning for children, and I incorporated some App suggestions in the Numeracy Newsletters.

Post interventions, I didn't feel as though there was much change in the parent's opinions regarding the teaching and learning of mathematics for their child. There was a positive response to the research in general. I believe this was because parents felt because of the research, an academic subject being emphasised in their child's classroom, over and above play. This was despite all our efforts to explain that teaching of EYM was play based and based on children's interests.

The Numeracy Newsletters received a mixed response, with several parents with ESL saying they did not really understand them. Other parents felt they were too lengthy and too detailed, and that I could have made them simpler. One parent said *"it is not my job to teach my child, it is your job – you must do it".* Other parents said they found the Numeracy Newsletters very informative and helpful. The Apps were reported as being used by all 10/11 parents.

After the period of interventions, some parents reported observing their child counting out loud more at home, one child in particular was observed counting out loud going up and down the stairs, when she hadn't previously. Mum did however say she may have noticed it

because she was *"more interested and knew more about it"* after reading the Numeracy Newsletter – which is positive. Two parents reported they had played card games at home more during the last few months than they normally would, and one family had bought a set of children's playing cards specifically for doing this. Overall, I felt as though we could have enthused parents more about their child's EYM education, and that we failed somewhat, possibly due to the social distance necessity of the Covid-19 pandemic.

4.4.3 Observations of Children's Mathematics Play

The overriding theme deduced from all the observations carried out on children whilst playing in a mathematical way is that of their confidence. They are confident in their mathematical abilities, counting out loud at any opportunity, and shouting out numbers – right or wrong – to demonstrate they are able to count – sometimes up to 100. Anyone who heard one child shout *"Eleventeen"* in the middle of the classroom will certainly agree to this confidence. Young children have not yet learned to put off by mathematics - they are quite happy to experiment and make mistakes. These findings fit in with Clements and Sarama's (2014) ideas discussed in Chapter 2 of children being excited by mathematics, being curious and eager to learn, and engaging with mathematics in a deep way. Other themes from observations and work examples of the child participants include that they see everything they do as play, they do not see anything as work; and that the novelty factor of the many new materials and displays was important in the 12 weeks of the study in all of the three classrooms. I observed progression of skills, knowledge and abilities for children across all 5 mathematical domains as demonstrated in their work and play, and have included some examples below to demonstrate this.

The photograph examples included below show clear progression of complexity of block constructions throughout the study. I observed children were becoming more interested and more challenged by the mathematics materials in the classrooms and gaining

confidence in playing with them. This progression in all areas demonstrates the ideas of Clements and Sarama (2004; 2009; 2014) regarding learning trajectories for mathematics. A future study could analyse the positions for all children on these trajectories and utilise them in a more detailed way to plot learning and assessment needs for each child.

Observation 1 The block area – progression of complexity of constructions during the study

Image 4.1 Block Construction Week 1

Image 4.2 Block Construction Week 3

Image 4.3 Block Construction Week 4

Image 4.4 Block Construction Week 5

Image 4.5 Block Construction Week 10

Image 4.6 Block Construction Week 12

Observation 2 Shadows jumping in the park

This narrative observation from week 7 of the study took place in the park close to the setting. 2 children were on the trampoline with their EYT. It demonstrates the beneficial EYMT&L strategy of use of maths talk (Klibanoff et al, 2006; Sfard, 2007) and good grasping of a teachable moment (Ginsburg, 2009) to explain about size, position and movement. One child noticed her shadow, and the shadows of the teacher and the other child.

Image 4.6 Shadow Jumping 1

Image 4.7 Shadow Jumping 2

Ellie: "*Look my shadow is the smallest…and it's jumping….up….down….up….. down*"

Teacher: *"Yes Ellie look there are three shadows, mine's tallest, Sean's is middle sized and yours is the smallest and they all jump up and down like us…"*

Sean…*"What is making the shad……shall…shadlow….move…. jumping…teacher?"*

Teacher…. *"You are – when you move, your shadow moves - your body blocks the sun and makes the shadow…can you see the sun over there?"* (points to the sun) *"and the shadow over here"* (points to the child's shadow).

This concept of shadows and the position of the sun compared to their position developed into the marking out of a sundial in chalk on the path the back garden, and the children using themselves as the pointer to tell the time. This demonstrated sustained, shared thinking between the children and the teacher (Sylva et al, 2004; Woods, 2013).

Observation 3 Birthday Boy

Tony's 5th birthday was in week 12 of the study, he was 5 years old. He spent every single conversation with any adult or child who would listen explaining how he was now 5 and demonstrating 5 fingers with his hand. This is a technique we used a lot during the study whenever discussing number up to ten – the teacher would hold up the appropriate amount of fingers. Tony has continued to do this since the study has finished. This demonstrates kinaesthetic learning (Gardner, 1999) – a child using bodily movement to reinforce learning. Here is a photo of Tony showing his friend how old he is.


Image 4.8 Birthday Boy

Observation 4 Pattern Girl

Jenna showed a prolonged interest in pattern throughout the study, I wrote a Learning Story for her as a way to help her and her parents construct her learning identity (Carr and Lee, 2012). This child scored the lowest in the class on the REMA short form baseline test but improved by the second largest amount by week 12. Her mathematic confidence increased dramatically as a result of the study.

Jenna's Pattern and Mathematics Learning Story March 2021

Dear Jenna,

I have thoroughly enjoyed learning together with you on our mathematical journey this term. You started knowing numbers 1, 2, 3, and by the time we finished, you were confidently counting to 10 and beyond, and are able to recognise different shapes spontaneously.

I watched you begin to join in with our number and counting rhymes and songs, becoming happier to do this every time. I saw you becoming more coordinated and able to use your finger to point to items when counting; and being confident to stop when you had counted the last item in the set and then name that set as being "7".

I noticed you concentrating on patterns in your play every day. Whether you are playing with the pegboard, the home corner, the doll's house, Lego or doing artwork, you are drawn to creating patterns and shapes in your play. You really like to play with pattern.

Your teacher, Clare, has also noticed your enjoyment of pattern and helped you to make a pattern mat like the crocheted dolls blanket we use for the cot. You were thrilled with this piece of artwork and we showed it to the rest of the class and to your parents before we proudly displayed it on the classroom wall.

Finally, when I checked out your latest test result I was delighted to note the big change in score from your first test through to the last test. You have learned A LOT! I am sure your mammy and daddy are very proud of their little girl and her interest in maths and in patterns.

Keep learning and enjoying patterns

Your teacher, Lynn

Image 4.9 Pattern Play

4.4.4 CHILDREN'S WORK SAMPLES

The following examples show enhanced confidence in shape – both in drawing and talking about shape. The 3rd picture was done using a stencil, which was one of the new equipment additions to each of the classrooms, and Aoife has returned to it many times in play, during and after the study. This increased confidence in shape correlates with the improved scores for the shape subscale in the ECERS-R/E audit carried out, see Fig. 4.2

"Squares and lectangles in my house" (Millie, 4.3 years)

Image 4.10 Drawing shapes 1

"Dada's eyes are BIG circles" (Suzie, 4.7 years)

Image 4.11 Drawing shapes 2

"Lynn, look at my shapes – I've coloured them all" (Aoife 3.7 years)

Image 4.12 Drawing shapes 3

4.4.5 Survey of EYT Sector - QUALITATIVE Responses

I included open ended questions for respondents to answer with a few sentences if they wished, so I was able to analyse the quantitative data in some more detail by adding in the qualitative data. This is one of the advantages of using MMR (Cohen et al, 2018). The quantitative data which demonstrated maths anxiety in this cohort of 181 responses (36% reported definitely having maths anxiety; 36% said they had it to some extent) were well backed up by the comments the respondents added in to the survey. Here is a selection:

- *"Primary school- daunting experience -each child was asked to stand up from their desks and rhyme off times tables. Secondary school from JC year to end of leaving cert all the class was paying for grinds weekly I may add I was in A2 class - maths was my weakest subject. I didn't enjoy it at all"*
- *"Anytime it got hard I gave up and fell behind"*
- *"I always felt I was behind in maths and could never catch up. Teachers did not seem to notice and focused on the students who were able for the level they were teaching"*
- *"Nerves always set in"*
- *"Just lacked confidence in maths, could do it in the classroom but failed to remember much of it that didn't apply to real life"*

Another clear theme from the qualitative answers was that those respondents that were Montessori qualified (Level 6,7,8) from St. Nicholas Montessori or AMI, had very clear EYMT&L instruction in this training; whilst those that had qualifications in ECEC had a mixed experience of EYMT&L education in their EYTT. Some had covered distinct Numeracy and Literacy modules as part of their L6, 7 or 8 qualifications, whilst others had only touched on teaching mathematics as part of Play and Learning or play and Curriculum modules.

- *"Maths is a part of Montessori and was covered as such in detail when I studied to be a Montessori teacher"*
- *"Montessori –measuring, number lines, counting in fun and tangible ways"*
- *"I did Montessori teaching. It taught us how to teach maths up to 6yr olds"*
- *"Yes I'm AMI Montessori trained so have excellent knowledge of the mathematical equipment used in a Montessori Preschool When doing a HDip in ECEC though I*

felt there was very little mathematics education shown for a more play based curriculum"

Versus EYT's not trained in the Montessori Method…

- *"I do not think I received much training in literacy or numeracy or subject areas in general...we were taught to teach children in a playful manner, but the topic/theme or subject wasn't addressed"*
- *"I didn't do any maths for your children during my qualification (Level 6). I believe my own background in maths helps me with children teaching"*
- *"I completed a Montessori course alongside my degree course. Montessori really covers math for early years. The degree course probably not"*

From analysing the quantitative data, it emerged that in many settings (62%) there is no written Mathematics Curriculum or Policy in their setting, as advised by Ginsburg (2009) and others, and as one of the quality standards from Síolta (CECDE, 2006). Although many EYT's know what they should do in order to teach EYM, it is very often not written down within the setting as a set of guidelines/instructions or policies in order to ensure that it happens. Interestingly, none of the 181 respondents referred to the Aistear curriculum in this question. Do they feel the curriculum framework (NCCA, 2009) is too vague in this sense? Comments from the respondents included:-

- *"I would say early mathematics is included in our teachings through games and activities. But there is no clear policy on it"*
- *"We do not have a policy however numeracy and literacy is all around the setting. We also do number recognition monthly and songs that have days of the week, seasons etc. At table top we use buttons, counters, different sized blocks etc. "*

4.4.6 Teacher Research Journal - Reflections

As described in Chapter 3, I kept a Teacher Research Journal for the whole of this year of study, and recorded observations, actions and reflections from June 2020 until July 2021. The TRJ was also analysed thematically using the Braun and Clark (2006) technique. Within it there is a lot of data which has added weight to themes arising from the other qualitative research instruments used. However, there has also been an element of personal reflection recorded within the TRJ that would not have been captured had I not kept this journal. The main themes arising from these personal reflections are particular enjoyment of the CPD element of the interventions, working with the team of EYT's to improve knowledge, skills and abilities of EYMT&L. A second theme would have been the massive realisation of the importance of the environment, particularly for a play-based, inquiry-led curriculum. Thirdly I have realised I am good at mathematics, and really do not need to feel anxious about my abilities in mathematics ever again.

4.5 Conclusion to Chapter 4

In this chapter, I have discussed and analysed the results of the data collection, both qualitative and quantitative, in order to come up with findings and new knowledge as a result of the SSAR study I carried out in order to answer my research question **"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?".** The 4 main findings I have concluded are:-

1. Children benefit from knowledgeable teachers guiding their play activities in a rich mathematical environment
2. Children Benefit from everyday mathematics education at home and EYT's Can help parents to support this

3. Current EYT Teacher training on EYMT&L is inconsistent or non-existent
4. A proportion of EYT's have Maths Anxiety

I have concluded this chapter with a summary of the 4 main findings, and will go on in Chapter 5 to summarise these, and make recommendations for my practice, for practice in my setting, and for Irish EY Policy in the future.

CHAPTER 5 SUMMARY AND CONCLUSIONS

In this final Chapter, I will summarise the findings and discuss each of these and how they each contribute to answering the overall research question – ***"How can I as curriculum leader enhance the teaching and learning of mathematics in the ECCE classrooms in my early year's' setting for children aged 3-5 year's".*** I will mention limitations of the study, and give my recommendations for future research in EYMT&L. I will discuss implications of the study for myself; my early year's' setting; the EYT's working in my setting and the wider community of EYT's, and for other early year's settings. I will also discuss implications for Irish EY policy; and for the educational bodies, the DES, NCCA and DCEDIY.

5.1 DISCUSSION OF FINDINGS

The SSAR project set out to answer the research question, whilst allowing me to follow values I hold dear. This meant finding a way to enhance the EYMT&L whilst being democratic, collaborative, inclusive and by foregrounding EYM in my setting and with the staff EYT's, children and their parents. I reviewed pertinent EYMT&L literature and policy to generate a research plan; measured the baseline for the mathematic environment and children's mathematic skills and abilities, and then carried out 3 cycles of intervention. These were – ARC1 - improving the mathematics in the classroom environment; ARC2 – CPD aimed at enhancing the EYT's mathematics knowledge, skills and abilities; and ARC3, supporting parental efforts at mathematics education for their child. Quantitative and qualitative analysis of the data generated 4 main findings which I will now discuss.

5.1.1 CHILDREN BENEFIT FROM KNOWLEDGEABLE TEACHERS GUIDING THEIR PLAY ACTIVITIES IN A RICH MATHEMATICAL ENVIRONMENT

All 3 ARC's were designed to enhance the overall EYMT&L environment for the children in each of the classrooms and at home. By ensuring that:-

- the classrooms and outdoors areas were suitably resourced;
- that the staff EYT's were knowledgeable regarding mathematics content and process knowledge;
- staff EYT's were trained in using new equipment, toys and games provided;
- we included mathematics daily within the play-based curriculum;
- we increased the level of "mathematics talk" happening in the classrooms.
- We engaged parents in their child's education and supported them with some simple educational ideas.

I was able as curriculum leader to enhance the EYMT&L via our play based, inquiry led curriculum. These findings certainly contributes to answering the overall research question. I can conclude form this that knowledgeable EYT's are key to the mathematics success of children aged 3-5 year's (Sylva et al, 2010; French, 2013; Hayes, 2017). I also conclude that the mathematics environment – both physical and educational, are important factors. I also feel that the value of the mathematics environment provision – the physical elements required for mathematics teaching and learning – although recognised (Ginsburg et al, 2008; Ginsburg, 2009; Stafford, 2012) is perhaps understated. In this SSAR, it has proven to be possibly THE most important factor in our play-based, inquiry led curriculum. If the appropriate mathematics materials are not present in the classroom, the children will not be

able to play with them, be curious about them, ask questions and find their own answers, and extend their play, with the help of the EYT.

5.1.2 Children benefit from everyday mathematics Education at home and EYT's can support this

Parental input to the child's education is enshrined in children's rights as described by the UNCRC (UN, 1989). Parents are seen as the child's primary educators. This is particularly true of mathematics education because mathematics is in everyone's daily life. Parents can play a valuable role in enhancing the EYMT&L at home and whilst carrying out everyday life activities such as shopping, travelling, and playing. Some parents will require support and encouragement to do this – others will not. EYT's, CL's and ECECS's are situated perfectly to support parents with their primary education role in EYM.

I can conclude from my SSAR project that parents are important in EYM education, and that we as EYT's can and should do much to help and support. In the research setting, we now have a resource pack of 5 Numeracy Newsletters to support us going forward.

5.1.3 Current EYT Teacher Training on EYMT&L is Inconsistent or Non-existent

My own staff EYT's and the wider survey of EYT's via Facebook gave qualitative and quantitative data which pointed to the following concerns:-

- Many EYT's had been provided with little mathematics subject knowledge as part of their initial teacher training; and some had none whatsoever
- Very few ECECC's had a mathematics curriculum within their setting
- A proportion of EYT's did not feel EYM was as important as EY literacy
- Montessori-trained EYT's generally had more EYMT&L knowledge and confidence

I can conclude from these findings that CL's need to ensure a mathematics curriculum and/or policy is in place for their setting; and that cogniscence needs to be taken of the staff EYT's EYMT&L knowledge in all ECECC's, and CPD requirements in this subject area may need to be addressed.

5.1.4 A PROPORTION OF EYT'S HAVE MATHS ANXIETY

A substantial proportion of EYT's still felt as though they were incompetent in EYMT&L due to long standing mathematics anxiety from their own school days, I would conclude from this that by developing strong and confident mathematicians from the early years, we as EYT's may be able to have an impact on reducing this level of MA into the future.

5.2 LIMITATIONS OF THIS STUDY

One limitation was that the study was spread out over 22 weeks instead of the planned 12 weeks, due to the second Covid-19 lockdown of early 2021. This may have meant that some of the interventions lost their impact for some of the children– for example the addition of equipment and displays in the outside play area were all installed and in use by the children in Class 1 by the time the Class 2 and 3 children returned to preschool. It may also have resulted in some reduction in enthusiasm and motivation from some of the researchers – myself included. Ethically, I felt it would have been wrong to cut down any of the study in any of the classrooms – which is why I decided to continue when these classes returned. Social distancing measures due to this pandemic may have reduced interactions and collaboration with parents to be less than we would have liked.

Class 2 and 3 children missed almost 9 weeks of preschool at the beginning of 2021, and so took some time to resettle and to follow routine and learning again once they re-joined the preschool classes. This may explain why some of the REMA scores were lower for the

ECCE sessional classrooms compared to the class of children of essential workers who were allowed to return to preschool in early January. Two children (siblings) did not return due to family relocation, down to Covid-19 restrictions.

Another limitation was that some of the parents semi-structured interviews were carried out by telephone rather than face to face, again because of the Covid-19 restrictions, and consequently some of the meaning and implication of their responses may have been lost. Also, communications with parents were in English only, due to the Covid-pandemic limiting any three-way translator discussions I had originally wanted to do; and the prohibitive expense of translating larger documents. However I did facilitate that all communications could be translated by parents using Google-translate themselves, and most parents felt this was satisfactory.

5.3 Recommendations For My Setting

Taking the above findings and conclusions into account, the recommendations for me as CL within the setting are:

- To review and adapt the mathematics curriculum within the setting
- To continue to up skill self and staff EYT's in the area of EYMT&L
- To regularly observe the EYMT&L that's happening in the classrooms
- To investigate a cost-effective way of translating the Numeracy Newsletters into the most common languages used by families in our setting
- To continue to be a mathematics champion within the setting and with parents

5.4 Future Research

There is very little research carried out in Ireland on EYMT&L. A larger scale, longitudinal study investigating changes in mathematics skills and abilities of children over the 2 years of preschool provision (the ECCE scheme) would be ideal. This would add weight to the choice of the Aistear (NCCA, 2009) holistic curriculum guidelines when comparing to the mathematics specific curricula used for example in the USA (e.g. Building

Blocks, Clements et al 2014) which tend towards the academic curricula rather than play-based. It would also justify the government spend on these preschool year's, and may support the professional status, improved pay and conditions of EYT's to move towards a par with their primary counterparts. Individual settings, EYT's and CL's could carry out smaller scale studies within their own settings similar to this piece of SSAR, to discover whether EYMT&L can be enhanced in similar ways.

5.5 Reflections on the SSAR process

This SSAR has been enjoyable from a personal perspective. I embraced the "swampy lowlands" (Schön, 1995) of this more practical, pragmatic approach to research, and felt as though I was able to live towards my values whilst I was teaching EYMT&L to my team; whilst I was adding equipment and displays to the classroom and outdoors environment, and whilst I was on the floor, playing at mathematics with the children in the 3 classrooms. I embraced the messiness (Cook, 2009) of copious amounts of data, upsets of staff changes and delayed class starts, and the fact that lack of face to face contact limited the study to a small extent. I really feel as though I have discovered a lot about myself in the last year – importantly that I can at last lose that old weight of mathematics anxiety from around my neck; I am good at maths!

5.6 Implications

I will go on now to look at implications for the governmental bodies/agencies involved in ECEC in Ireland; the research setting, and for my own personal practice. I will conclude this section with some other questions that have arisen for me as I have progressed through the SSAR and through the research, and the study of all modules included as part of this MEd (Research in Action).

5.6.1 Implications for DCEDIY, NCCA, DES, HEA

The educational and academic agencies need to support better and more consistent EY teacher training in subject areas, especially mathematics for all novice EYT's. More EYMT&L CPD for practicing EYT's needs to be provided. The Aistear review which is just beginning needs to be cogniscent of the research around the enhanced importance of EYM and make even more implicit the EYMT&L within the framework. The Montessori Method of teaching EYM should be reviewed as part of this, and examples used, without being too didactic or academic, but using the strengths of the this way of teaching EYM whilst remaining anchored in play.

The new Primary Maths Curriculum must be inclusive of EYM carried out in ECECC's and have goals and plans around transition of children from preschool to primary school, and particularly focused on transition of EYM skills and abilities. The DCEDIY must follow the First 5 Action Plan and move towards a fully graduate led workforce for the education of very young children in Ireland. The Government of Ireland must commit to properly funding this to give young children consistent, knowledgeable EYT's in their ECEC settings.

5.6.2Implications for the Research setting

We will implement this EYM approach across all age groups in the research setting – the classrooms for very young children aged 1-2 years and 2-3 year's; as well as in the SAC classrooms. This requires some additional budgetary spend on new mathematical games, toys and equipment, and some additional training for some other staff EYT's. We

are in the process of writing a Mathematics Policy and Curriculum, and will possibly follow that up with a similar document for Literacy.

5.6.3 Personal Implications

This year of studying the MEd (Research in Practice) has been transformational for me. I have realised I am very good at EY mathematics. I have also realised I am good at teaching other EYT's how they can approach EYMT&L in their classrooms in order to improve outcomes for children. I enjoyed the research aspects of the study, especially understanding the policy documents. I enjoyed the practical nature of teaching young children mathematics on a day to day basis. I particularly enjoyed carrying out the CPD with the team of EYT's. I have made a decision to change my career towards one where I can use the skills I have developed to support more EYT's realise they are actually good at maths. I am going to apply for lecture work for EYT initial teacher training, and look at continuing my research journey, possibly another postgraduate qualification, or even a doctorate.

5.6.4 Some Further Questions Arising

Biesta et al (2019) advocates that by carrying out educational research, researchers should be left with many more questions requiring answers. These are key ones that have arisen for me in the course of this SSAR:-

- Why isn't there a more widely understood and explicit EYM curriculum?
- Why doesn't the responsibility for education of Ireland's youngest children fall under the DES/NCCA?
- Why is such an important phase in young children's educational lives left to private businesses to provide?
- Why is there such a wide discrepancy in EYT qualifications ranging from QQI Level 5 to Level 9? Why not train all to BEd/PMEd level and reward accordingly?

5.7 Final Conclusions

Living to one's values can be a challenge. It requires reflection, reflexivity, and a certain amount of self-criticism. However, what I can conclude overall from this MEd (Research in Practice) is that it is entirely worth it. One's well-being can be affected positively, as can one's relationships in the classroom with children and teachers, and with other colleagues. The most important factor for me during this study has been to observe the increased mathematics teaching and learning happening in the classrooms in the setting, and understanding what a positive impact that will have on children's lives into the future. If all this can be achieved, especially improving outcomes for young children whom we have the responsibility to educate, then it really does feel like "living my best life!"

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APPENDICES

APPENDIX 1 AISTEAR THEMES, AIMS AND LEARNING GOALS LINKED TO EYM THEME: EXPLORING AND THINKING

AIMS 1-4

1. **Children will learn about and make sense of the world around them.**
    - Learning Goal 5. Develop a sense of time, shape, space, and place
    - Learning Goal 6. Come to understand concepts such as matching, comparing, ordering, sorting, size, weight, height, length, capacity, and money in an enjoyable and meaningful way.
2. **Children will develop and use skills and strategies for observing, questioning, investigating, understanding, negotiating and problem solving, and come to see themselves as explorers and thinkers.**
    - Learning Goal 1. Recognise patterns and make connections and associations between new learning and what they already know
    - Learning Goal 2. Gather and use information from different sources using their increasing cognitive, physical and social skills
    - Learning Goal 3. Use their experience and information to explore and develop working theories about how the world works, and think about how and why they learn things
    - Learning Goal 4. Demonstrate their ability to reason, negotiate and think logically
    - Learning Goal 5. Collaborate with others to share interests and to solve problems confidently
    - Learning Goal 6. Use their creativity and imagination to think of new ways to solve problems

3. **Children will explore ways to represent ideas, feelings, thoughts and actions through symbols.**
    - Learning Goal 1. Make marks and use drawing, painting and model-making to record objects, events and ideas
    - Learning Goal 2. Become familiar with and associate symbols (pictures, numbers, letters, and words) with the things they represent
    - Learning Goal 3. Build awareness of the variety of symbols (pictures, print, numbers) used to communicate, and use these in an enjoyable and meaningful way leading to early reading and writing
    - Learning Goal 4. Express feelings, thoughts and ideas through improvising, moving, playing, talking, writing, story-telling, music and art
    - Learning Goal 5. Use letters, words, sentences, numbers, signs, pictures, colour, and shapes to give and record information, to describe and to make sense of their own and others' experiences
    - Learning Goal 6. Use books and ICT (software and the internet) for enjoyment and as a source of information.
4. **Children will have positive attitudes towards learning, and develop dispositions like curiosity, playfulness, perseverance, confidence, resourcefulness and risk-taking.**
    - Learning Goal 5. Develop higher-order thinking skills such as problem-solving, predicting, analysing, questioning, and justifying.

APPENDIX 2

FROEBELS' GIFTS

The Gifts

There are 6 original Froebel Gifts that are meant to be 'given' to children in order, as they age:

Gift 1: Set of multi-coloured yarn balls with strings (for the infant)

Gift 2: Wooden ball, cylinder, and cube (for the 1-2 year old)

Gift 3: Set of 8 small wooden cubes (blocks) (for the 2-3 year old)

Gift 4: Set of 8 small wooden planks (blocks) (for the 2-3 year old)

Gift 5: Set of wooden blocks that includes cubes, planks, and triangles (blocks) (for the 3-4 year old)

Gift 6: Set of more complex wooden blocks that includes cubes, planks, triangles (blocks) (for the 4-5 year old)

Froebel's Gifts were the first 'educational' playthings. The Gifts are made of natural materials, and are specifically designed to demonstrate the key concept of spiritual 'unity' that can be recognised in play, which Froebel believed to be the clearest expression of the human soul.

NUMERACY NEWSLETTER NUMBER 1

Activities for number, counting and simple arithmetic at home

Adapted from *Mathematics in Early Year's Education* (2018)
Montague-Smith, A., Cotton, T., Hansen, A. and Price, A. London & New York, Routledge.

These activities do not require any special equipment, as they make use of everyday items in the home. The most important thing we can teach children to give them the best chance at maths is number and counting. Teach them how to count from 1-10, in order, in their home language as well as English. Initially this will be a memorising exercise but that is OK, it is thought this is the best way to learn this sequence.

Then we need to teach them how to count items; and how to recognise number symbols – again in the home language and in English. I have attached some information and some hints and tips to help you do this. It is important to do this with children in everyday situations as well as being covered in preschool, because number and counting is something we all use every day in our everyday lives, so we can shop, use the bank, do our jobs etc. Once numbers and counting are learned, we can move onto simple addition and subtraction.

Number and counting everyday things at home

- Count the cans of beans going into the cupboard; the carrots going into the rack; the apples into the fruit dish
- Count all the red cars; all the play-people; the bricks as they go away; the stairs on the way to bed
- Count enough plates for everyone at dinner; biscuits for each person; fish fingers onto the plates, enough for everyone to have a sweet
- Notice and use numerals (number symbols) on the mobile phone, the TV remote control, the calendar, the clock
- *Addition and subtraction* – at breakfast, count the toast slices, how many each person eats and then how many are left
- *Division and fractions* – sharing out sweets, cutting a pizza, or breaking a bar of chocolate – use words like half, quarter, eighth etc.

Number and counting on the way to Preschool

- Count the houses along the street, the cars that go past, the tress in the park, the windows in a house, the chimneys on the roof
- Notice the numerals on the houses; car registration plates; identifying buses by number
- Noticing numerals on vehicles e.g. phone numbers on tradesman's vans etc.

Number and counting out shopping

- Coins and notes for paying for goods; all the cent coins; the postage stamps for the letters; how many cupcakes/cookies for tea; enough oranges for all the children to have one
- Notice prices and compare and contrast prices, quantities etc.

- *Addition and subtraction* – involve children in discussions about money and change
- *Simple multiplication* – how many Satsuma's will we need if we both eat two?

Number and counting games that can be played at home

Simple basic toys and games in the home can be used to enrich the learning of numbers and counting, e.g. playing cards, dominoes, dice, lotto, snakes and ladders. With dice, encourage your child to "guess" the small numbers of dots and shout the number out quickly, rather than count. This is a special skill and helps them later to recognise numerals. With playing cards, start by taking out the larger number cards, leaving 1-5 in play.

Snap – match cards by number

Pelmanism Game – place cards face down, in rows, take turns to pick up two; if numbers match, keep the pair and the winner has the most matching pairs

Lotto – picture lotto with images that can be counted and matched; number lotto to match numbers

Board games with a dice – Snakes and ladders, Ludo and other simple track games where numbers (dots) on dice are counted and same number of places are counted and moved on the board

Story Books, songs and rhymes

- Grey Rabbits 1,2,3 (Alan Baker)
- One Bear at Bedtime (Mick Inkpen)
- Anno's Counting Book (Mitsumasa Anno)
- How Many Legs (Kes Gray)
- One is a snail, ten is a crab (April and Jeffrey Sayre)
- Three Billy Goats Gruff (Traditional)
- Three Little Pigs (Traditional)
- Cockatoos (Quentin Blake)
- Kipper's Toy box (Mick Inkpen)
- The Doorbell Rang (Pat Hutchins)

Lots of stories offer the chance to count items in illustrations.

Rhymes: One, two, three, four, five, once I caught a fish alive; Five Little Spacemen; Ten Green Bottles; Five Little Sausages; Five Little Ducks.

Recommended Apps

Endless Numbers (available free on apple and android app stores)

Quick Math Junior (available free on apple)

Count up to ten (€2.29 on apple store)

NUMERACY NEWSLETTER NUMBER 2

Activities for shape, space and position at home

Adapted from *Mathematics in Early Year's Education* (2018)
Montague-Smith, A., Cotton, T., Hansen, A. and Price, A. London & New York, Routledge.

These activities do not require any special equipment, as they make use of everyday items in the home. Studies of children's mathematical achievements show that young children who understand shape and space concepts are better at arithmetic and geometry in later years. In the early years, it begins as developing understanding of shapes and of spatial orientation – a child knowing where they are in relation to things around them, and the language of position and movement. This understanding is later extended to understanding geometric shapes, their properties, and changes in shapes.

Understanding shape and space is essential for making sense of the world, since all physical objects possess three-dimensional shape and occupy spaces and positions in our world. Understanding shape in the early year's is about children recognising and being able to draw simple, regular shapes (e.g. square, triangle etc.) and understanding some of their properties (e.g. a triangle always has three straight sides). Understanding space and position means understanding the position and orientation of objects and also changes in position including sliding (translation) turning (rotation) and flipping (reflection).

I have attached some information and some hints and tips to help you do this at home with your young child. It is important to do this with children in everyday situations as well as being covered in preschool, because shape, space and position is something we all use every day in our lives. The best thing you can do is to discuss shapes with your child as you or they see them, and to use the shape, space and position words as much as possible in conversation with your child.

Sorting shapes, stacking and position words

- Putting away the shopping and naming the shapes of the packaging – cubes (e.g. Oxo cubes) cuboids (e.g. cereal boxes) and cylinders (food tins)
- Noting how all the packages stack together in the cupboards and discussing this.
- Talking about where you are putting the shopping away – the top of the press, the bottom of the freezer, the back of the pantry, the front of the drawer
- In the car – talk about maps and/or the satellite navigation system and explain how maps work
- Draw a map of the neighbourhood with your child using position words and shape words to describe the features on the map and where your home is in relation to the park, the shops, the cinema etc. Plan and draw out routes when you go for a walk, to the shops, to the preschool.

Exploring shapes

- Using construction kits – Lego, Duplo, Magnetix, Sticklebricks, Knex and describing the shapes created using shape words

- Cooking and play dough – making pastry shapes, pastry and cookie cutters, baking circular cakes, jam tarts, cup-cakes, tray bakes etc. and talking about shapes as you make them
- Cutting out – Cutting around pictures, following outlines, cutting in straight lines, making home-made jigsaw puzzles – use old Smyth's catalogue and a small pair of scissors
- Puzzles and games – posting shape toys, inset puzzles, simple jigsaws
- I-Spy - ask your child to go around the house and find a square, a circle, a triangle, a semi-circle etc. This can be done on journeys, whilst walking around the village, the supermarket etc.

Drawing

- Drawing favourite toys, family members, trees in the garden, a house/buildings and discussing the shapes in the drawings
- Line drawings - drawing lines – straight, curved, wiggly, wavy, zig-zag and explaining these. Especially useful if lines drawn from left to right.

Reflections

- Mirrors – describing what can be seen in mirrors in the house, car mirrors, the bowls and the backs of spoons.
- Looking at reflections in puddles, ponds, lakes, the sea, and describing the reflections and their positions

Small World Play

- Dolls house – describing where the furniture and people are, and where they are being placed or a story as to where they are going e.g. mammy doll is going upstairs to check on the baby doll…
- Cars/Garage/Train-set and train tracks – talk about routes, positioning, relationship to other toys e.g. the red train is in front of the green train but behind the blue train….

Story Books, songs and rhymes

- All shapes and sizes (Shirley Hughes)
- The Blue Balloon (Mick Inkpen)
- I can build a house (Shigeo Watanabe)
- Bears in the night (Jan & Stan Berenstein)
- Rosie's Walk (Pat Hutchins)
- We're going on a Bear Hunt (Michael Rosen)
- Over Under and through (Tana Hoban)
- Me on the Map (Joan Sweeney)
- The secret birthday message (Eric Carle)

Lots of stories offer the chance to spot shapes and to describe positions in illustrations, e.g. can you see the bunny hiding behind the tree?

Rhymes: to the tune of "Round and round the garden like a teddy bear"

Round and round the circle, draw one in the air *(draw a circle shape in the air with your finger*).

Stop! Look! Find one! Circles are everywhere

Recommended Apps

Shapes for kids (apple)

Shape Up! (Apple and android)

Dragon Shape – Lumio Geometry Challenge (€299 on apple store)

Friendly Shapes (€3.99 apple and android)

Questions used in Survey Monkey© Survey of EYT's via Social Media

1. How long have you been working in the Early Year's Sector?

- 1-2 year's
- 3-5 year's
- 6-10 year's
- 11-20 year's
- 20+ year's

2. What is your highest Early Year's Education Qualification to date?

- Level 5
- Level 6
- Level 7
- Level 8
- Level 9
- I'm on the Grandfather clause
- I have no formal early year's qualifications

3. What is the highest level of mathematics exam you have passed to date (either at school or other institution)?

- Junior Certificate or equivalent
- Leaving Certificate or equivalent
- 3rd Level Institution
- I didn't pass mathematics exam
- None of above

4. In your opinion, did you suffer from "maths anxiety" when you were studying maths at school?

- Yes I definitely did
- To some extent
- Not at all, I was confident at mathematics

Please explain your answer

5. In your opinion, did your early year's education and training specifically equip you to teach early year's mathematics to young children?

- Yes
- No
- Somewhat

Please explain your answer

6. What curriculum is used in the centre you currently work in?

- Play-based
- Montessori
- Steiner
- Hi-Scope
- Kindergarten
- Other – please specify

7. What age-group of children do you regularly teach?

- <1 year
- 1-2 year olds
- 2-3 year olds
- 3-5 year olds

8. Within your centre or classroom, is there a separate clear policy or curriculum on teaching mathematics?

- Yes
- No
- Do not know

Please add additional comments or explanations here

9. What topics do you cover when teaching early year's mathematics to young children in your classroom? (Please tick all that apply)

- Shapes
- Measurement
- Sequencing
- Time/telling the time
- Pattern recognition
- Number recognition – written/spoken
- Counting
- Simple arithmetic
- Structure/construction
- Digital technology
- Maths talk – teachers and children
- Problem solving
- Creativity
- Estimating/guessing
- Cooking and baking

10. How important do you think the teaching and learning of numeracy and mathematics is in the early years?

- Most important subject
- Equally as important as literacy
- Important but not as important as literacy
- Not important

Please explain your answer

APPENDIX 5 EARLY YEAR'S MATHEMATCS LEARNING ENVIRONMENT AUDIT

Early Year's Mathematics Learning Environment Audit

Adapted from: Northamptonshire County Council (2017*) Early Year's Improvement Team Learning, Skills and Education Early Year's Mathematics Learning Environment Audit*© Northamptonshire County Council Available at: https://www.northamptonshire.gov.uk/councilsettings/children-families-education/early-year's/information-for-childcare-providers/Documents/Maths%20Learning%20Environment%20Audit%202017-2018.doc

Item - Indoors	**Present? x or √**	**Notes on quantity, condition etc.**
Is the classroom light, bright, inviting to walk into?		
Are all resources and areas clearly labelled with words and pictures?		
Do resources reflect all families/cultures?		
Is there a number line displayed (0-20) at child height?		
Are larger numbers displayed e.g. 100 square?		
Do displays include print/typed numbers and children's representations of numbers?		
Are numbers written in other relevant languages/scripts?		
Do displays celebrate children's maths learning?		
Is there a dedicated "maths area" where maths resources are stored and children can access independently every day?		
Are there story books available to support number, space, shape, measure, and sequencing?		
Is there a height chart showing standard and non-standard measures e.g. cm and hands?		
Is there a visual timetable with times & activities marked on it?		
Is there a wide range of natural resources for counting, sorting, matching e.g. shells, pebbles, acorns, corks etc.?		
Are there tape measures – paper, cloth, metal?		
Are there rulers? Wood, plastic, 12cm; 30cm?		
Is there a weighing scales?		
Is there a balance set?		
Is there a "child friendly" clock?		
Is there sorting sets? To sort by size? By weight? By colour? By shape?		
Is there a number of chunky dice?		
Is there a collection of sand timers?		
Is there a few timers/stop watches?		
Is there a collection of 2D and 3D shapes?		

Is there a collection of number flash cards?		
Are there number games children can access and play themselves? Lotto, Snap, Dominoes, Memory Match games?		
Are their collections of things children can investigate, sort, sequence, and match independently e.g. boxes, buttons, socks, coins, keys?		
Is there a display drawing attention to numbers in everyday life?		
Do children's attempts at recording numbers get recorded in Learning Journals or displayed in the classroom?		
Is there a child height washing line for pegging numerals in the correct order? For pegging matching items together?		
Is there a Rhyme and Song Book with a collection of number related rhymes and songs readily available? E.g. 5 little ducks, 10 little sausages etc.		
Is there a good collection of junk materials (boxes, packaging etc.) to encourage junk art/construction?		
Are there numerals present in small world play materials?		
Are there many opportunities to explore shape, volume, space, measure with different materials e.g. sand, water, play-dough, clay, gloop?		
Do water, play dough, clay and sand play materials include measuring jugs/tubes, pouring jugs, cutting options, shape options?		
Does the construction area have visual images of things children can construct and photos of children's constructions?		
Are there tape measures and spirit levels in the construction area?		
Is snack time used as a maths learning opportunity e.g. counting, correspondence, sharing etc.?		
Are there opportunities for children to cook? Is this used as a maths learning opportunity e.g. weighing out ingredients, counting cookies etc.		
Are there mark making materials always accessible in the maths area for children to record attempts at writing numerals and/or simple tallying?		
Are there calculators in the maths area?		
Are there magnetic numbers/magnetic boards in the maths area?		
Is there plenty plain and squared paper/exercise books available?		

Is there a calendar at child's height?		
Are there telephones – land-line and mobile? A phone book with useful phone numbers?		
Are there notebooks, shopping lists etc. in the home corner?		
Are there recipe books in the home corner?		
Are there weighing scales – balancing, digital in the home corner?		
Are there 3D objects e.g. cereal boxes, cans, tins, fruit, vegetables etc. in the home corner?		
Is there play money, wallets, and purses available?		
Is there a table to set and matching plates, cups, cutlery etc. provided?		
Are there items available to play shops/restaurants, price up items and use money?		
Are there alarm clocks, clocks in home corner?		
Item - Outdoors	**Present? x or √**	**Notes on quantity, condition etc.**
Does the outdoor environment complement and extend the indoor environment?		
Is the area well organised, inviting and challenging every day?		
Can children access resources and return them independently?		
Are there large scale maths resources outdoors e.g. den building, obstacle courses, construction on a large scale?		
Are there large scale construction materials available e.g. tyres, crates, wooden planks?		
Are there natural resources for children to explore and count, sort, match, organise e.g. sticks, twigs, logs, stones, pebbles etc.?		
Are real materials accessible for children to understand concepts of weight, size, pattern, shape e.g. real bricks?		
Are there measuring tools which can be used outdoors?		
Is there an outdoor version of the washing line at child height?		
Are there opportunities every day for large scale painting/chalking of numbers and shape, number lines/grids e.g. chalk boards, chalk, walls, easels, buckets and brushes?		
Are there permanent markings outdoors of shapes, numerals, tracks, parking bays for bikes, scooters, Hop-Scotch etc.?		

Is there a permanent number line (0-100) on the wall? On the floor? Permanent Height Charts on the walls?		
Are there games/resources/targets to support scoring e.g. basketball hoop, beanbags, quoits, skittles etc.?		
Is there an outside clock?		
Is there an outside thermometer?		
Is there an outside weather chart?		
Do you have a system to measure rainfall outside?		
Are there opportunities to look for natural shape/pattern in the outdoor environment, e.g. spiders webs? Do children have access to cameras to photograph these? Do you go on nature walks to extend these ideas?		
Are indoors/outdoors steps numbered?		
Is outside water play always available? Are there calibrated measuring jugs, tubes etc. for pouring and measuring always available? Is there an outside tap?		
Is there a water-play wall with various hoses, pipes, guttering for playing with pouring water/angles/flow etc.?		
Is there an outdoors kitchen? Is it well resourced?		
Are clip boards, paper and pencils taken outside to facilitate mark making and recording whilst doing outside play and maths?		
Are there weaving materials outdoors? E.g. fencing and scrap wool, ribbons etc.?		
Is there an outdoors large size balance and associated resources e.g. buckets and items to balance/weigh?		
Are there numbered items available as outdoors resources e.g. painted number pebbles? Painted number bricks, logs etc.		

APPENDIX 6 ECERS-E AND ECERS-R AUDIT TOOL

Mathematics Learning Environment Audit

Adapted from Sylva, K., Siraj-Blatchford, I. and Taggart, B. (2011) *ECERS-E – The Four Curricular Subscales Extension to the Early Childhood Environment Rating Scale (ECERS-R) 4th Edition with Planning Notes.* New York, NY: Teachers College Press; and from Harms, T., Clifford, R.M. and Cryer, D. (2015) *Early Childhood Environment Rating Scale (3rd Ed.)*. New York, NY: Teachers College Press.

Scoring system

1 = Inadequate; 3 = Minimal; 5 = Good and 7 = Excellent. Rote counting/use of pre-prepared worksheets is not allowed as evidence. P= evidenced in planning; D=evidenced from displays; R=evidenced in children's Learning Journals; Q=evidenced in questioning adults and children.

1 Counting and the Application of Counting		Score
Number activities could include counting songs/rhymes; counting books; counting games; computer/tablet programmes including counting; counting during play. Daily routines include the non-play-based activities such as snack, lunch, arrival, departure, putting on coats, clean-up time etc. so use of number during routine activities might include counting how many children in the line; how many plates/cups to put on the table etc.		
1.1 Children rarely take part in activities or routines where counting is used (P,D,R,Q)	Score Yes if < once/week	
1.2 Very few resources are available to encourage the children to take part in counting activities (e.g. acorns, shells, buttons, counting books, counting games	Score Yes if < 3 sets of resources available	
3.1 A few number activities, counting books, games, songs or rhymes are used with children (P, D, R, Q)	Score Yes if > once a week	
3.2 Numbers are named as part of daily routines	Score Yes if observed during audit	
3.3 Math materials include a few resources that encourage children to take part in counting activities (e.g. posters featuring numbers; sets of countable objects; counting books, games or other resources)	Score Yes if least 2 examples present	
5.1 Number activities such as songs, rhymes, counting books and/or games are often used with the children (P,D,R)	Often means daily. Score Yes if see number activities during the observation OR its clear from evidence that this happens daily	
5.2 Children are encouraged to count objects and associate spoken numbers with concrete maths concepts e.g. counting children in the room; six cups for 6 kids; asking child to count blocks in tower they built	Score yes for 2 or more examples- can be in group time or free play time, but adults must be observed encouraging the children to count	
5.3 Adults use ordinal numbers when working with the children (1st, 2nd, 3rd etc.)	Score Yes for at least 1 example, look for evidence of this happening e.g. 1st, 2nd, 3rd linked to turn taking, place in line, height measurement etc.	

7.1 All children encouraged to take part in counting objects in a variety of contexts (e.g. dramatic play, snack time, sharing Legos)	Score Yes if EYT's look beyond the obvious and bring counting concepts into a wide range of contexts, formal and informal, with individuals, small and large groups, and seen in several instances during one observation across different contexts	
7.2 Activities are planned that encourage one to one correspondence indoors and outdoors e.g. place settings, sharing of materials and equipment, parking spaces for outdoor vehicles etc. (P)	Score Yes if at least 3 different samples of activities that explicitly encourage one to one correspondence are found in the sample of planning reviewed; at least one must relate to activities outdoors	
7.3 EYT's incorporate working with children on specific number based games and activities into their curriculum planning e.g. dice games, dominoes, matching number pairs/picture-number pairs (P)	Score Yes if specific number activities are explicitly planned several times/week	
7.4 There is a well-equipped maths area with number games, countable objects and related books	Score Yes if number games, countable objects and books are accessible to children on a daily basis	

2 Reading and representing simple numbers		**Score**
Children's use of written number at this stage should be "emergent number" i.e. young children's own attempts at representing and recording numbers in a written form. In its earliest stages may appear as lines and squiggles, or simple "tallying". For older children this might include writing a shopping list and listing how many of each required. Formal writing of numbers is not suggested for children in this age range. Written number work should be linked to a practical purpose and concrete experiences (e.g. pricing items in a shop or restaurant) rather than through formal activities or worksheets.		
1.1 Attention is not paid to the reading and/or representation of simple numbers (P,D,R)	Score Yes if no evidence in obs. Or P, D, R that adults draw children's attention to written numbers, or that no opportunities are provided for children to recognise/represent numbers	
1.2 No written numbers are displayed (D)	Score Yes if displays are present and are easily visible to children, at EYT level or large enough to read from a distance	
3.1 Numbers and the equivalent objects are displayed next to each other e.g. 1 next to one apple, 2 next to 2 sweets etc. (D)	Score Yes if displays are present and are easily visible to children, at EYT level or large enough to read from a distance	
3.2 Some children occasionally read or represent numbers (P, D, R)	Evidence not required for all children. Score Yes if at least	

	one child reading/representing number OR seen in Learning Journals	
3.3 Children's attention is drawn to written number sequence (e.g. by a number line or by talking to the children about a counting book)	Score Yes if at least one example is observed. Adults should be observed drawing explicit attention to written numbers in sequence, and the numbers should also be spoken aloud so that children associate spoken numbers with the written symbols. This can be whole group, small group or individual work.	
5.1 Children are regularly encouraged to read and/or represent simple numbers (P,D,R)	Score Yes if opportunities are available in the classroom environment that allow children to recognise and represent numbers where appropriate. This should be happening daily but at least 3 x per week. Need to see at least one example of EYT explicitly encouraging number recognition and/or representation in small group/large group or free play.	
5.2 Children have materials that are readily available to support them in representing numbers e.g. magnetic numbers, number shapes to trace, sandpaper numbers etc.	Score yes if these are accessible daily	
7.1 There are planned classroom activities containing numbers and adults encourage children to recognise and represent numbers in a variety of media e.g. playing the number fishing game and writing down the numbers of the fish caught; singing a number song and beating out/clapping out the number in the beat/claps (P,D,R)	Score Yes if number activities are planned at least weekly. Also must see at least 2 examples of children being encouraged to recognise or write/represent simple numbers in different contexts/media (e.g. drawing numbers in sand, clay, paint, pencil, on tablet/computer, reading numbers in the environment on displays, packaging etc.)	
7.2 Written number work is linked to a practical purpose, e.g. putting age on a birthday card; writing prices out on a play-restaurant menu (P,D,R)	Score Yes if children encouraged to use numbers for a practical purpose in order to support their activities within the setting. If not seen in observation, at least 2 examples from reviewed materials.	

3 Mathematical Activities - Shape		**Score**
1.1 Little evidence shown that children have opportunities to experience or learn about shape (e.g. shape is rarely commented during ordinary play or daily routines, adults do not plan activities that involve shape(P,D,R)	Score Yes if no references to shape are seen during the observation and there is no evidence in planning, records or display that shape work has been carried out in the past	
3.1 Some different shapes are accessible to children	Score Yes if at least 2 resources with different shaped pieces can be found (e.g. play dough shape cutters, shapes displayed on wall, blocks with different shapes) **and** are accessible on a daily basis	
3.2 Shapes are named outside planned shape activities (P, D, R)	Score Yes if EYT's use shape related language during observation – proper names AND common names also acceptable e.g. tube (for cylinder), and use of pattern names e.g. wavy, zigzag	
3.3 Shape is an explicit part of some activities (P, D, R)	Score Yes if at least one example is observed. Adults should be observed drawing explicit attention to written numbers in sequence, and the numbers should also be spoken aloud so that children associate spoken numbers with the written symbols. This can be whole group, small group or individual work.	
5.1 A wide variety of shapes are available and accessible and EYT's draw children's attention to shape names (e.g. circle, square, triangle, rectangle) (P,D,R)	Score Yes if a good selection of shape resources (5 or more) are accessible on a daily basis. (E.g. poster, set of shape puzzles, a set of blocks of different shapes, shapes to trace, a book on shape in the book area, a set of 3-D shapes). In addition should see at least 2 examples of EYT's drawing attention to names of shapes.	
5.2 EYT's draw children's attention to shape in their own work e.g. constructions, drawing, and record this in writing in their learning journals alongside photos of constructions and drawings etc.	At least one example must be observed during observation, and several must be seen in children's learning journals	

7.1 Many activities and materials are available which encourage children to generalise shape across a variety of contexts (e.g. art activities, construction activities, group play, socio-dramatic play etc.) (P,D,R)	Score Yes if at least 3 examples are seen or are evident during the observation, and confirmatory evidence is seen in the materials reviewed	
7.2 EYT's encourage children to understand the different properties of shapes (e.g. a triangle has 3 sides, a square has 4 sides all the same length) and to use this understanding to solve shape puzzles and apply their knowledge to new situations (P,D,R)	Score Yes if there is evidence on the day OR in materials reviewed that there is application of knowledge about shape.	

4 Mathematical Activities – Sorting, matching and comparing		**Score**
There are many easy ways to incorporate these type of activities into daily routines as well as free play. A washing line and pegs at child's height with matching pairs (e.g. laminated socks); well labelled baskets and shelves to sort correct items away when tidying up; and many discussion opportunities during meals – comparing quantities, colours of plates/cups; comparing coats – yes he has a hood on his coat and you do not etc. etc.		
1.1 Children are not encouraged to sort, match or compare objects and materials(P,D,R)	Score Yes if no references to sorting, matching or comparing are seen during the observation and there is no evidence in planning, records or display that such work has been carried out in the past	
3.1 Some items to support sorting, comparing and matching are accessible to children	Score Yes if at least 2 examples accessible on a daily basis of everyday items that could be matched, sorted or compared e.g. collections of natural materials (pebbles, pine cones, shells) and different shaped or sized resources (e.g. sand/water play toys, blocks) plus some of more commercial materials e.g. counting bears, Unifix cubes, sorting/matching games.	
3.2 Children sort, compare and/or match by at least one unifying feature e.g. colour, heavy/light etc. (P, D, R)	Score Yes if children are seen sorting, matching or comparing (+/- adults) AND at least 2 examples seen in materials reviewed	
3.3 EYT's demonstrate sorting, comparing or matching and encourage the children to participate (P, D, R)	Score Yes if at least one example is observed. EYT's must actively demonstrate and support sorting/matching/comparing – as part of planned adult led activity or small group, or even during tidy away time.	

5.1 Activities occur regularly that develop and extend sorting, comparing and matching skills (P,D,R)	Score Yes if at least one example is observed and it is clear from planning materials reviewed this happens regularly – at least 3 or 4 times/week	
5.2 Characteristics that form the basis for sorting, matching and comparing are made explicit by the adults	Score Yes if at least one example observed	
5.3 EYT's encourage children to use comparative language when sorting, matching, comparing or measuring (e.g. big, bigger, biggest)	Score Yes if at least one example is observed. The focus here is on encouraging children to use comparative language	
7.1 Children are encouraged to identify the characteristics of sets of objects that form the basis for sorting, matching or comparing (e.g. they are all round)	Score Yes if at least one example is observed	
7.2 Sorting, comparing and matching language is used in a variety of contexts across a range of activities (using words such as curlier, bigger, heavier)	Score Yes if at least 2 different examples must be observed	
7.3 Children are encouraged to complete a sorting/matching/comparing activity, then repeat it using a different criterion as the basis for sorting, matching, comparing e.g. first sort by colour, then by size, biggest to smallest	Score Yes if one example observed on the day OR at least one explicit example is seen in sample of materials reviewed	

(The following sections are adapted from Harms, T., Clifford, R., Cryer, D. (2015) *Early Childhood Environment Rating Scale (ECERS-R) 3rdEdition.* New York: Teachers College Press).

5 Mathematical Activities – Block Play		**Score**
There are 2 types of blocks considered in this section – unit blocks and large hollow blocks. Blocks must be organised by different type; and there must be sufficient space for large constructions to be built and remain in place for some time if possible.		
1.1 No blocks accessible for children's use	This section should not consider interlocking blocks, e.g. Lego, or small table blocks. Unit blocks are usually made of wood, and in a set, there should be varied shapes, all related in scale; e.g. 4 small blocks of 1 unit are same size as rectangular block of 4 units. Large hollow blocks allow children to build much larger structures, and can be made of wood or plastic.	
1.2 Staff show little or no interest in children's block play	Score Yes if staff do not encourage block building; interact only to stop quarrels, insist children ALWAYS clean up their constructions; don't	

	talk about the block play/show appreciation for their constructions	
3.1 Enough blocks and accessories accessible for at least 2 children to build sizeable independent structures at the same time for 25+ minutes during the observation	Score Yes if 25+ minutes during the observation	
3.2 Enough clear floor space for 2 children to build sizeable independent structures	Score Yes if enough clear floor space and children allowed to leave constructions in place for some time; to go back to later	
3.3 Blocks and accessories organised by type	Accessories include small toys to be played with alongside the blocks, e.g. small world toys such as animals, vehicles, people, small buildings, signs, fences, trees etc.	
3.4 Some positive involvement by staff when children play with blocks	Score Yes if hear positive comments about what children are building; staff show some interest in children's block play; staff ask children to identify shapes	
5.1 Enough blocks and accessories accessible for at least 3 children to build sizeable independent structures at the same time for 25+ minutes during the observation	Score Yes if 25+ minutes during the observation	
5.2 Blocks and accessories are stored on open, labelled shelves with accompanying picture labels	Score Yes if observed	
5.3 Special block interest centre set aside, with storage and suitable building surface, out of traffic	Score Yes if observed	
5.4 Block interest centre accessible for play for at least 1 hr. during the observation	Score Yes if observed	
5.5 Staff have many conversations with interested children about their block play	Score yes if hear conversations involving open ended questions about their block play; what are they building, what are their favourite shapes etc.	
7.1 Large hollow blocks are accessible for use in a suitably large area where play can be very active	Score Yes if observed	
7.2 Staff link written language/number symbols to children's block play	Score Yes if staff record children's comments about what they've built, take photos and write these notes, write about shapes children use in structures, share these notes with parents	

7.3 Staff point out the maths concepts that are demonstrated in unit blocks in a way that interests and engages the children	Score Yes if this is noted – discuss more/less relationships; size/shape relationships e.g. half as big, twice as big, look 2 square blocks make a rectangle block etc.	

6 Mathematical Activities – Maths in daily events		**Score**
Daily events consists of parts of the daily routine not linked to play or structured activities. This covers the use of maths words and concepts during non-maths activities. Thus staff are modelling the use and value of maths in everyday lives, and this helps children generalise their maths learning to many different circumstances		
1.1 Staff do not use maths words or ideas when talking to children during daily routine	Score Yes if not observed (e.g. 5 more minutes until clean-up, first we will get our coats then second we will go outside)	
1.2 Staff maths talk is observed being used in a threatening or punitive manner with the children during the observation	Score Yes if observed (e.g. I am going to count to three and if you do not have your coat on you will not go outside)	
1.3 Staff become irritated or negative with children if they do not understand and respond appropriately to maths talk	Score Yes if observed (e.g. staff member tells child to take 2 slices banana and child takes 3; staff tells child off for getting it wrong)	
3.1 Staff occasionally count/use other maths words during transitions or routines	Score Yes if observed (e.g. count while children wash hands; tell amount of time until clean up, use first second third when giving directions etc.))	
3.2 Staff sometimes use maths talk whilst children are playing with non-maths toys in non-maths areas	Score Yes if observed (e.g. count blocks in a tower, trains on a track, dolls in a cot; ask how many pizza slices fit on the plate, what shape are the pizza slices etc.)	
3.3 Staff use maths talk referring to daily events during large group time	Score Yes if observed (e.g. count number of children present; absent; discuss days of week and how many days until the weekend etc.)	
5.1 Staff encourage maths learning as part of daily routines	Score Yes if observed (e.g. explain setting table; one plate for each person; name rectangular table, round plates; count to 20 whilst washing hands; use measuring cup to measure portions of meals/measuring jug to measure drinks etc.)	

5.2 Staff engage children in conversations about maths as they play in non-maths areas	Score Yes if observed (e.g. discuss using measuring cups to water plants; count how many cups are needed for the dolls; how to measure feet when playing shoe shops)	
7.1 Staff help children to connect printed numbers or shapes with everyday use in their environment	Score Yes if observed (e.g. count number of days on calendar until weekend; talk about numbers on a clock and what they mean related to when going out to play; talk about shapes of traffic and other signs when out for a walk in local environment)	
7.2 Staff often ask questions while interacting with children in non-maths areas to encourage children to explain their own maths reasoning	Score Yes if observed (e.g. how do you know one more person can sit here? How did you know if you got enough crayons for everyone?)	
7.3 Children aged 4-5 given more complex maths related tasks	Score Yes if this is observed (e.g. count number of children present to figure out how many are absent; count children to work out how many plates/cups needed for dinner; use tape measure to see if table will fit in a space; use a map whilst talking about school outing)	

7 Mathematical Activities – Understanding written numbers		**Score**
A key factor in maths understanding is the understanding of number symbols and this is across language barriers also. Highly important then is the visual demonstration of what a written number represents, followed by verbal back up, fingers shown etc. NB Staff expectations for children reading/writing numbers should be age and stage appropriate.		
1.1 No print numbers on display materials/any numbers displayed do not have pictures to show what the number means	Score Yes if not observed	
1.2 No obvious print numbers found in classroom toys/materials that are accessible to children	Score Yes if not observed	
1.3 Inappropriate expectations of EYT's for children to be able to read or write numbers	Score Yes if observed (e.g. worksheets are used that are too difficult; staff respond negatively when children lose interest in difficult number writing work)	
3.1 Some print numbers in display materials are accompanied by pictures that show what the number means	Score Yes if observed (e.g. poster with numbers and corresponding images to match the number)	

3.2 Some play materials with numbers are accessible during the observation	Score Yes if observed (e.g. toy/real telephones; play money; number stencils; menus with prices; shop goods with prices etc.)	
3.3 When children are playing with materials with numbers, staff sometimes point out the numbers and talk about them in a way that interests children	Score Yes if observed (e.g. point to the price of a meal on a menu. Also give credit for staff writing down numbers whilst playing with children e.g. making price labels for the shop etc.)	
3.4 Staff sometimes relate print numbers to corresponding numbers of objects	Score Yes if observed (e.g. when reading a book, counting items that are numerated in the book; when playing a number based game, pointing to the number of objects represented by the print number e.g. in picture match dominoes etc.)	
5.1 At least 3 different play materials that help show children the meaning of print numbers are easily accessible to children	Score Yes if observed (e.g. puzzle with number on one piece and matching items on other piece; Flash cards with dots and matching print numbers; simple number card games; bingo etc.)	
5.2 These materials are available for at least 1 hour during the observation	Score Yes if observed	
5.3 Staff show children how to use materials with printed numbers and talk about the meaning of the printed numbers on the materials	Score Yes if observed (e.g. count objects with the child and read/write the number; use “first, second, third” etc. as child uses printed number sequence; point out numbers on rulers, thermometers, menus, showing how they indicate difference in size/amount etc.)	
7.1 At least 5 different appropriate materials that help children attach concrete meaning to print numbers are accessible at all times	Score Yes if observed (e.g. displays relating number symbols to sets of items; games/puzzles with similar; set of playing cards; number jigsaws; menu’s; shopping lists etc.)	
7.2 Materials in 7.1 are accessible for at least 1 hr. during the observation		

7.3 Staff frequently show children how to use the number materials and talk about the meaning of printed numbers	Score Yes if observed at least twice (if children are obviously familiar with how to use these materials, it is important to observe this coupled with staff explaining numbers and the game/other maths words	
7.4 Print numbers are often related to number of fingers shown by staff; or children (and staff comment on this – e.g. "yes that's right that is two" when two fingers are shown)	Score Yes if this is observed (e.g. when reading a number book/rhyming/singing a number rhyme/song, whenever numbers are verbalised, adding the finger symbol reinforces learning for the child)	

APPENDIX 7 ADAPTED REMA SHORT FORM TEST AND SCORE SHEET

Short Form of the Research Based Early Mathematics Instrument (REMA)

Adapted from: Weiland, C., Wolfe, B., Hurwitz, M., Clements, D., Sarama, J., Yoshikawa, H. Early mathematics assessment: validation of the short form of a prekindergarten and kindergarten mathematics measure. *Educational Psychology*. 32 (3) 311-333

ITEM	**DESCRIPTION**	**CORE COMPETENCY**	**LEVEL OF THINKING IN LEARNING TRAJECTORY (Clements & Sarama, 2009)**
1	Count to 5	Counting - verbal	Reciter (1-5) Reciter (1-10) Counts 10-20 Counts 100 (21 and higher)
2	Compare quantities (3&4), identifies larger quantity	Comparing number; sequencing	Non-verbal comparer of similar items
3	Subitises 3	Recognition of number; subitising	Perceptual subitiser up to 4
4	Subitise 10	Recognition of number; subitising	Conceptual subitiser to 10
5	Subitise 15	Recognition of number; subitising	Conceptual subitiser to 15
6	Match numeral to set - 5	Numerals	Numerals
7	Counts 8 objects	Counting objects	Corresponder
8	Count 4 objects	Recognition of number and subitising	Producer (small numbers)
9	Hide 3, show 2 – How Many?	Composition of number	Composer to 4 then 5
10	Hide 4, show 6 – How Many	Composition of number	Composer to 10
11	Add 7 and 5	Arithmetic	Make it
12	Which is smaller? 27 or 32?	Comparing number and sequencing	Place value comparer
13	Identify triangles	Shape	Shape recogniser
14	Identify rhombuses	Shape	Identifying shape
15	Use straws to make a triangle	Shape	Constructor of shapes from parts
16	Identify the sides of a geometric shape	Shape	Side recogniser
17	Make ABB pattern	Patterning	Pattern duplicator
18	Identify rectangle	Shape	Constructor shape from parts
19	Identify triangle and trapezoid	Compose shape	Shape decomposer

Short Form of the Research Based Early Mathematics Instrument (REMA) – Instructions and score sheet

Child's randomised number_____ Date of investigation_____

Score 1 for demonstrated skill and 0 for no demonstration/incorrect demonstration.

ITEM	DESCRIPTION	Instructions to tester	Yes	No
1	Count to 5	Ask child to count to 5		
2	Compare quantities (3&4), identifies larger quantity	Put down a set of 3 items and a set of 4 – ask child which group has the most?		
3	Subitises 3	Put down 3 items –ask the child to quickly tell you how many (not counting – 'sees' there are 3		
4	Subitise 10	As above with 10 items		
5	Subitise 15	As above with 15 items		
6	Match numeral to set - 5	Put down 5 items as a set; ask child to point to the number which is the same (from a number line)		
7	Counts 8 objects	Put down 8 objects in a line and ask child to count them out loud		
8	Count 4 objects	Same as above – might shout out 4 quickly as has subitised rather than counted (note this)		
9	Hide 3, show 2 – How Many?	Show a group of 5; hide 3 with a cloth; ask how many in total?		
10	Hide 4, show 6 – How Many	As above		
11	Add 7 and 5	Ask the child to do the sum – 7+5		
12	Which is smaller? 27 or 32?	Point to the 2 numbers on a number line and ask which is the smaller number. Could back up by a group of 27 items and 32 similar items.		
13	Identify triangles	Put out triangles and ask what shape is called		
14	Identify squares/rhombuses	Put out squares/rhombuses and ask what shape is called (rhombus might be called a diamond)		
15	Use straws to make a triangle	Put out several short straws and ask the child to make a triangle shape		
16	Identify the sides of a geometric shape	Ask the child to point to the sides of the triangle or rhombus		
17	Make ABB pattern	Put out red and blue beads/Legos and ask the child to make a pattern that is red-blue-blue-red-blue blue-red-blue blue etc.		
18	Identify rectangle	Put out triangles and ask what shape is called		
19	Identify triangle and trapezoid	Put out triangles and trapezoid ask what the different shapes are called		

APPENDIX 8 CHILD INVOLVEMENT OBSERVATION PROFORMA

Child Involvement Observation Proforma

Adapted from Bertram, T., Pascal, C. (1999) *Effective Early Learning Programme Child Involvement Scale*

Name of setting						
Observer						
Date						
Name of child		Sex M/F	DOB			
SEN?						
No. children present		No. adults present				
AM/PM	Description of type of play in 2 minute period		Level of involvement			
TIME			1	2	3	4	5
TIME			1	2	3	4	5
TIME			1	2	3	4	5

The child involvement scale consists of 2 components:

1. A list of signals

2. The levels of involvement in a 5-point scale

The Child Involvement Signals

Concentration

The attention of the child is directed toward the activity. Nothing can distract the child from his/her deep concentration

Energy

The child involves much effort in the activity and is eager and stimulated. Such energy is often expressed by loud talking, or pressing down hard on the paper with a crayon or paintbrush. Mental energy can be deducted by an observer from facial expressions which reveal "hard" thinking.

Complexity and creativity

This signal is shown when a child freely mobilises his cognitive skills and other capabilities in more than routine behaviour. The child involved cannot show more competence – she is at her very best. Creativity does not mean that that original products have to result, but that the child exhibits an individual touch what she does furthers her own creative development. The child is at the very edge of her capabilities.

Facial expression and posture

Nonverbal signals are extremely important in reaching a judgement about involvement. It is possible to distinguish between "dreamy, empty EYTs" and "intense EYTs". Posture can reveal high concentration or boredom. Even when only viewed from behind their posture can be revealing.

Persistence

Persistence is the duration of the concentration at the activity. Children who are really involved do not let go of the activity easily; they want to continue with the satisfaction, flavour and intensity it gives them, and are prepared to put in effort to prolong it. They are not easily distracted by other activities. Involved activity is often more prolonged but can depend on the age and the development of the child.

Precision

Involved children show special care for their work and are attentive to detail. Non-involved children gloss over such detail, it is not so important to them.

Reaction time

Children who are involved are alert and react quickly to stimuli introduced during an activity e.g. rush to a proposed activity, show prolonged motivation and keenness.

Language

Children can show that an activity has been important to them by their comments e.g. they ask for the activity repeatedly. They tell you they enjoyed it!

Satisfaction

The children display a feeling of satisfaction with their achievements

NB the signals are channels for observer awareness. They are not to be used on a scale basis but as an overall judgement of the child's involvement. The observer should use the signals to build an image of the child. By trying to establish how the child really feels, the level of involvement can be ascertained. NB the signals can be exhibited in different ways by different children, so individual children should be observed and their signals recognised, ideally by someone who knows them.

The Child involvement scale (to be read in conjunction with the signals for involvement)

Level 1. Low activity

Activity at this level can be simple, stereotypic, repetitive and passive. The child is absent and displays no energy. There is an absence of cognitive demand. The child may stare into space. NB this could be a sign of inner concentration.

Level 2. A frequently interrupted activity.

The child is engaged in the activity but half of the observed period includes moments of non-activity., in which the child is not concentrating and is staring into space. There may be frequent interruptions in the child's concentration, but her involvement is enough to return to the activity.

Level 3. Mainly continuous activity.

The child is busy at an activity, but it is at a routine level and the real signals for involvement are missing. There is some progress but energy is lacking and concentration is at a routine level. The child can be easily distracted.

Level 4. Continuous activity with intense moments.

The child's activity has intense moments during which activities at level 3 can come to have special meaning. Level 4 is reserved for the kind of activity seen in those intense moments and can be deduced from the involvement signals. This level of activity is resumed after interruptions. Stimuli from the surrounding environment, however attractive, cannot seduce the child away from the activity.

Level 5. Sustained, intense activity.

The child shows continuous and intense activity revealing the greatest involvement. In the observed period, not all the signals for involvement need to be there, but the essential ones must be present: concentration, creativity, energy and persistence. This intensity must be present for almost all of the observation period.

How to carry out the observations

- Observe 50% of your study children up to a maximum of 12 children. Ensure equal number of both sexes and similar ages.
- Complete observations during 2 sessions in one week (one in am and one in pm)
- Each observation to last 2 minutes
- Observe each child 3 x per session but not continuously
- A total of 6 observations/12 minutes per child
- Record each observation on the child involvement observation proforma – 2 sheets per child.

Discussion Guide for Semi Structured Interviews with Staff EYT's

Pre-Intervention

1. What level did you pass exam in mathematics?
2. Tell me how you feel about mathematics?
3. Have you ever suffered anxiety around mathematics?
4. What did you learn in your early childhood education (L5/6/7/8/9) regarding teaching early mathematics for children aged 3-5?
5. Did you cover a specific module on teaching early year's mathematics or numeracy?
6. What do you understand as "early maths" activities in your classroom?
7. What proportion of your classroom time is spent on adult guided mathematic activity for children?
8. Do the children in your class choose mathematic play?
9. Is mathematic play/early maths equipment always available?
10. Do you think you enable early maths opportunities for your children every day?
11. How important do you think early mathematics is for young children? Is it as important as literacy, for example?
12. How do you make sure early mathematics is covered as well as early literacy?

Discussion Guide for Semi Structured Interviews Staff EYT's

Post-Intervention

1. Overall, did you find the study positive or negative?
2. Why do you think this?
3. Do you think you have increased or decreased the amount of mathematics teaching in your classroom since the beginning of the study?
4. Why do you think this?
5. Did you find the CPD modules on teaching maths in the early years helpful?
6. Why do you think this?
7. Did you find the new mathematical materials, toys and games a positive addition to the classroom?
8. Why do you think this?
9. Did you observe more or less mathematical free play in your classroom after the study (i.e. play the children choose to do themselves)?
10. Did you use much more maths talk in the classroom after the study?
11. Did you get any interaction with parents on the numeracy newsletters?
12. Overall, do you think the children in your class benefitted from the increased emphasis on mathematics in the classroom?
13. Any other comments or feedback?

Discussion Guide for Semi Structured Interviews with Parents

Pre-intervention

1. How do you feel about the mathematics research happening in your child's classroom?
2. Whose responsibility is it to teach your child maths?
3. Do you think the preschool is the right time/place for your child to begin to learn more maths?
4. Does your child enjoy numbers, shapes, and maths games?
5. Do you teach your child maths at home?
6. Do you count items out e.g. steps; money; packets and tins at home?
7. Do you read books with your child at home?
8. Do you play cards and/or board games at home?
9. Do you download educational apps onto your phone/a tablet for your child to play?
10. How confident are you about mathematics? Was it a subject you enjoyed at school?
11. What else could we do in preschool to help your child learn maths?
12. What else could we do to help you as parent support your child's maths education and learning?

Discussion Guide for Semi Structured Interviews with Parents Post-intervention

1. How do you feel about the mathematics research that was carried out in your child's classroom?
2. Why do you think this?
3. Did you find the Numeracy Newsletters 1-5 helpful?
4. Could we have improved them? How?
5. Has your child talked to you about mathematics more since the research has been carried out in their class?
6. Have you talked to your child more about maths since reading the Numeracy Newsletters?
7. What mathematical play and talk do you do now that you didn't do before?
8. Why has this changed?
9. Do you feel more confident, less confident or about the same about teaching maths to your child now compared to before the research happened?
10. What could we have done differently to help you help your child learn maths?
11. Do you have any other comments or feedback to add?

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 Masters I am doing a research project. The focus of my research is how we can enhance and improve numeracy and early maths teaching and learning for 3-5 year old children at XXXX Preschool. This will happen during term time from January to Easter 2021.

In order to do this, I intend to carry out research in your child's classroom by assessing the current numeracy teaching situation. I will do this by auditing our numeracy provision and the play environment. I will observe the children engaging in numeracy talk, numeracy play and numeracy learning.

The data will be collected using observations, audits, a daily research journal and by recording teachers and children carrying out numeracy and mathematical discussions in the classroom (audio recordings only – no video will be used). The children will be asked their opinions and their thoughts about early mathematics through discussing how they like to play with numbers, counting, shape, size, measure, pattern, and blocks and also through rhymes, songs and stories.

I will then assess all of this information, and decide what we need to continue doing and how/where we could improve. I will carry out environmental and teaching interventions to improve on what we are already doing, and will assess the classroom situation again, make some conclusions, and we will amend our numeracy and mathematics curriculum accordingly.

Throughout the research I will also provide information to parents regarding everyday numeracy at home, so you can help your child develop numerical and mathematical knowledge. If I am able, within Covid-19 restrictions, I would also like to hold a parents evening to share with you all some of the research findings and some of the best practice ideas and advice to maximise numeracy and early mathematics education for preschool children. This might be possible virtually, with zoom or WhatsApp if we cannot meet face to face as a group.

Your child's name and the name of the preschool 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. Participation is entirely voluntary, and no negative consequences will occur if you decide *not* to allow your child to participate, or not to participate yourselves.

All information gathered will be confidential and hard copies of information I use will be stored in a locked press, to which only I have access; electronic data will be

encrypted and stored on a hard drive of a desk-top PC; and all data will eventually be destroyed within a stated timeframe in accordance with the University guidelines.

The required legal and professional guidelines will be complied with at all times when carrying out this research. The research will only be carried out with approval granted by the Ethics Committee and the Froebel Department of Primary and Early Childhood Education at the University of Maynooth.

I will endeavour to continue this research in the event of closure of classrooms or even the full setting due to the Covid-19 situation. I will rearrange my research plans and if necessary, will contact parents and children by telephone, zoom, WhatsApp, or by post in order to continue to gather and to share information and advice.

I would like to invite you to give permission for yourself and your child to take part in this project. Please talk to your child(ren) about getting involved in this research, and read through their own permission slip with them. I have attached some additional information you can read before you decide to consent your permission.

If you have any queries on any part of this research project feel free to contact me by email at lynn.odwyer.2016@mumail.ie

Yours faithfully,

Lynn O'Dwyer

Lynn O'Dwyer

Child's Assent Form

Child's name ……

I am trying to find out how children like to play with numbers and with early maths in preschool. This type of play includes block play, construction, songs and rhymes, stories, role play (e.g. shops), numbers, counting, and play with patterns and sequences (e.g. days of the week). I would like to find out more about how you learn through this kind of play. I would like to watch you play and listen to you speak when you are in school and to write down some notes about you. Would you be ok with that? Pick a thumb:

Yes

No

I have asked your Mam and Dad to talk to you about this. If you have any questions, I would be happy to answer them. If you are happy with that could you ask your mam or dad to sign the form that I have sent home and you can sign it too if you want? If you change your mind after we start, that's ok too.

Thank you,

Lynn

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/we voluntarily agree to the participation of my/our child (ren) in this study. I/we also voluntary agree to be involved personally. 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 or mark: _____

Date: _____

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Information Sheet - Parents and Guardians

Who is this information sheet for?

This information sheet is for parents and guardians.

What is this Action Research Project about?

Early Year's Teachers studying the 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. Data will be generated using observation, reflective notes, audio recordings, surveys and questionnaires. The student is then required to produce a thesis documenting this action research project.

What are the research questions?

How can I as curriculum leader improve the teaching and learning of numeracy in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?

- What is current baseline of the numeracy environment/provision in each of the 3 classrooms?
- What is current baseline of numeracy teaching and learning in each of the 3 classrooms?
- What are the individual teacher attitudes to numeracy teaching and learning before the interventions?
- What are the individual teacher knowledge levels of numeracy teaching and learning before the interventions?
- What interventions will improve the numeracy teaching and learning, given results of baseline studies and knowledge gained during literature review?
- Once interventions have been carried out, what is the level of numeracy environment and provision in each of the 3 classrooms?
- Once interventions have been carried out, what is the new level of numeracy teaching and learning within these classrooms?

What sorts of methods will be used?

- Observations, Daily Réflective Journal, Audio recordings, Surveys, Questionnaires, Structured Interviews ; Semi-structured interviews.

Who else will be involved?

The study will be carried out by me, **Lynn O'Dwyer**, as part of the Master of Education course in the Froebel Department of Primary and Early Childhood Education at Maynooth University. The teachers in the ECCE classrooms will also be involved. 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 your child, who is attending ECCE classes at xxxxx PRESCHOOL. You are also being asked for your consent to get involved with some parent led numeracy teaching initiatives at home, and to attend a parents "Early Year's Maths and Numeracy Advice" evening (in person or virtually) in order to gain further advice and support from me and the Early Year's Teachers regarding numeracy learning for your child in the home environment.

Confidentiality and Data Collection:

In all cases the data that is collected will be treated with the utmost confidentiality and the analysis will be reported anonymously. The thesis will be written in a way to anonymise the setting and to ensure the identity of all participants – children, teachers and parents, is also kept anonymous.

As the research is being carried out with children, if a Child Protection Disclosure is made during the course of the research, we will not be able to keep that as confidential, as per Children First: National Guidance for the Protection & Welfare of Children (DCYA, 2015) and XXXXX PRESCHOOL Adult and Child Protection Policy and Procedures.

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 eventually be destroyed in accordance with University guidelines.

Contact details: Student: Lynn O'Dwyer **E:** lynn.odwyer.2016@mumail.ie

APPENDIX 12 INFORMED CONSENT FORM FOR EARLY YEAR'S TEACHERS INVOLVED IN THE STUDY AT THE RESEARCH CENTRE

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Dear Early Year's Teacher,

I am a student on the Master of Education programme at Maynooth University. As part of my Masters I am doing a research project. The focus of my research is on assessing how we teach numeracy in the ECCE classrooms with children aged 3-5 year's, and how we can improve how and what we teach, and how we can enhance numerical and early maths learning for children. This will happen during term time from January to Easter 2021.

In order to do this, I would like to carry out research by assessing the current numeracy teaching and learning provision at xxxxxx PRESCHOOL. I will do this by auditing our numeracy provision, our numeracy play environment and equipment. I will take photos and keep notes on these points. I will stay in the classrooms for periods of time in order that I can observe numeracy talk, numeracy play and numeracy teaching and learning. I will record this via audio recordings (no video will be used), narrative and other written observations, field notes, and in my daily research journal. As part of my observations I will ask the children their opinions and their thoughts about early mathematics through discussing how they like to play with numbers, counting, shape, size, measure, pattern, blocks and also how they like to use numbers through rhymes, songs and stories.

I would also like to ascertain your own views on the numeracy teaching and learning that happens in your classroom; and get your assessment of how you teach numeracy and early maths. I will gather your opinions on what you feel we are doing well, and what we could maybe change, to improve the amount of numeracy and early maths children are exposed to in our ECCE classrooms. I will ascertain your opinions via a semi-structured interview format.

I will then ask you to carry out environmental and teaching interventions to improve on what we are already doing, and will assess the classroom situation again, make some conclusions, and we will work on changing our numeracy and mathematics curriculum accordingly, in line with the findings of the research.

Throughout the research I will also provide information to parents regarding everyday numeracy at home and how they can help their children develop numerical and mathematical knowledge. Within Covid-19 restrictions, I would also like to hold a parents evening to share with parents some of the best practice ideas and advice to maximise numeracy and early mathematics education for preschool children. This

might be possible virtually, with zoom or other video-conferencing software if I cannot meet parents face to face as a group.

The teacher's names, the children's' names and the name of the preschool will not be included in the thesis that I will write at the end of the research. You will be able to withdraw from the research process at any stage. Participation is entirely voluntary, and there will be no adverse or negative effects, should you choose not to get involved with this piece of research.

All information gathered will be confidential and information I collect will be stored in a locked press only accessible by me; electronic data will be encrypted, and all data will eventually be destroyed in a stated timeframe in accordance with the University guidelines. The required legal and professional guidelines will be complied with at all times when carrying out this research. The research will not be carried out until approval is granted by the Ethics Committee and the Froebel Department of Primary and Early Childhood Education at the University of Maynooth.

I will endeavour to continue this research in the event of closure of classrooms or even the full setting due to the Covid-19 situation. I will rearrange my research plans and if necessary, will contact parents and children by telephone, zoom, WhatsApp, or by post in order to continue to gather and to share information and advice.

I would like to invite you to give your permission to take part in this project. I have attached some additional information you can read before you decide to consent your permission.

If you have any queries on any part of this research project feel free to contact me by email at lynn.odwyer.2016@mumail.ie

Yours faithfully,

Lynn O'Dwyer

Lynn O'Dwyer

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Information Sheet – XXXXX PRESCHOOL Early Year's Teachers

Who is this information sheet for?

This information sheet is for XXX PRESCHOOL Early Year's Teachers.

What is this Action Research Project about?

Teachers studying the 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 practice. Data will be generated using observation, reflective notes, audio recordings, surveys and questionnaires. The student is then required to produce a thesis documenting this action research project.

What are the research questions?

How can I as curriculum leader improve the teaching and learning of numeracy in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?

- What is current baseline of the numeracy environment/provision in each of the 3 classrooms?
- What is current baseline of numeracy teaching and learning in each of the 3 classrooms?
- What are the individual teacher attitudes to numeracy teaching and learning before the interventions?
- What are the individual teacher knowledge levels of numeracy teaching and learning before the interventions?
- What interventions will improve the numeracy teaching and learning, given results of baseline studies and knowledge gained during literature review?
- Once interventions have been carried out, what is the level of numeracy environment and provision in each of the 3 classrooms?
- Once interventions have been carried out, what is the new level of numeracy teaching and learning within these classrooms?

What sorts of methods will be used?

- Observations, Daily Reflective Journal, Audio recordings, Surveys, Questionnaires, Structured Interviews, Semi-structured interviews.

Who else will be involved?

The study will be carried out by me, Lynn O'Dwyer, as part of the Master of Education course in the Froebel Department of Primary and Early Childhood Education at Maynooth University. The children in the ECCE classrooms, and their parents, will also be involved. 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 participate in this study and work alongside me Lynn O'Dwyer in researching the numeracy teaching and learning in your classroom; and also working with me to put in improvements and developments to enhance that teaching and learning for the benefit of the children in your classroom.

Confidentiality and Data Collection:

In all cases the data that is collected will be treated with the utmost confidentiality and the analysis will be reported anonymously. The thesis will be written in a way to anonymise the setting and to ensure the identity of all participants – children, teachers and parents - is also kept anonymous.

As the research is being carried out with children, if a Child Protection Disclosure is made during the course of the research, we will not be able to keep that as confidential, as per Children First: National Guidance for the Protection & Welfare of Children (DCYA, 2015) and Sunflowers Adult and Child Protection Policy and Procedures.

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 eventually be destroyed in accordance with University guidelines.

Contact details: Student: Lynn O'Dwyer **E:** lynn.odwyer.2016@mumail.ie

Maynooth University Froebel Department of Primary and Early Childhood Education

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

XXXXXPRESCHOOL EARLY YEAR'S TEACHER CONSENT FORM

I have read the information provided in the attached letter and all of my questions have been answered. I voluntarily agree to participate in this study. I am aware that I will receive a copy of this consent form for my information. I am aware that participation in this research project is entirely voluntary, and that no negative consequences will occur should I decide NOT to participate, or should I withdraw from the research project whilst it is ongoing.

ECCE Teacher Signature_____

ECCE Teacher Name_____

Date: _____

Maynooth University Froebel Department of Primary and Early Childhood Education

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

Information Sheet – EARLY YEAR'S EDUCATORS VIA SOCIAL MEDIA

Who is this information sheet for?

This information sheet is for EARLY YEAR'S EDUCATORS who respond to a survey via social media.

What is this Action Research Project about?

Teachers studying the 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 practice. Data will be generated using observation, reflective notes, audio recordings, surveys and questionnaires. The student is then required to produce a thesis documenting this action research project.

What are the research questions?

How can I as curriculum leader improve the teaching and learning of numeracy in the ECCE classrooms in my early year's' setting for children aged 3-5 year's?

- What is the current knowledge of early year's educators of numeracy and early maths teaching and learning?
- What are the attitudes of early year's educators to numeracy and early maths teaching and learning?
- Are early childhood education and care settings generally well provided with equipment to support a rich mathematic learning environment? If not, where are the gaps?

What sorts of methods will be used?

- On-line Survey

Who else will be involved?

The study will be carried out by me, Lynn O'Dwyer, as part of the Master of Education course in the Froebel Department of Primary and Early Childhood Education at Maynooth University. 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.

your early year's qualification; your maths education; and your opinions on early maths and numeracy teaching and learning related to your current educational role. By completing the survey, your consent is assumed.

Confidentiality and Data Collection:

In all cases the data that is collected will be treated with the utmost confidentiality and the analysis will be reported anonymously. The thesis will be written in a way to ensure the identity of all participants is not disclosed.

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 eventually be destroyed in accordance with University guidelines.

Contact details: Student: Lynn O'Dwyer **E:** lynn.odwyer.2016@mumail.ie

APPENDIX 14 PHOTOGRAPHS OF NEW MATHS CENTRE & NEW MATHS TOYS /GAMES /EQUIPMENT

APPENDIX 15 MATHEMATICS BOOKS LIBRARY AT THE END OF THE INTERVENTION

Maths	A squash and a Squeeze	Julia Donaldson & Axel Scheffler
Maths	Abigail	Catherine Rayner
Maths	Circle	Mac Barnett & John Klassen

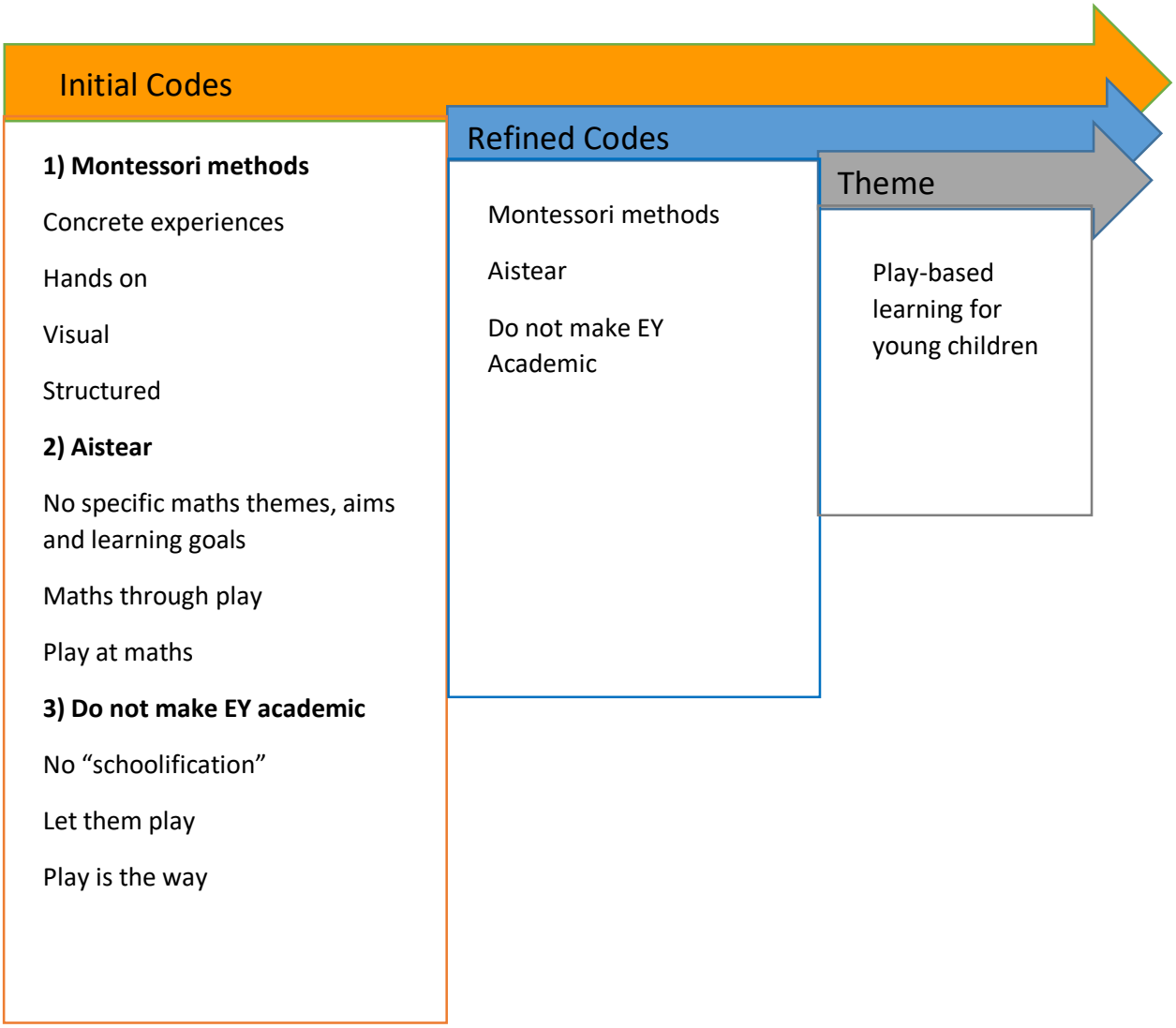
Maths	Counting on Frank	Rod Clement
Maths	Flat Stanley goes camping	
Maths	Flat Stanley	
Maths	Handa's Surprise	Eileen Browne
Maths	Kipper's Birthday	Mick Inkpen
Maths	Kipper's Toybox	Mick Inkpen
Maths	Man on the Moon	Simon Bartram
Maths	Me on the map	Joan Sweeney & Qin Leng
Maths	Mr Grumpy's Outing	John Burningham
Maths	One year with Kipper	Mick Inkpen
Maths	Over in The Grasslands	Anna Wilson, Alison Bartlett
Maths	Over Under and Through	Tana Hoban
Maths	Six Dinner Sid	Inga Moore
Maths	Square	Mac Barnett & John Klassen
Maths	Ten black dots	Donald Crews
Maths	Ten Little Fingers 100 number rhymes	Louise Binder Scott
Maths	Ten Terrible Dinosaurs	Paul Stickland
Maths	The Blue Balloon	Mick Inkpen
Maths	The Doorbell Rang	Pat Hutchins
Maths	The Pig in the Pond	Martin Waddell & Jill Barton
Maths	The Secret Birthday Message	Eric Carle
Maths	Three Tapping Teddies	Kaye Umansky
Maths	Tick tock clock book	
Maths	Tom Thumb's Musical Maths	Helen MacGregor
Maths	Triangle	Mac Barnett & John Klassen
Maths	We’re going on a bear hunt	Michael Rosen & Helen Oxbury
Maths	Winnie the Pooh Colours	
Maths	Winnie the Pooh Count on us	
Maths	Winnie the Pooh Food	
Maths	Winnie the Pooh Opposites	
Maths	Winnie the Pooh Seasons	
Maths	Winnie the Pooh Shapes	
Counting	1 2 3	Lesley Clarke
Counting	Anno's Counting Book	Mitsumasa Anno
Counting	Counting Farm	Kathy Henderson
Counting	Down in the daisies	Lucy Coats
Counting	Have you Seen my Dragon?	Steve Light
Counting	Mouse Count	Ellen Stoll Walsh
Counting	Mr Wolf's Week	Colin Hawkins
Counting	My first animal numbers	
Counting	Numbers- Les Nombres	Clare Beaton
Counting	One Bear at Bedtime	Mick Inkpen
Counting	One is a snail, Ten is a Crab	April Pulley Sayre and Jeff Sayre
Counting	One, Two, Three count with me	Catherine and Laurence Aholt
Counting	Ten in the bed	Penny Dale

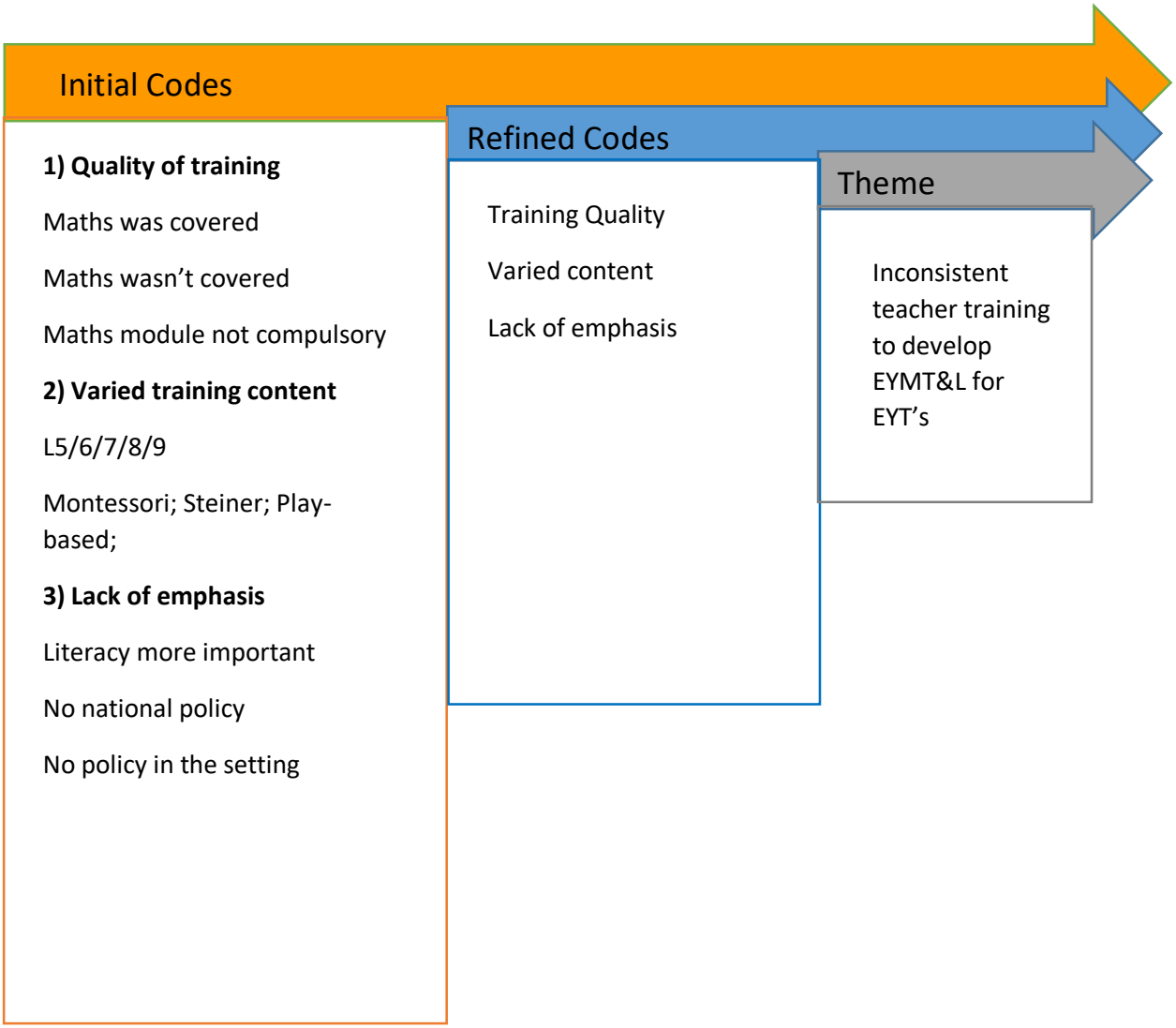
Counting	Ten Cakes	Maire Buoncore
Counting	Ten out of bed	Penny Dale
Counting	Ten Play Hide and Seek	Penny Dale
Counting	There were 10 in the bed	Wendy straw
Counting	Thomas's 1 2 3	
Counting	When we went to the park	Shirley Hughes
Shapes	Jungle shapes	
Shapes	Shapes	Monica Hughes
Shapes	Shapes with Peppa	
Shapes	Shapes with Peppa	
Shapes	Shapes with Peter Rabbit	
Shapes	Shapes with Peter Rabbit	
Shapes	Simple shapes	
Shapes	What shapes do you see?	

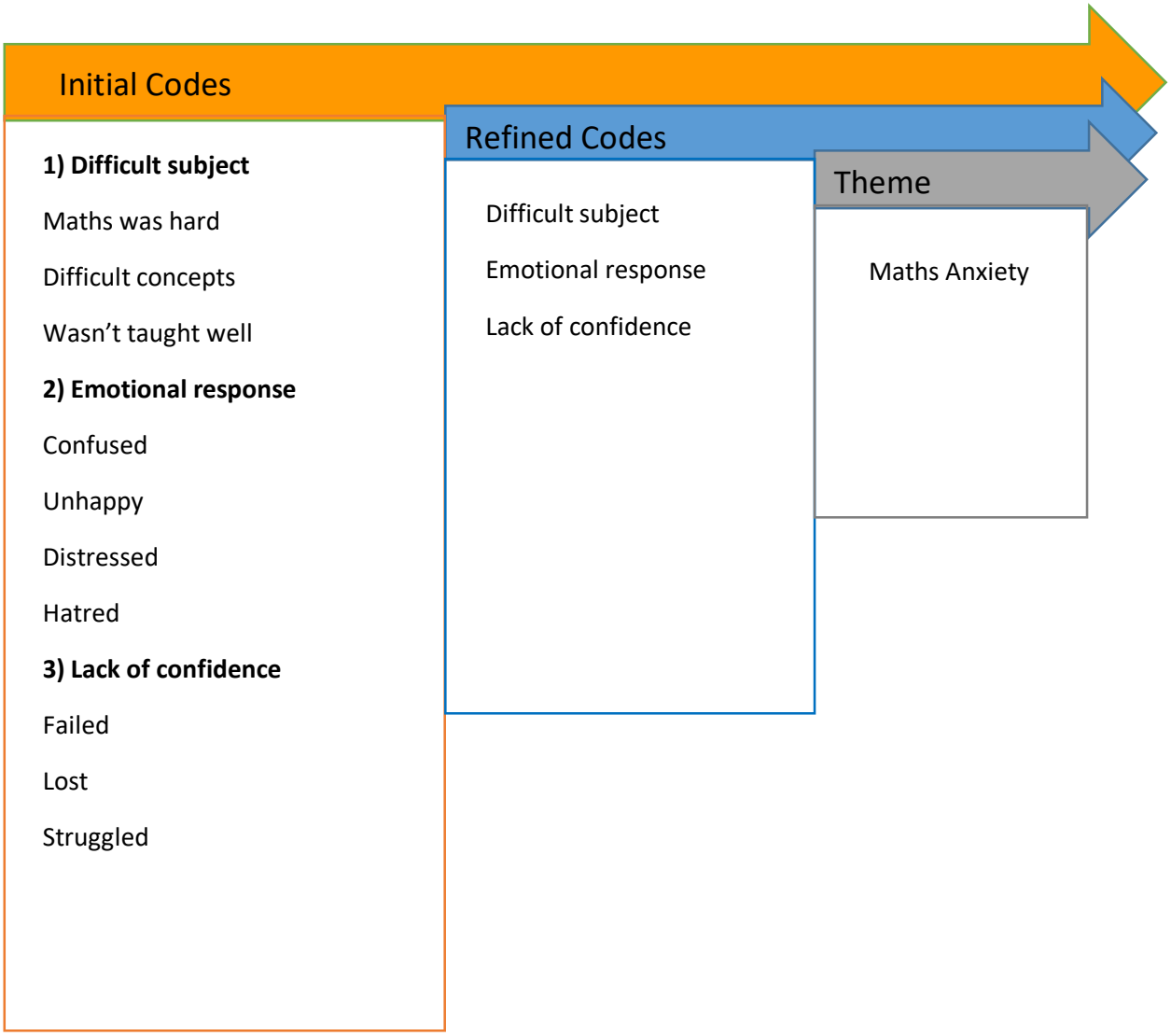
APPENDIX 16 REMA TEST RESULTS SCORES CLASSROOMS 1, 2, 3 ALL CHILD PARTICIPANTS

REMA Short Form Test Results		
Classroom 1	Pre-Interventions	Post-Interventions
Child 1	12	17
Child 2	3	10
Child 3	14	17
Child 4	12	16
Child 5	5	11
Child 6	6	9
Child 7	9	17
Child 8	10	17
Child 9	10	17
Child 10	9	15
Child 11	12	17
Child 12	4	10
Ave Classroom 1	8.8	14.4
Classroom 2		
Child 13	3	9
Child 14	6	11
Child 15	4	8
Child 16	6	8
Child 17	6	11
Child 18	8	12
Child 19	7	12
Child 20	3	10
Child 21	3	8
Child 22	6	10
Child 23	8	14
Child 24	2	9
Child 25	9	14
Child 26	10	14
Child 27	9	13
Child 28	4	10
Child 29	9	14
Child 30	8	13
Child 31	4	9
Child 32	4	9
Child 33	6	11
Child 34	11	17
Child 35	10	15
Child 36	Withdrew	
Ave Classroom 2	7.0	12.4
Classroom 3		
Child 37	10	14
Child 38	12	15

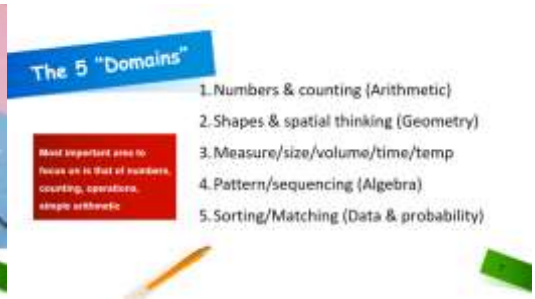
Child 39	12	17
Child 40	11	16
Child 41	9	15
Child 42	9	16
Child 43	14	18
Child 44	11	18
Child 45	9	16
Child 46	10	14
Child 47	Withdrew	
Ave Classroom 3	10.7	15.9

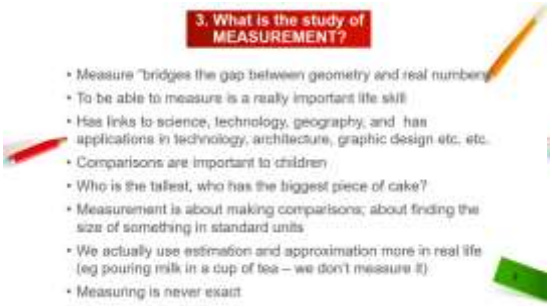

Initial Codes
1) Montessori methods
Concrete experiences
Hands on
Visual
Structured
2) Aistear
No specific maths themes, aims and learning goals
Maths through play
Play at maths
3) Do not make EY academic
No "schoolification"
Let them play
Play is the way
Refined Codes
Montessori methods
Aistear
Do not make EY Academic
Theme
Play-based learning for young children

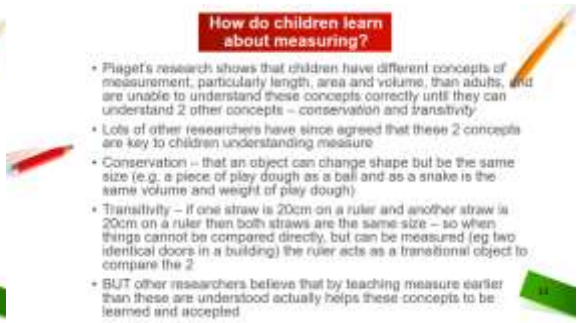

Initial Codes
1) Quality of training
Maths was covered
Maths wasn't covered
Maths module not compulsory
2) Varied training content
L5/6/7/8/9
Montessori; Steiner; Play-based;
3) Lack of emphasis
Literacy more important
No national policy
No policy in the setting
Refined Codes
Training Quality
Varied content
Lack of emphasis
Theme
Inconsistent teacher training to develop EYMT&L for EYT's

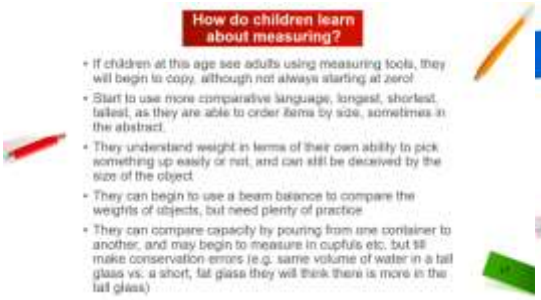

Initial Codes
1) Difficult subject
Maths was hard
Difficult concepts
Wasn't taught well
2) Emotional response
Confused
Unhappy
Distressed
Hatred
3) Lack of confidence
Failed
Lost
Struggled
Refined Codes
Difficult subject
Emotional response
Lack of confidence
Theme
Maths Anxiety

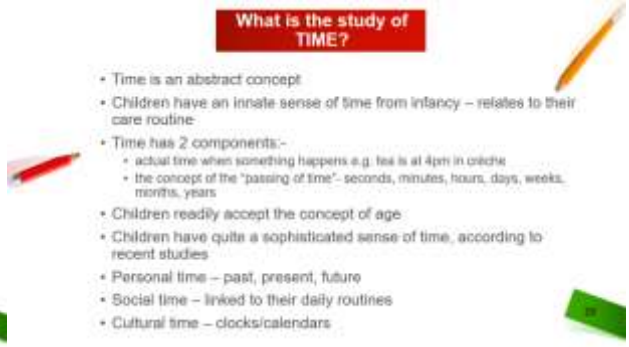
APPENDIX 18 SAMPLES OF POWERPOINT PRESENTATION USED IN CPD FOR STAFF EARLY YEAR'S TEACHERS DURING STUDY











How do children learn about TIME?

- Use sequencing of events and comparative language to explain the concept of time passing and past, present, future
- Visual timetable of daily routine in the classroom with actual times when events happen marked next to the pictures can be helpful
- Ask children describe past events – weekend is often used
- Can sequence events in classroom floor book and children can look back and remember what they did last week, last month
- Height chart with children's ages/date and height recorded to look back on and see how much they've grown
- Old photographs of children – when they were babies – to see how they've changed over time
- Use a calendar to count down to events in the room e.g. a birthday, the weekend, a party etc.

Time words

- Then
- Now
- Today
- Yesterday
- Tomorrow
- Morning
- Afternoon
- Next
- Before
- After

- Days of the week
- Months of the year
- Seasons
- Ages/birthdays
- Festivals/celebrations
- "There are 7 days in the week" song
- Months of the Year song

Thank You!

Lynn O'Dwyer