Title:

Can play in the senior primary classes encourage mathematical thinking, develop mathematical understanding, promote mathematical discussion, and facilitate the use of mathematical language?

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Declaration:

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

Josephine O Meara.

Abstract.

The New Primary Mathematics Curriculum (2023), which espouses playful and engaging learning experiences built upon the knowledge, skills, and attitudes developed in the home and in preschool settings gave teachers in the senior primary classroom, reason for thought and discussion (NCCA, 2023). As a teacher in a senior primary class, I noted how the Mathematics Curriculum, which guides instruction and evaluation of the highest caliber, and promotes a range of pedagogical techniques and strategies, references the advantages and importance of play, playfulness, and creativity throughout all classes in primary school (I.N.T.O., 2023).

The benefits of play-based early learning, in preschool and junior primary school have been well documented by theorists and educators who have illustrated how early play based mathematical experiences can be clarified and enhanced to support children's mathematical development and formal mathematical thinking (Tudge, J. R. H., & Doucet, F., 2004). The purpose of this thesis is to consider to what extent playful mathematical learning is used in senior Primary Classes and to answer the following question: Can play in the senior Primary Classes encourage mathematical thinking, develop mathematical understanding, promote mathematical discussion, and facilitate the use of mathematical language?

The characteristics of playful learning settings in senior primary classrooms are ones in which under the guidance of teachers, children make choices about their learning, ask questions, and share thoughts or observations, can move freely inside the classroom to connect with other children and resources, and are allowed time to make thoughtful decisions. The methodology I chose for this thesis was a research interview which had as its focus the thoughts, and insights of five teachers in senior Primary School classes about playful learning in mathematics (Cohen et al., 2018). Some conclusions were that teachers in the senior primary classes in this study were predisposed to playful learning in mathematics and embraced it in their classrooms to promote cognitive and social development. The teachers highlighted the importance of using materials to develop

mathematical thinking and understanding, of connecting mathematics meaningfully with real life experiences and of the significance of discussion and using mathematical vocabulary in the playful mathematics environment.

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Glossary of terms.

I.N.T.O.: Irish National Teachers Organization.

N.C.C.A.: National Council for Curriculum and Assessment

ROI: Republic of Ireland

NI: Northern Ireland

Chapter 1.

Introduction.

In 2023 educators introduced changes to the Primary Mathematics Curriculum that would offer a novel vision for children's mathematical learning in all classes. This vision incorporates playfulness to support the development of creativity, challenge, risk-taking, teamwork, and opportunities for reasoning and problem-solving (INTO 2023). The New Primary Curriculum Framework, which was released in September 2023 and was the product of engagement with educators and school administrators, was created to serve as a guide for improving Primary School Mathematics Education in the years ahead.

Historically, the role of play in a child's learning development was emphasized by Aristotle and Plato as a natural and essential activity for young children. Play, according to Plato, afforded children the chance to develop through movement, as well as a variety of concrete experiences that introduced them to the natural world and its contents and provided them with ideas for later reflection (Neumann, 1971). Aristotle, a Greek philosopher believed a child's playful experiences serve as the foundation for his or her subsequent cognitive processes and skills (Neumann, 1971).

Play was viewed as being a child's natural way of learning, according to 17th-century educator Fenelon and 18th-century philosophers Rousseau and Pestalozzi (Neumann, 1971). According to them, a child's activity incorporated the comprehensive and vigorous acquisition of knowledge and skills by doing, listening, and exploring their surroundings, with hands-on experimentation. The child's physical and mental abilities were developed by training of the senses and an abundance of real-world experiences, which equipped them to handle more challenging learning tasks in the future (Neumann, 1971). Educators like Dewey, Froebel, and Montessori further emphasized the benefits of playful learning, such as Dewey’s connection between children's natural experimentation during play and scientific inquiry (Smith et al., 2015). Then the principles of Piaget's constructivism revealed that playful learning is essential for the construction of logic and objectivity (Bringuier et al., 1989).

Professionals in scientific, mathematical, and engineering fields have highlighted the importance of creative thinking and argued that play components can help prepare future professionals to think creatively and playfully in their disciplines (Bergen, 2009). Playful thinking has significantly influenced discoveries in biological science, engineering, and computer-related learning. Educators preparing the next generations of practitioners in these fields emphasized that playfulness facilitates and strengthens phases of inquiry at the appropriate place and time (Bergen, 2009). Innovation, which is a crucial component of productivity in engineering uses many of the characteristics of playful learning (Bergen, 2009). In computer-related subjects, the importance of integrating play and learning to foster motivation and creativity is recognized, and play leads to a deeper understanding of science, as they are components of a single epistemology (Bergen, 2009).

As professionals shared their experiences of play, they also articulated how teachers who incorporate play into their mathematics curriculum help students connect meaningful play with mathematicians' work and bridge the gap between children's play experiences and academic mathematics (Bergen, 2009). Playfulness, characterized by enjoyment, motivation, and self-regulation considered essential for success in academic fields can be incorporated successfully into mathematics teaching to help primary school students acquire cognitive skills.

During the past 20 years, studies and consultations have given us greater knowledge of the most effective educational settings for children and the methods that may be applied to improve children's mathematical learning experiences. Research and theoretical literature that contextualizes and supports teaching, pinpoints opportunities for increased learning, and enhances teaching and learning experiences. This research highlights how preschool teachers typically encourage young children's interest in mathematical ideas through play. Playing is considered part of learning, and learning is a part of playing. Researchers also argue that opportunities for playful inquiry and discovery must be fostered and developed in Primary Schools. The special abilities of mathematicians must not remain undiscovered

and underdeveloped during their primary school years (Assouline & Lupkowski-Shoplik, 2021)

As playful discovery is the hallmark of a child's early educational experiences, the New Primary Mathematics Curriculum encourages primary schools to incorporate engaging and dynamic playful learning activities that will enhance students' foundational knowledge, abilities, and attitudes (NCCA,2023). Teachers are urged to use play as one of the wealth of options to enrich the child's learning experience. The teacher-student and peer-to-peer interactions that arise from playful learning promote the child's development and engagement. The playful experiences in the new curriculum that combine challenge and choice with independent or group activities are intended to promote inquiry, creativity, and discovery. The mathematical procedures of testing and discovering, revising, and transforming, that children engage in during play, are designed to prepare them for more formal mathematical vocabulary and concepts (NCCA, 2023). Educators who encourage students to explore and discover and who instill a positive attitude towards learning are believed to have a significant impact on the students' long-term willingness to recognize and pursue challenging problem solving which results in more self-reliant, intelligent, creative students (Bergen, 2009). Through the playful experiences championed by the New Curriculum, the child is motivated to improve their grasp of mathematical principles, make use of a variety of methods and techniques for solving problems, and communicate and share ideas (NCCA,2023).

As a teacher in a multigrade classroom where science and math investigations were frequently interwoven to create hypotheses or answer real-world questions, I considered how the curiosity, inventiveness, and confidence of children could be fostered through engaging and playful learning. Children had opportunities to link to what they were learning and collaborate with their classmates. Children who found the textbook challenging and sometimes tedious were inspired to explore mathematical concepts, conduct scientific investigations in hands-on activities, and report their scientific or mathematical findings.

Children were encouraged to listen to others, share their thoughts and reasoning, and voice their opinions. At teacher meetings and on in-service days, I was fascinated to hear other teachers discuss their ideas around playful learning and their thoughts about its effectiveness as a pedagogical tool.

If the benefits of play include providing students with the opportunity to experiment with materials and methods creatively, understanding concepts and achieving goals, communicating mathematical ideas, and developing and thriving in the best possible learning environment, the significance of playful learning in senior classes should not be underestimated (Bergen, 2009).

Can play, which is central to early learning environments and junior primary classrooms, be used more extensively in senior primary classrooms? The thesis question was chosen because of these debates. Can play in the senior primary classes encourage mathematical thinking, develop mathematical understanding, promote mathematical discussion, and facilitate the use of mathematical language? For this thesis, play is a creative, solution-centered activity that allows children to take charge of their explorations, utilize their prior knowledge to establish connections between concepts, and foster mathematical problem-solving, which is beneficial to children of all ages (Sarama and Clements, 2009). Senior primary classrooms that have playful learning environments allow students to make decisions about their education, ask questions, share ideas, and move freely around the classroom to interact with resources and other students. These environments also give students time to make well-considered choices, all under the direction of the teachers. Investigations that combine mathematics and science, experiments with space and shape, problem-solving in measurement using preferred manipulatives, exploration and creation of mathematics trails, and mathematical games and activities involving cards, and

dice, can all spark playful learning.

As playfulness is a predisposition towards creative actions and is considered the "medium" for learning at all ages, how does it improve learning processes and contribute

to a continuous “knowledge search” for students in senior Primary classes in the opinion of teachers today?

Chapter 2.

Review of Literature.

Introduction.

Can play in the senior primary classes encourage mathematical thinking, develop mathematical understanding, promote mathematical discussion, and facilitate the use of mathematical language? To consider this research question, I will examine what playful learning means and the policy that guides playful learning in primary school mathematics in Ireland. I will also convey how according to research, mathematical thinking and understanding, discussion, and mathematical language are fostered and developed through play.

What does playful learning mean?

According to the National Council for Curriculum and Assessment, mathematical learning may be significantly enhanced by the dynamic, captivating, inclusive, and encouraging setting that play provides (NCCA., 2023). By skillfully fusing play and learning, teachers can foster creativity, understanding, enjoyment, and learning, to create an engaging environment (Hyvonen, 2011). Free play, guided play, and games are all included in a spectrum of playful learning. Zosh et al.,(2022) examined research from the literature on playful learning and discovered that guided play was an effective and alternative pedagogical strategy In their research, Fisher, Hirsh-Pasek, Newcombe, and Golinkoff (2013), examined how well children might learn about the characteristics of shape using three distinct approaches of teaching: (1) guided play, where an adult partner follows the child's lead while they play with shapes and asks questions to help them learn important information; (2) direct instruction, where an instructor presents the same material while the child just listens and watches; and (3) free play, where the child can interact with the materials independently. Children who learned through guided play outperformed those in direct teaching by 30% and those in the free play by 55% when it came to applying their understanding of shape characteristics to new, atypical forms.

Guided play provides an excellent pedagogy for mathematical learning, according to Weisberg et al., (2014) because it values children's independence and sense of accomplishment in learning. It fosters a child's passion for learning by encouraging their involvement and promoting meaningful learning. Guided play establishes the proper “mise en place,” which is a combination of psychological and environmental elements that create a positive attitude to mathematical learning, leading to richer learning opportunities (Weisberg et al., 2014). The child's innate desire to participate in and enjoy play is one of the driving forces behind playful learning that allows children to make choices and decisions within their learning (Hunter,2020).

Other researchers outline the components of play: choice, wonder, and delight which characterize the experience that students have as they increase their understanding, skill, and knowledge (Mardell et al., 2016). Academics like Barnett (1990) and Liebman (1977) contend that children must view an activity as play for it to be considered playful (Mardell et al., 2016). These researchers indicated that the task becomes play because of the child's playfulness, which may be defined as the tendency to interpret or reinterpret a situation in a way that allows for enjoyment, choice, and discovery (Mardell et al., 2016).

During play, teachers can offer added information and other viewpoints that broaden the activity's application of mathematical representations and concepts (Van Oers, 2013). In classrooms with talented and gifted children, teachers can use play to channel additional energy and maintain classroom order or as a rejuvenating activity that allows children to unwind and refocus (Beisser et al.,2013). Psychoanalysts such as Freud, saw that children utilized play to get over their fears and deal with anxiety (Beisser et al.,2013). Others such as Erikson, saw that play helped children improve their social and physical skills, which in turn raised their self-esteem (Beisser et al.,2013). An important and necessary step towards prioritizing play throughout the school is establishing a school culture that values play's essential elements—taking chances, making mistakes, trying new things, and having fun (Mardell et al., 2016).

Play in Irish Curriculum and Policy.

Influential philosophers like Rousseau, Froebel, and Pestalozzi, who linked children's learning to enjoyable and child-led activities as early as the eighteenth century, are credited with developing playful learning theories and approaches. In Ireland, playful teaching approaches have been implemented in junior primary and early childhood education settings. Since play is a prominent medium for young children's learning and development, early childhood education has gained widespread recognition for this developmentally appropriate approach. These settings have been characterized by the ideas of child-centeredness, child-initiation, and holistic learning experiences, which rely on the use of independent play, exploration, and the building of children's understandings within engaging and playful contexts (Bubikova-Moan et al., 2019).

Meanwhile, discussions about the effectiveness of playful teaching approaches in senior classes have frequently taken a backseat (Walsh et al., 2010). As the children move from junior/senior infants in the Republic of Ireland or levels 1/2 in Northern Ireland, teaching and play are frequently perceived as opposing ideas (Walsh et al., 2010). Although play-based learning has been studied extensively in the field of early childhood education, less study has been done on the advantages it may have for older students (Johnston et al., 2023). This information gap highlights the need to investigate the advantages and possibilities of play-based learning for all primary students. Recent policy and curricular improvements in both Northern Ireland and the Republic of Ireland demonstrate a rising acknowledgment of the significance of play-based learning in primary school throughout the Irish educational system (Grey & Ryan, 2016). Policy and curriculum advancements such as ROI's Aistear early childhood curriculum framework and the NI's Foundation Stage (FS) Curriculum have recognized play as an essential component of early childhood education and emphasize the value of playful learning in the education of young children. The Department of Education and Skills redesigned the primary curriculum and the Primary Curriculum Framework in 2023, indicating that play would be valued across the entire primary school curriculum in the ROI.

The New Primary Mathematics Curriculum (NCCA., 2023) advocates playful learning for children in primary and special education programmes at all levels. Children work on a variety of mathematical tasks, including testing, discovering, revising, and extending, before formal mathematical terminology and ideas are introduced. Educators may use play to interact with students purposefully and meaningfully and to promote a positive attitude toward mathematics. The playful learning that children enjoy during childhood continues to engage them in the learning process as they grow, by enhancing their learning experiences and relationships. Children have opportunities to link ideas and communicate them, and their mathematical conceptions are stronger and more expansive, and their approaches and strategies improve. The Primary Curriculum Framework's pedagogical techniques and guiding ideas are reflected in the "stem" that introduces learning outcomes for all stages: "Through appropriately playful and engaging learning experiences."(NCCA., 2023).

The Primary Mathematics Curriculum places special emphasis on creating a learning environment that inspires children to advance their mathematical skills and offers them rich learning opportunities which follow relevant instructional approaches (NCCA., 2023.).

The curriculum acknowledges learning occurs in a variety of settings for teachers and students. As a result, the path of teaching and learning is unique and varies among settings (NCCA., 2023). Because of this, teachers' pedagogical content knowledge, which comprises the most effective ways to represent concepts, and the most potent comparisons, examples, explanations, and demonstrations of the subject is paramount (Ball, 1988). A learning outcomes approach underpins the curriculum which acknowledges teachers' capacity to ascertain the learning requirements and strengths of their students. Teachers determine what to teach and how to assess it by using appropriate instruction and resources.

Can play encourage mathematical thinking and develop mathematical understanding in senior primary classes?

Research suggests that playful engagement with concrete materials, cognitive play, cross-curricular learning, and making choices and decisions within play can encourage mathematical thinking and develop mathematical understanding.

Using concrete materials in senior primary classes.

Jean Piaget's theory, which proposed that students aged seven to ten years old work primarily in concrete ways and that abstract conceptions of mathematics may only be available to them through embodiment in real resources, has consequences for the use of concrete materials in the mathematics classroom during play (*Manipulatives in the Primary Classroom | NRICH*, 2022). Teachers were asked to provide a variety of justifications for their use of concrete materials in a research study where they were given a toolkit of mathematical tools to use in the classroom along with some professional assistance (*Manipulatives in the Primary Classroom | NRICH*, 2013). One of the reasons for working with them according to these teachers was more engagement than working with abstract and symbolic mathematics alone. The researcher's findings that when materials were utilized in the classroom, students were attentive, involved and interested, supported this (*Manipulatives in the Primary Classroom | NRICH*, 2013). When Maria Montessori developed the use of manipulatives, she intended to empower children to learn by independent inquiry and discovery by using manipulatives in the classroom, the foundation for promoting critical thinking and student agency was created (Hurst & Linsell, 2020). The initial steps towards developing comprehension and internalizing mathematical processes, procedures, and strategies are taken by pupils when they investigate ideas by playful manipulation of concrete materials first (Hurst & Linsell, 2020). In addition, concrete materials assist teachers in making informed decisions about the next stages for their students by having a clear picture of their understanding (McDonough, 2016). Concrete materials are seen as essential to the early formation of mathematical concepts in many nations, particularly for students under the age of eleven. The children were able to abstract a deeper knowledge and to generalize about the subject because of the presentation of a range of representations using concrete materials (*Manipulatives in*

the Primary Classroom | NRICH, 2013). According to the research, when concrete materials are utilized as tools to assist sense-making, mathematical reasoning, and thinking, rather than as an addition to following an established procedure, they may be highly effective for promoting understanding(*Manipulatives in the Primary Classroom | NRICH*, 2013). How can we make use of this information to create classroom practices that reinforce this? Materials are essential to the objectives of the new Primary Mathematics Curriculum (NCCA, 2023) to increase the students' proficiency with mathematical methods and improve their ability to solve problems and reason logically.

How teachers use the materials will have an even greater impact on our students' learning than merely what is used (*Manipulatives in the Primary Classroom | NRICH*, 2022). Playful exploration of materials in small groups is an effective starting point. Unrestricted access to all materials and choosing materials according to their strengths is important for problem-solving. There is the need to provide opportunities for students to highlight and share with other students how resources illustrate mathematical hypotheses(*Manipulatives in the Primary Classroom | NRICH*, 2022). When senior students study the structure of the problem and the choice of concrete materials as tools to solving it, they may capture their solutions as digital images for sharing on the interactive white board using classroom iPad. 'Show me' assignments can be used effectively to illustrate how various representations contribute to the understanding in the mathematics learning environment.

The students can generate their own meanings by playfully exploring the materials individually or in small groups and tying tangible materials to abstract thinking in ways that make sense to them (*Manipulatives in the Primary Classroom | NRICH*, 2022). Playful learning using concrete materials in small groups becomes part of the classroom culture when students are afforded more opportunities to demonstrate to the teacher and one another their mathematical reasoning using a range of materials (*Manipulatives in the Primary Classroom | NRICH*, 2022). Recent teacher in-service demonstrated how unrestricted access to concrete materials for students of ages 5 to 11 years old and beyond is crucial and that the students should have the freedom to choose what to use to

model any problem they may be tackling (NCCA, 2023). When the range of resources is as wide as possible, senior students can explore and investigate varied materials to represent their thinking or justify mathematical ideas, then, teachers develop mathematical thinking at the deep level required to support students' conceptual understanding (*Manipulatives in the Primary Classroom | NRICH*, 2013).

Cognitive Play in Senior Primary Classes.

Cognitive play, which is simple to include in the classroom because of the variety of board, dice, and online games, offers an atmosphere that encourages taking chances, quick thinking, humour, and verbal communication (Beisser et al.,2013). Cognitive play can be used in the mathematics classroom to inspire pupils and improve concentration, attention span, and retention. In senior classrooms, games can provide students with more opportunities to practice vocabulary and reasoning than they would be required if presented with a traditional textbook problem (*Using Games in the Classroom | NRICH*, 2011). Card games, games with dice, digital games, and even board games can make the math class more attractive for learners of all abilities. Students are motivated to perform above their grade level because there is a natural desire to win, and they will frequently invent new methods of looking at the work they are doing and think more creatively (*Using Games in the Classroom | NRICH*, 2011). Research from grade 5 and 6 classrooms, indicated that children were inspired to acquire more complex reasoning skills and assess arguments when they realized the importance of their actions in strategy games (McFeetors, P.& Palfy, K., 2017). Researchers concluded that strategy games which are selected with care and supported with targeted questions provide students with a real-world setting in which to develop mathematical thinking (McFeetors, P.& Palfy, K. 2017).

Pupil Agency in Senior Primary Classes.

Play allows children to participate in complex mathematical activities, and make decisions about their learning (NCCA., 2023). Educational theorists, researchers, and educators have acknowledged that children explore ideas, test hypotheses, experiment with

symbolic systems, and take chances through play-based learning (Dooley,2019). This is exemplified when senior students play with temperature and insulation in science and math investigations. While play evolves, children continue to make meaning of their experiences, and failed attempts provide an opportunity to create multiple strategies to solve mathematical problems (Dooley,2019). When teachers present playful experiences that encourage investigation, dialogue, and hands-on learning, children enjoy making decisions for themselves, choosing their materials, and working as a group (Parks,2020). Playful learning gives students autonomy and choice, which fosters the development of critical thinking abilities (Moyles, 1989). Integrating the concepts of learner agency and choice regarding process and materials, are essential to the development of mathematical decision-making and independent thinking (Parker et al., 2022). Students allowed to play with mathematics in activities using measurement of distance and ramps are given ownership by their mathematics teacher to investigate and find patterns and provide a rationale for them (Su, F 2020). In the senior classes allowing pupils some struggle while they try to make sense of problems and keep working towards solutions as they try ideas, form, and test hypotheses, can help to foster originality, and promote agency (Su, F 2020).

It is feasible to view playfulness as a useful teaching and assessment technique in mathematics (Palmer et al.,2023). Play also creates an authentic learning environment for both students and teachers and enables teachers to understand the requirements of their students (Moyles, 1989). Moyles describes how play allows teachers to assess their pupils' learning and general development. Students frequently show us how they think when playing games, which enables teachers to diagnose and evaluate students' learning in a stress-free environment (nrich.org.,2011).

Programming, or coding, is a perfect way to encourage mathematical habits of mind and computational thinking. Using programming and coding can develop children's.

problem-solving skills, fostering tenacity; encouraging attention to detail; and using suitable tools to develop original concepts or create new ideas (Goldenberg & Carter, 2020). Scratch, which is designed for play, creativity, and self-directed learning can be

used to develop creative thinking, methodical reasoning, and collaboration with others (Resnick,2014).

Cross-Curricular Learning in Senior Primary Classes.

Children's mathematical learning results from the interaction between what they are taught and what they bring to every learning environment, according to constructivist theory (Ball,1988).

Children's life experiences may shape their learning when they are given the chance to investigate mathematical concepts in a play-based learning setting, and this is perfectly acceptable. By integrating and combining mathematics with other activities, children are given the chance to study in a real-world setting (Dooley, 2019).

The integration of various disciplines can result in substantial learning opportunities (Dooley, 2019). Playful learning in cross-curricular projects can create meaningful connections across a wide range of topic areas and guarantee that students learn broad skills like problem solving, collaboration, and critical thinking while maintaining the integrity of each subject (Dooley, 2019). Two outcomes occur when educators encourage curricular integration. Pupils incorporate added information into their frame of reference to deepen and improve their understanding of the world (Beane, 1993). In addition, students explore, learn, and apply information and refine their critical thinking, questioning, and assessment abilities (Beane, 1993). An example is using math trails which increases students' curiosity and participation, and boosts student confidence and self-esteem when collaborating to create and address specific inquiries about their surroundings (Wang et al., 2021).

Can play encourage and promote discussion and the use of mathematical language in senior primary classes.

Math discussion is encouraged through playful learning since play offers a framework for mathematical thinking as well as the growth of mathematical vocabulary and ideas (NCCA, 2023). Clements and Sarama (2005) found that unless teachers involve their students in discussing and expressing the mathematical concepts that have emerged in their play,

playing alone will not ensure mathematical progress (Clements et al.,2005). Teachers can increase the knowledge of students in senior classes during play that makes serious use of student thinking by giving "worthwhile mathematical tasks" to small groups while orchestrating effective discussion (Ball,2001). These ideas are evidenced in a study where students were invited to use play to work through their mathematical ideas using manipulatives (Delaney, 2019). After the playful investigation, groups of students were invited to present their answers and explain their ideas to their classmates, and the discussion advanced from simpler to more complex problem-solving strategies (Delaney, 2019). During the discussion, orchestrated by the teacher, students were asked to explain their solutions, which were revised. This discussion time which connects classroom discussion and playful learning engagement can be effective for fostering mathematical insight (Delaney,2019).

Researchers indicate that teachers who use playful pedagogies proficiently integrate several forms of facilitation (Parker et al.,2022). They use discussion preceding lessons to review students' prior knowledge and to prepare their minds for learning (Parker et al.,2022). After playful learning, they feature opportunities for group reflection (Parker et al.,2022). By using techniques like questioning and scaffolding during playful interaction, the teacher intentionally positions and integrates guided play and mathematical activities within the classroom, and makes the links to learning clear (Hunter,2020).

There are occasions when inviting "listeners" to become more involved can be challenging. Some ideas that teachers include1. Let pupils know what to look out for. 2. Teach them how to practice their listening skills. 3. Invite comments from the class following each share; 4. Establish procedures in advance for situations in which listening pupils are unable to react such as asking the teacher or classmate to repeat their idea (Bahr,2017). Using a show of hands for responses such as agree/disagree, thumbs up thumbs down, think pair and share, recording images of their work on iPad in pairs, and using" I notice I wonder" can add a playful element to classroom discussion.

Teachers can increase the knowledge of a class by preparing techniques ahead of time and using them during well-planned class discussions (Bahr,2017). A lot of educators claim

that by having their pupils essentially "run the discussions" themselves, these techniques serve to create a set of "sociomathematical norms" that eventually make discussing topics simpler to plan (Yackel and Cobb, 1996). These tactics are crucial tools for enabling teachers to teach mathematics in senior primary classrooms in ways that honour the integrity of mathematics as a discipline and that make serious use of student thinking (Ball, 2001).

Effective mathematical conversation using a menu of thinking levels from different taxonomies to enhance the class's overall participation, which is accessible to students, may encourage them to make sense of what they have learned, and eventually challenge them to create compelling arguments using appropriate mathematical language (Bahr,2017).

Teachers are aware that for students to actively interact with the material through higher order thinking processes like synthesis or analysis, as well as critical thinking the teacher must drive playful learning by asking questions (Edwards et al.,2015). By asking numerous questions and providing guided instruction, teachers can offer opportunities for the students to use mathematical vocabulary (Riccomini et al., 2015). According to research by Rubenstein and Thompson, the challenges posed by the complexities of math vocabulary must be addressed by teaching vocabulary in rich, context-specific interactions (Riccomini et al., 2015). This mathematics language instruction may be facilitated in the classroom using manipulatives and context, images, and diagrams and repeated at every lesson in a playful learning environment (Cramer & Karnowski, 1995). The growth of mathematical competency then also depends on the teaching and learning of the mathematical language. Learning mathematical vocabulary by students is crucial to their capacity to use words, for explanation, justification, and other mathematical communication and to their mathematical aptitude. If higher level mathematical thinking cannot be communicated without mathematical terminology, students must regularly utilize, comprehend, and apply mathematical terms, symbols, and diagrams in their task (Riccomini et al., 2015). The vocabulary can then be practiced in open-ended discussions

or where students are motivated to clarify, expand, and communicate mathematical thinking after playful learning has taken place (Treacy, 2013).

How does planning support playful learning in senior primary classes?

Examples of playful math instruction have demonstrated that play does not have to be sacrificed for teaching mathematical knowledge and skills (Stipek, 2017). Numerous studies (Clements and Sarama 2014; Carpenter et al. 2016) have shown that young children love studying mathematics and can learn significantly more than previously thought when their teacher is using playful approaches, without the use of a single flash card or worksheet (Stipek, 2017). Teachers must use intentional, planned activities to ensure that their students' learning experiences are child-centered and engaging. Teachers can take advantage of naturally occurring learning opportunities, but they cannot rely primarily on spontaneous, child-initiated teachable moments. This would allow the sequence in which mathematics topics are taught to be left to chance.

If teachers rely only on children's initiative, their learning chances may vary greatly; some will have many, while others may have few. When teachers arrange small groups and whole groups playful activities, they will receive systematic information on children's knowledge and abilities, they will be able to keep track of what students understand and what help they require to grow and learn. Children come to class with a variety of information and skills and instruction must reach children where they are in what the Russian psychologist Lev Vygotsky (1978) calls the zone of proximal development (Stipek, 2017). “Each learner is entitled to a broad and deep mathematics experience that connects with their existing knowledge and understanding and helps them flourish” (Su,2020)

Play in Senior Primary Classes.

Play should be considered an appropriate medium for children to absorb and investigate mathematical concepts with the help of their instructors (Johnstone,2022). For students to engage appropriately and learn through play, teachers must provide personalized, open-

ended, and intentionally designed play experiences. Throughout these playful learning experiences, the teacher acts as a "co-player," following the children's lead while directing their learning through discussion, concept, and vocabulary development (Johnstone, 2022). During mathematical play, the children learn through discovery and exploration, which are enhanced by interactions with the teacher and other children" (Johnstone, 2022). What are the benefits of playful learning in senior classes? Play encourages curiosity. Play provides a challenge. Play offers time. Play is linked with identity, an essential issue for mathematics. How we believe in ourselves, and our self-image impacts how effectively we perform and approach a subject (Williams,2022). Play and playfulness provide students with time to experiment with the concepts we are teaching them and time to ask questions, think, and express their views (Williams,2022). Furthermore, being creative and giving children lots of opportunities to express their own views and mathematical thinking, helps them fulfill their potential as mathematicians (Williams,2022)

Chapter 3.

Research Methodology.

The methodology I chose for this thesis was a research interview. The interview process had as its focus the thoughts, and insights of teachers in senior Primary School classes around playful learning in mathematics (Cohen et al., 2018). The research interview is "a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information" (Cohen et al., 2018). Data is gathered through direct verbal interaction between the people involved and the interviewer records the replies to predetermined questions (Cohen et al., 2018).

In the first instance, I used research to inform and guide the composition of the questions. There were many articles and journal writings about the importance of playful learning in Junior Classes, but less is documented about playful approaches to mathematics learning in senior Primary School classes. I was conscious that the new Primary Mathematics Curriculum recommended playful learning approaches in mathematics classes throughout the school (NCCA, 2023). The recent teacher in-service on the new Primary Mathematics Curriculum had also highlighted playful learning approaches and I was interested in teachers' perspectives on playful mathematical learning in the senior classes (O'Donoghue, 2018) The questions were designed to probe how playful learning in senior primary classes contributed to the development of thinking, understanding, discussion, and mathematical language.

The study was created around individual interviews with five teachers, including some teaching principals primarily in the west of Ireland.

I knew the teachers from principal support meetings and other networking spaces and the research project also strengthened the link of friendship, fostered a sense of unity, and a shared pursuit of a teacher-centered question (Cohen et al., 2018). I was fortunate to meet three teachers face-to-face for the interview and I used teams to interview two teachers.

In the interview, the phrasing and order of questions were predetermined. As the interviews unfolded, I realized the importance of allowing open-ended questions which allowed the teachers to expand upon and justify their answers preventing the participants from

becoming nervous. When there are many interviews used, it reduces interviewer effects and prejudice (Cohen et al., 2018). I also realized that while the interview took place with willing participants, it can be difficult to manage every facet of the interaction and the engagement requires careful analysis to document their assertions accurately (Cohen et al., 2018). The driving force behind the interviews was a desire to learn people's perspectives and impressions, to hear their experiences, and to measure or gauge their feelings (Cohen et al., 2018).

An advantage of the interview was that it could be done at a reasonable pace, and it provided the opportunity for depth as a data-collecting method (Cohen et al.,2018). Interviews are thought to have a higher response rate than questionnaires because the participants are motivated to become more involved allowing more to be said about the research and they are also better than questionnaires for handling more difficult and open-ended questions (Cohen et al.,2018). The challenge for me as an interviewer was to avoid subjectivity and bias (Cohen et al.,2018).

The unique contextual and comprehensive features of qualitative research are to comprehend and examine the nature of a topic, in this case, playful learning and, to focus on description, comprehension, and interpretation (Lichtman, 2023).

A technique for finding, examining, and summarizing patterns in data is thematic analysis (Braun & Clarke, 2006). It reaches beyond organizing and describing the data collection to developing an understanding of the many aspects of the study question (Braun & Clarke, 2006). The analytical procedure is fascinating because it enables the researcher to identify patterns and themes that are present throughout conversations.

Since a theme reveals the level of pattern or relevance during data collection, it is an essential part of every research project. By labeling each data item according to its space and the theme's prevalence across the collection, I worked to establish the magnitude and prevalence of a theme (Braun & Clarke, 2006). The importance of the theme is determined less by quantitative measurements and more by whether it provides a meaningful

perspective on the overall research question. Depending on how many speakers discussed the topic overall in the data, it would be counted.

Thematic analysis is the critical step in qualitative research, which comes after the data has been collected and analyzed. This stage's goal was to familiarize myself with the data (Braun & Clarke, 2006). Reading the data again and actively searching for patterns and meanings was important before beginning to code since ideas and patterns began to emerge as I was reading (Braun & Clarke, 2006). The method of theme analysis might be seen as an essential stage in an interpretative qualitative approach. The verbal data collected during the interviews was written up to do a theme analysis (Braun & Clarke, 2006) Making notes on texts, underlining patterns using coloured pens or highlighters, and tagging data segments with post-it notes were some of the methods I used to systematically go through a data collection and uncover noteworthy aspects that could serve as the foundation for themes (Braun & Clarke, 2006). I coded extracts by considering as many themes and patterns as possible and remembering that each extract might be assigned to as many different "themes" as it fits into. Then I consulted with my supervisor who gave me feedback which guided my analysis.

The fourth step of theme analysis is the formulation and improvement of a list of themes. The themes themselves were recognized from one another, and the material provided in each subject should make sense when combined. This phase entails assessing how well each theme fits into the data set and if my suggested thematic map accurately conveys the meanings found in the data set.

Once the thematic map of my data was created, I went back over the data. I determined the "essence" of each theme and the portion of the data that each theme represents while thinking about how each theme fits into the wider narrative in addition to figuring out the "story" that each theme expresses.

Limitations.

The limitations of the study may be the sample size. Notwithstanding the small sample, there were relationships between the teachers' insights.

Because the researcher does not have extensive experience in primary data collection there is a risk that the data collection method is limited.

Asking the correct questions and following up on the teacher's response requires certain skills and experience. There is a delicate balance between asking questions and listening to the participants with sensitivity to ensure that teachers' insights are recorded accurately.

Some of the questions were framed too broadly. They could be narrowed to deal with specific aims of playful learning so that the level of focus of the study could be increased. Further research might narrow the aims to address this.

Figure 1. Initial Coding.

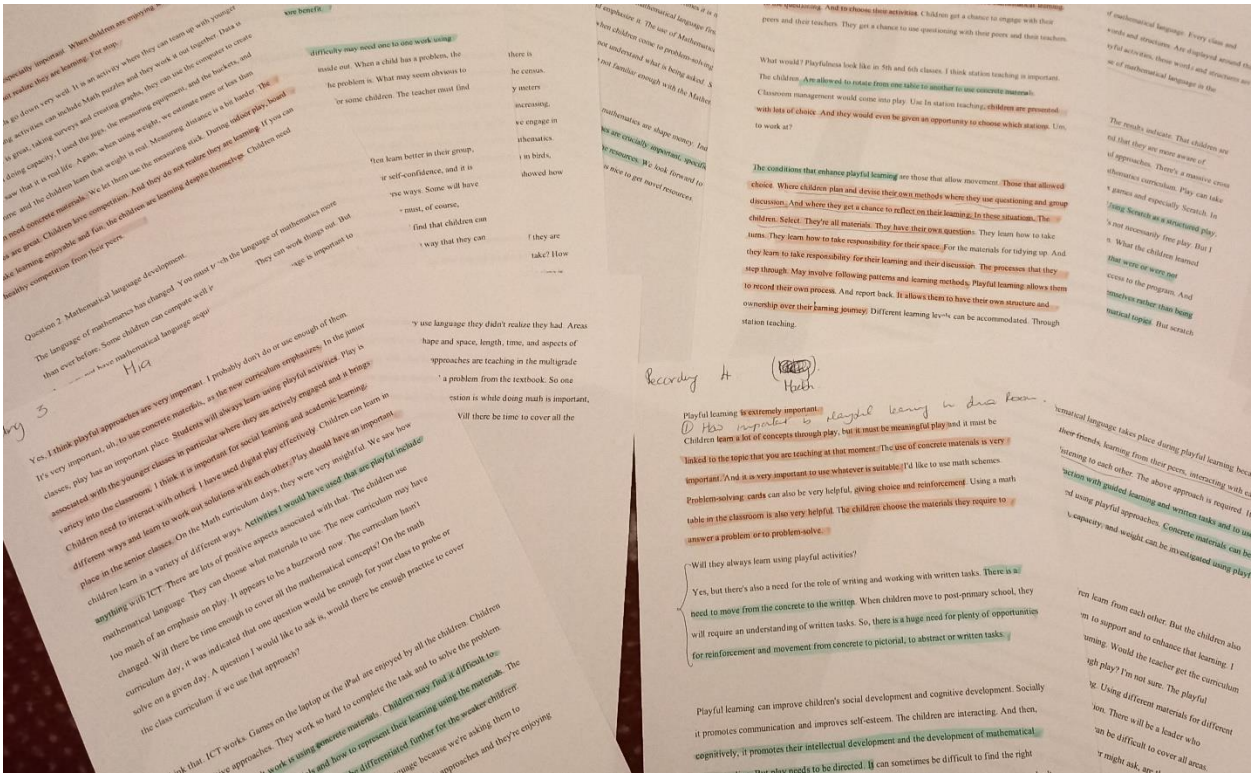
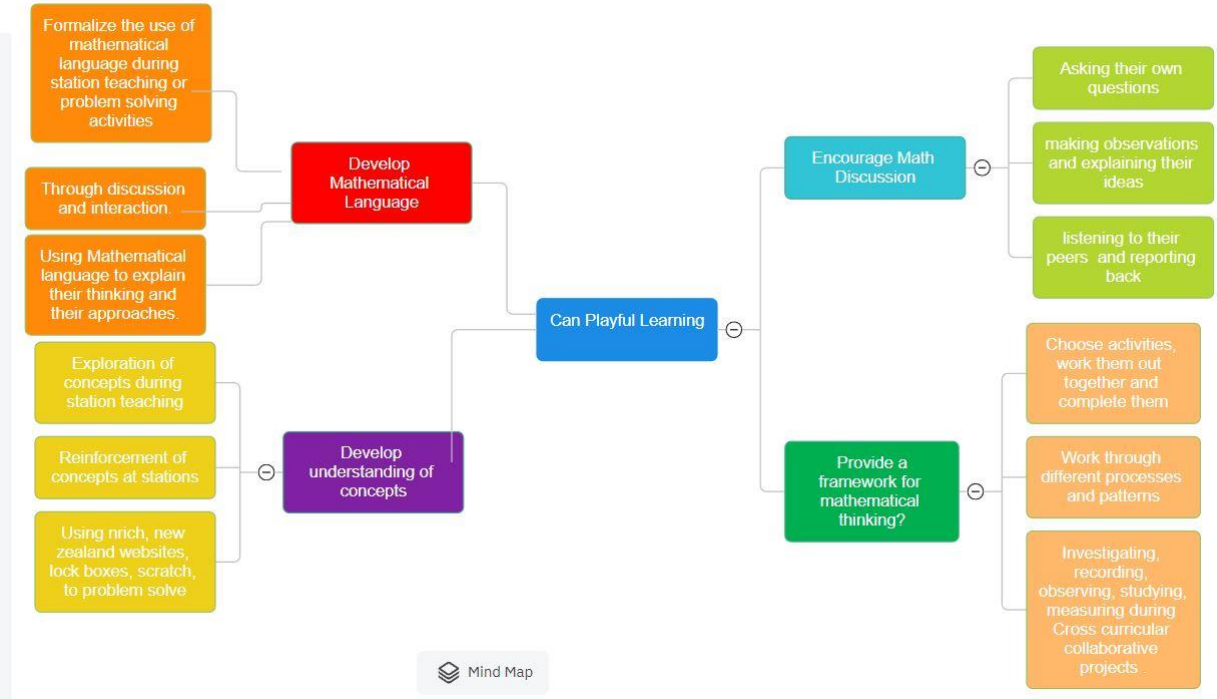


Figure 2. Flow Chart.



Chapter 4.

Findings Chapter.

Introduction.

The five teachers in the study have given thought to the use of play in their mathematics teaching and all of them have used play in their mathematics class. All the teachers viewed playful learning as "important for cognitive and social development in senior primary mathematics teaching". Mark indicated how "the learning that is taking place is engaging, useful, and worthwhile" and how "the children can see the mathematics and make associations, and that it means something to them". "It is not procedure-driven and can be differentiated by the teacher to the needs of the children". Rhea articulated how "playful learning in groups boosts students' confidence. If children are enjoying and understanding what they are learning, it helps boost their self-confidence and self-esteem." Miriam described how "playful learning promotes communication and improves self-esteem". Mark outlined how "having the children working together in groups facilitated social interaction and enhanced their social development, which in addition to the development of mathematical understanding and thinking, was a positive outcome of playful learning experiences". Mia indicated that "playful learning promotes their intellectual development and the development of mathematical understanding and that they have greater ease with learning the concepts".

These teachers' insights described the significant contribution of play to the development of pupil thinking and learning in senior primary classrooms and their interviews revealed their ongoing commitment to reviewing the types of playful engagement that they use. Their interviews also highlighted their continued practice of self-reflection following the recent New Primary Mathematics Curriculum in-service days.

The Research Question.

In this chapter, the findings relevant to the research question: Can play in the senior primary classes encourage mathematical thinking, develop mathematical understanding,

promote mathematical discussion, and facilitate the use of mathematical language? " are presented under some subheadings, according to themes identified through data analysis. The themes are:

1. Playful learning environments encourage students to make choices (of materials, tasks, and methods) and decisions.
2. Playful learning can involve collaborative learning through cross-curricular projects on real-world issues.
3. Playful learning promotes discussion and the use of mathematical language.
4. Playful learning environments are carefully planned and guided by teachers.

   Within each subsection, findings are presented from interviews with five Primary School teachers which I will relate to literature.

1. **Playful learning environments encourage students to make choices (of materials, tasks, and methods) and decisions.**

One of the themes from the findings was the importance of offering and encouraging choice and decision-making opportunities within the playful learning environment to benefit pupils' learning. That children made thoughtful decisions about learning through playful methodologies was emphasized by Maebh. During playful learning, Maebh stressed how the children" learn to take responsibility for their space, for the materials, and for tidying up. In addition, "they learn to take responsibility for their learning and their discussion." She observed how "the processes that children step through may involve following patterns and learning procedures." Playful learning allows children to" record their process and report back." Playful learning, she asserted, allows them "to create their structure and have ownership over their learning journey."

In another interview with a resource teacher who was responsible for small groups and whole class group teaching from the multigrade setting, Miriam indicated a preference for using a math table to offer a choice of materials to engage with mathematical play. "Using a math table can be helpful" she revealed. Miriam described how the children she teaches" choose the materials they require to answer a problem or to problem-solve from

a wide selection” and again” the children choose what they like, they move around, they pick the materials they like and that they think will support their problem-solving. "Within the station teaching Miriam spoke about” the children negotiating choices at the station, with a leader who organizes” the activities.

Maebh considered the idea of choice to be particularly important and she highlighted that “through playfulness, children learn about making choices.” During “station teaching, children are presented with lots of choices” in Maebh's classroom, including the choice about “which stations to work at and which ones to omit". Maebh also asserted that “the conditions that enhance playful learning are those that allow choice.” In her classroom, Maebh recounted how there are many opportunities to choose as "children plan, devise their methods and select their materials.”

Interestingly, Miriam and Maebh have elaborated on the importance of choice because research indicates that giving students real control over what they learn and how they apply it is, a crucial component of deep learning tasks where students are given” voice and choice (Fullan and Langworthy,2014).

Digital Resources were favoured by 4 out of 5 of the teachers as a playful method of learning, and the teachers had different insights into the best resources for playful learning experiences.

“I had the biggest breakthrough with playful methods when I engaged in the use of digital Math games and especially Scratch in my classroom” enthused Maebh. “When using Scratch as a structured playful approach, the children were given tasks in a diversity of math topics. “Scratch covered so many topics: numbers, equations, tables, shape, symmetry, lines, and angles.” “I would consider scratch to be the number one playful approach, for mathematics in my classroom, Maebh celebrated. “The children learned self-correction. They could see the physical elements that were or were not working, they had to try and figure out the answer. They found themselves trying to fix, correct, and problem-solve by themselves rather than being told how to do it.”

Mia thought that the competitive element offered by digital learning was enjoyed by the children. She insisted that the children were prompted “to work extremely hard to complete the task” or “find a solution” and that there were “many positive aspects” associated with digital learning. Rhea used digital games “to reinforce the concepts explored which were to the children's benefit” rather than unnecessary “repetitive” textbook exercises. Mark indicated that “digital learning was used playfully during station teaching to advantageous effect” where children were” responsible for and could identify and track their progress.” As students with disabilities frequently struggle with mathematical subjects in middle school, teachers must employ a variety of instructional strategies and tactics to assist pupils in overcoming obstacles and realizing their potential. Research indicates that better learning results may be achievable by using technology where students can be motivated and challenged to their best learning levels (Riccomini et al., 2015).

The use of technology in mathematics education presents unique opportunities but every instrument must be used meaningfully if it is to increase mathematical comprehension (Sarama & Clements, 2016). Digital Learning enables students to receive quick feedback, facilitating more individualized learning elevating mathematics as a problem-solving tool when appropriately implemented (Dooley,2019).

While Miriam and Maebh described the importance of choice, there was also reference within the group to cross-curricular projects and we will examine the theme “playful mathematical learning in cross-curricular projects” in the next subsection.

2. **Playful learning can involve collaborative learning through cross-curricular projects on real-world issues.**

When children collaborate on cross-curricular projects and use nature or their local environment it can set the stage for playful mathematical learning. Working together on cross-curricular projects was an important example of playful mathematical learning for Rhea and Maebh. Rhea was very enthusiastic about integrating mathematics with other areas such as orienteering, the census, the introduction of the new electricity meters, the

Green and Active Flags, and recent science investigations around heartbeats per second in humans, birds, and animals. Rhea also spoke about how making learning enjoyable empowers the children to learn “unknown to themselves and remain focused.” Math Trails were popular with the children because the children could form teams to” work things out together.”

Maebh agreed with the importance of learning collaboratively using the children's immediate environment when "children have freedom, flexibility, and movement, while they are learning mathematics outside and being aware of mathematics in the world around them. “She highlighted the importance of undertaking treasure hunts and developing situational awareness” as being playful and collaborative. Maebh also suggested that students were “more aware of mathematics in their environment due to play-based learning.”

Mark outlined how creating and taking surveys helped children to share thoughts, make observations, and discuss solutions to make mathematics “real for the children” in his classroom.

These are interesting viewpoints because research reveals that to build on children's informal mathematical knowledge, it is necessary to value and inquire about how children apply mathematics in their daily lives (Dooley,2019). Opportunities for children to explore mathematics-based concepts in a play-based learning environment are entirely appropriate because they allow children's lived experiences to frame their learning. Children are provided with opportunities to learn in a real-world context, integrating and connecting mathematics with other activities (Dooley,2019).

The idea that children learn mathematical language and develop mathematical understanding as they share thoughts, make observations, and discuss solutions with their peers was another theme prevalent in the interviews, which I will document in the next subsection.

3. Playful learning promotes discussion and the use of mathematical language.

Rhea outlined how children in her class can develop their understanding of mathematics by learning together and how “children with mixed abilities often learn better in a group, from their peers, and by bonding with others.” She also mentioned that she believes that” everybody in the group is learning in diverse ways.” Rhea stressed that children” can often learn better from their peers” and that she has noted with interest how “another child may explain the concept in a way they can clearly understand.”

Miriam stated how “the children learned from each other while the teacher provided the stimulus to support and enhance their learning”. Maebh indicated how “the children learned by discussing with each other planning and devising their methods and asking questions”.

Mia discussed how play, which is usually associated with younger children, should be part of the senior classes as it brings “variety into the classroom where children are actively engaged with each other.” "Children need to interact with others, they can learn in different ways and learn to work out solutions with one another” Mia added.

These assertions provide interesting teacher perspectives. Sfard (2001) makes the case that learning is accomplished by engagement in activities. According to Sfard, thinking is a "dialogical endeavour" in which an individual participates in conversation, argumentation, and conjecture, a theory that draws inspiration from Vygotskian thought (Sfard,2001). In Sfard's view, the function of a teacher is to assist students in transforming their everyday language into a more mathematical language (Sfard, 2007).

Although play-based mathematical learning produces discussion interaction questioning and engagement, teaching the mathematical language was considered by 5 teachers to be important, and discrete teaching was necessary.

Maebh articulated how mathematical language can be normalized during playful learning when she said “Playful learning can promote the common use of mathematical language. Every class and classroom have keywords and key phrases. The words and structures are displayed around the classroom and during playful activities, those words and structures

are normalized and there is a substantial improvement in the use of mathematical language in the classroom" she specified. The language of mathematics is being used, and the children are given opportunities to listen to it in the correct context.

Miriam explained how" The development of mathematical language takes place during playful learning because the children are discussing with their friends, learning from their peers, interacting with each other, learning from each other, and listening to each other." Because of the talking that is happening and the engagement with one another, mathematical language is being used, repeated, and tested.

Mia asserted that" playful learning helps children use mathematical language because" teachers are asking them to explain their thinking" and using language to explain their approaches as they are "enjoying" playful learning, the children" lose themselves in it" and "sometimes they use language they didn't realize they had." Mark indicated how when the children are" trying to work things out "and "are working as a team" during playful learning" it "facilitates discussion" much more than working as individuals in a classroom situation when a teacher might assign exercises from a textbook for completion.

Rhea spoke about the importance of teaching mathematical language at first. "The language of mathematics can be difficult because it is not the kind of language that children use every day" she stated. "It is important to teach mathematical language first, then as a teacher, you must use the language, focus on it, and emphasize the use of mathematical language when you are explaining the concept" she added. "Otherwise, when children attempt problem-solving, children who have difficulty with mathematical language may not understand what is being asked and some questions may be missed by children because they are not familiar enough with the mathematical language" Rhea concluded.

The participants discussed the usefulness and importance of playful approaches and the need for planning to incorporate playful learning effectively into the mathematics class.

Therefore, planning became a component of the playful learning theme. We elaborate on these findings in the next subsection.

4. Playful learning environments are carefully planned and guided by teachers.

The teachers agreed that playful learning requires thoughtful planning to ensure that the play is directed, meaningful, and connected with the math topic of the moment. Rhea outlined how the activities in a school need to be well planned by the teacher and she articulated how" teachers see what works and what does not" and that" activities need to be well-planned and well-organized." "Play needs to be directed" or guided according to Miriam. Even when the teacher plans carefully, it can be "difficult to find the right material or the right approach, and the material suited to the correct level." Nonetheless, the teacher needs to plan consistently because it is important to gauge the level of, and the appropriateness of, the task for the class.

Mark recalled how when they had spoken extensively as a staff about the importance of the progression from concrete to pictorial to abstract, he examined each chapter at the beginning of the year and "documented ideas for each strand which involved introducing games, practical activities, exploring concrete materials, and tasks" that would be "playful and engaging" all of which he concluded was very successful.

The participants also discussed the use of digital resources which became a component of the playful learning theme. We elaborate on these findings in the next subsection.

Summary.

The interviews with five Primary School teachers reflect Jean Piaget's theory that play is essential to children's development. In addition, the perspectives of the teachers concur with Vygotsky's theory that children require meaningful teacher direction to enhance their learning experiences. The teacher has a responsibility to discuss, integrate, and expand the learning with the pupils, and play is to be viewed as an opportunity for children to absorb and investigate academic ideas, supported by their teachers (Johnstone,2022).

The children are "learning through discovery and exploration, which at times, are mediated through interactions with others, both adults and other children"(Johnstone,2022). The results of these interviews suggest that the teachers in this study believe that playful learning has several advantages, including enhancing students' well-being and helping them build their social and emotional competencies.

Chapter 5.

Discussion and Conclusion.

Introduction.

According to John Dewey, learning is an active process. This activity enables students to apply their mathematical knowledge and develop problem-solving strategies and cognitive skills (Edwards, 2015). When teachers integrate playful activities for intellectual, social, and physical development into the learning process, they promote a more engaged and productive learning environment. Such activities can enable students to develop critical thinking abilities, have enhanced understanding, and achieve meaningful learning (Edwards, 2015).

While all the teachers interviewed for this study agree that play is important for enhancing children's learning cognitively and socially, the teachers in this study defined playful learning quite broadly and used playful learning to include activities such as station teaching, digital learning, Scratch, and the use of mathematical games. What is significant is that the teachers in the study reflected upon and included playful mathematical activities that the children in their classrooms perceived to be playful. These activities, which all the teachers stated allow for enjoyment, choice, and discovery, became play because of the children's playfulness (Mardell et al., 2016).

Learning from making choices in playful mathematical activities.

Three components of play: choice, wonder, and delight characterize the experience that students have as they increase their understanding, skill, and knowledge, according to researchers (Mardell et al., 2016). In the study undertaken for this thesis, four of the teachers interviewed spoke about the importance of choice, in playful learning experiences in their classroom settings. Two of the teachers, Miriam and Maebh, associated choice with increased enjoyment and better learning outcomes. Two teachers, Mia, and Rhea indicated that choice added the essence of play to mathematical activities.

One teacher spoke about choice in association with differentiation activities that provided more challenges for some learners and made learning more manageable for others.
Playful learning indicators as described by researchers and associated with choice, reveal student enjoyment and increased motivation as observable behaviours and feelings. These feelings were observed by the teachers in this study, during digital learning games, at mathematics stations, and mathematical learning using the Scratch programme. The indicators, according to one of the teachers, were also exhibited by students working individually or in a group, as they made choices and decisions about representing their solutions to problem-solving activity cards using materials of choice. According to Miriam, along with choosing the challenge cards, children chose when to move about to choose and change materials to represent their work. The teachers' ideas evoke research from Mardell et al., about choice within playful learning leading to the development of student agency and self-determination (Mardell et al., 2016). In the case of mathematical learning within Scratch programming, the teacher's description of children's choices as they self-corrected to create solutions, formulate ideas, and work through obstacles also points to student empowerment and ownership (Mardell et al., 2016). Although the instructor set the time allocation and the objectives of the lesson: equations, tables, computation, shapes, symmetry, or lines and angles, the children had the freedom to make choices which Maebh stated helped to foster autonomous, self-reliant learners who were skilled at decision-making (Parker et al.,2022). The learner choices leading to ownership and structuring of content and learning process articulated by Maebh were reflective of the findings of Parker et al., highlighting choice as a crucial component of a playful pedagogy (Parker et al.,2022).

The higher levels of engagement and motivation of students described by the teachers Rhea, Miriam, Maebh, and Mark, during these hands-on investigations, exploration, and meaningful discovery, facilitated by the teacher, were highlighted by researchers as a benefit of playful learning (Parker et al.,2022). Mathematical learning environments where students make choices provide a clearer idea of what students can do as they experience

growth as individuals, taking charge of their education, persevering through demanding situations, and linking learning and doing (Fullan and Langworthy,2014).

Two of the five teachers indicated that children throughout the school enjoyed and benefited from choices within cognitive play every Friday. Davies described the advantages of integrating games into mathematics, in a 1995 study where he stated that games provide valuable situations in which to apply mathematical knowledge (nrich.org.,2011). The fact that children can choose to play motivates them to learn and the fact that the teachers offer choices within cognitive play appears indicative of their commitment to providing diversity within playful approaches to mathematics (nrich.org.,2011).

Guidance for playing games is also derived from Alridge & Badham who stress the importance of providing meaningful play linked to the development of understanding of mathematical concepts, rather than playing for its own sake. Within a children's play group, one child may be learning a subject for the first time, another may be refining their understanding, and a third child may consolidate ideas they have previously learned (nrich.org.,2011). Games can help children develop a positive attitude towards mathematics and improve their self-concept by reducing the fear of making mistakes and failing (nrich.org.,2011). There is increased learning compared to more structured activities because playfulness encourages children to participate, to try out their hunches and problem-solving strategies (nrich.org.,2011).

Playfulness is regarded by the teachers in this study as a valuable teaching and evaluation tool in mathematics, where children are motivated and challenged by a diverse range of games activities, and tasks.

Teacher planning and scaffolding.

When pupils are given the freedom to use a variety of resources to work independently, they use critical thinking skills to produce original ideas based on the knowledge they have acquired (Edwards, 2015). In these educational settings, the benefits of playful learning facilitated by teachers' setting up the environment and gradually scaffolding student actions have been suggested by researchers to create a positive learning environment

(Weisberg et al., 2015). Teachers in these settings can ask open-ended questions, to prompt attention to understandings that may go unnoticed or to redirect play if required (Weisberg et al., 2015). Four teachers in this study referred to mathematical units that especially lend themselves to using playful approaches and described how children in their classrooms can explore shape, length, area. weight and capacity, and probability and develop mathematical understanding in an organized setting using the teacher's knowledge to guide their approach to the problems that arise (Weisberg et al., 2015). Mark indicated how the learning that is taking place is engaging, useful, and worthwhile how the children can see the mathematics and make associations, and that it means something for them. It is not procedure-driven and can be differentiated by the teacher to the children's needs.

Mark also highlighted the need for the teacher to be adaptable throughout the playful tasks and Miriam emphasized the need for the teacher to direct them, to continue to provide additional challenge, during playful learning, and enable children to explore new math perspectives (Palmer et al,2023).

What the teachers articulated in the study resonates with research which suggests that during play activities that are characterized by freedom, exploration, and discovery, teachers need to add novel content and perspectives to further develop children's understanding of mathematical representations and ideas (Palmer et al.,2023). The teacher's actions and how they explain or question the mathematical relationships scaffold the students' mathematics experiences and can foster deeper learning (Palmer et al., 2023).

To promote student participation and engagement the teachers in the study indicated their commitment to instructional approaches that actively create new knowledge in various ways, through questioning, investigation, and problem-solving (Edwards et al.,2015). They are aware that for students to actively interact with the material through higher order thinking processes like synthesis or analysis, as well as critical thinking the teacher must scaffold the playful learning (Edwards et al.,2015). Playing with mathematics problem-solving described in the study fosters creativity and exploration were identifying and

attempting appropriate problem-solving approaches is just as crucial as figuring out the right answer. This resonates with research that indicates how effective teaching should place a high priority on students' use of problem-solving techniques, in interesting problems (Delaney, 2019). Mathematical play is an important setting in which to pose and solve problems through imaginative and engaging methods (Dooley, 2019).

Teachers as agentic professionals who use the proper educational strategies and resources, decide what to teach and how to assess it. Sharing Learning Outcomes with the children can help them set clear goals and take an active role in their education allowing kids to discuss what they've learned, reflect, and decide what to do next frequently.

This enables children to feel more confident and self-assured as mathematics learners.

Teachers can provide children with the necessary tools to evaluate themselves and their peers, reflect on them, and assume greater responsibility for their mathematical learning by providing them with the necessary skills, sharing the focus of the lesson, and establishing criteria for successful learning with the students.

Can playful learning in senior primary mathematics class develop mathematical thinking and understanding?

Not alone can playfully learning in the mathematics class offer pupils freedom and choice which helps to develop critical thinking skills, but it also provides students and teachers with an authentic learning environment and supports experienced, perceptive teachers to gain insight into the learners' needs (Moyles,1989). Moyles outlines how in addition to shielding children from anxiety and negative attitudes, play offers instructors and students possibilities for reciprocal education. Within the educational setting, this translates to teachers being able to gauge where students "are" in terms of their learning and overall development. Davies described how children often demonstrate their thinking to us during games, allowing teachers to diagnose and assess pupils' learning in an anxiety-free setting(nrich.org.,2011). Miriam articulated this when she spoke of how the child's engagement during the playful learning activity, can reveal whether the child understood

the mathematical concept, an insight which provides the teacher with a foundation from which to build new learning (Moyles, 1989).

All the teachers spoke about the importance of creating, buying, and using materials and resources to develop the child's understanding. The fact that some children may struggle to represent their thinking using concrete materials was noted by Mia and reflective of research by Kaput(2012). However, Rhea contended that using materials consistently facilitated by the teacher can scaffold and support the child's understanding pointing to important research that indicates that a culture of playfulness is required in the school to ensure its effectiveness as a learning strategy throughout the school (Edwards et al.,2015).

The teachers' assertions align with research that children understand mathematical concepts more deeply when represented using various modes, including manipulatives (Suh, 2007). When Miriam and Mark highlighted the role of an opportunity for learning and reinforcement across concrete, pictorial, and written modes they elucidated how children's understanding of concepts is shaped by connections across different forms of representation (Suh, 2007).

The teachers explained the importance of children being able to explain their thinking and model it by using mathematical tools which resonates with the researcher's assertion that student capacity for strategic thinking and adaptive reasoning is supported (Suh, 2007). What the teachers have stated about the children using these representations (producing meaning) resonates with research that by representing their thinking across various modes, children were provided with conceptual reinforcement (Suh, 2007). It also suggests that play provides a learning environment that enables children to move from concrete to abstract thought (Vygotsky, 1933). Researchers have highlighted the importance of creating engaging learning environments by skillfully fusing play and learning in a way that fosters critical thinking, creativity, understanding, and enjoyment (Hyvonen, 2011). The teachers in this study were confident that the playful learning activities they employed facilitated engagement, mathematical thinking, and enjoyment. All the teachers interviewed agreed that play is important for enhancing learning and

promoting cognitive development. They indicated that they carefully chose playful mathematical activities that motivate and challenge students and that their pupils used resources and materials to represent their thinking.

Theorists of cognitive development put forth their theories on play, arguing that it helps children understand language (Piaget, 1926), develops self-control, and helps children make the shift from concrete to abstract thought (Vygotsky, 1933)

The teachers in this study were asked to consider if playful learning can promote mathematical thinking. The child's freedom to choose tasks, methods and materials as discussed by teachers Maebh and Miriam, underpins the child's mathematical decision-making which in turn empowers them to plan, track progress, and develop self-regulation all of which optimize their learning (Hyvonen,2011).

Can playful mathematics learning develop mathematical understanding by connecting mathematics to the real world and cross-curricular projects?

The stage is set for playful mathematics learning when children work together on cross-curricular projects and make use of the outdoors or their neighbourhood according to Maebh and Rhea. A significant example of Rhea and Maebh's playful mathematics learning was their collaboration on cross-curricular projects. Orienteering, the census, the new electricity metres, the Green and Active Flags, and current scientific studies or investigations in their environment were just a few of the areas Rhea and Maebh were excited about incorporating mathematics into. Rhea also discussed how children are empowered to learn when they find learning pleasurable. Because they could create teams to work things out together, Math Trails were enjoyed by the children according to these two teachers. The viewpoints expressed by Rhea and Maebh about the integration of mathematics playfully in cross-curricular projects are of interest because they connect with research that reveals that to build on children's informal mathematical knowledge, it is necessary to value and inquire about how children apply mathematics in their daily lives (Dooley,2019.) The opportunities for children to explore mathematics-based concepts in a play-based learning environment as described by the teachers are entirely appropriate because they allow children's lived experiences to frame their learning. The teachers provide the children with opportunities to learn in a real-world context, integrating and connecting mathematics with other activities that can offer significant and extensive educational benefits (Dooley,2019). Students will have the chance to forge significant connections across many topic areas to ensure that children are learning in a meaningful, holistic context, preserving the integrity of topics but increasing the likelihood that students will acquire skills like problem solving, and critical thinking (Dooley,2019).

When teachers support curricular integration, two things happen. First, students integrate learning experiences into their schemes of meaning to expand and enhance their understanding of the world. Secondly, they investigate, acquire, and apply knowledge, "integrating" experiences and insights into their conceptual framework, and developing skills in questioning, critical thinking, and value appraisal. (Beane, 1993).

When Rhea expressed her enthusiasm for math trails which focused on real-world observations and queries, she also highlighted the value of students “observing, noticing and recording” as part of notice and wonder routines (Wang et al.,2021). By observing, reading instruments, and examining challenges posed in real-world locations, math trails foster students' interest and inquiry. Students' confidence in asking arithmetic questions, curiosity, and involvement all rise when they participate in math trails (Wang et al.,2021). The students can work together to designate places as trail stops on campus, in the neighbourhood, or within the classroom. The benefits as described by researchers included the student's improved ability to craft questions that were precise and easy to understand. Students' self-evaluation revealed that attitudes towards mathematics improved, student involvement increased and, positive mind-sets prevailed (Wang et al.,2021).

Rhea also described how” bringing the census to the attention of the pupils, reading, and observing the new electricity meters and taking note of changes make mathematics real for children. Cross curricular projects draw pupils' attention to “how mathematics is real in the world, it is in the world, it is the world” she concluded. We may conclude that children's life experiences may shape their learning when they are given the chance to investigate mathematical concepts in a play-based learning setting (Dooley,2019).

Can play in the senior primary classroom encourage math discussion?

Miriam indicated that discussion is enriched during play, where the children learn from each other while the teacher provided support to enhance their learning which reminds us that while play provides a wealth of opportunities it will not guarantee mathematical development unless teachers include children in discussing and describing the mathematical concepts that have surfaced in their play (Clements et al.,2005). Teachers who provide questions that elicit explanations, extensions, and the creation of new understanding enable students to learn mathematics more effectively (Clements, D. H., & Sarama, J.,2005). Mark indicated how when the children who are working together during playful learning discuss their thinking much more than if they are working as individuals in

a classroom situation when a teacher might assign exercises from a textbook for completion. Pondering problems on task cards and trying out problem-solving approaches, according to Miriam, can result in insightful learning when supported by discussions where children, talk about strategies, share their knowledge, and enjoy the experience (Clements, D. H., & Sarama, J. 2005).

Rhea indicated that children could learn effectively from their peers whose explanations of concepts were easily understood by others in the group which evokes research that documents how a teacher engaged middle and senior students in cognitively demanding work by using playful learning and mathematical discourse (Delaney,2019).

Maebh also described how the children learned by discussing with each other, planning, and devising their methods, and asking questions suggesting that in line with research, these kinds of classroom conversations help with clarifying what is learned through play (Delaney, 2019).

Mia articulated how play, which is usually associated with younger children's classes, facilitates diverse ways of learning where children are actively engaged and learning to work out solutions with others. This is interesting because researchers conclude that peer interactions which might include asking questions and responding, adding to each other's contributions, and explaining their viewpoint, create "new" common knowledge and that this knowledge exchange, functions as a "natural pedagogy" (Zosh et al.,2018).

The author of 4Ts Instructional Framework for Math, described how the four dimensions of Tasks, Teachers, Tools, and Talk encourage open-ended and probing discussion. It emphasizes the development of mathematical thinking through class discussion and revoicing, reasoning and the revision of hypotheses and solutions. What is important is that the author emphasizes the importance of a meaningful task used to motivate students to clarify, expand, and communicate mathematical thinking. (Treacy, 2013).

Mathematics instruction using playful approaches involves assigning students meaningful assignments, letting them work in small groups, and then selecting students to share their thoughts during teacher-led class discussions (Bahr, D. L., & Bahr, K.,2017). Teachers

allow students to share their thoughts in public without forcing their beliefs or providing approval or condemnation to orchestrate good debate. By allowing them to voice their opinions, motivating them to make sense of what they have learned, and helping them formulate compelling arguments the objectives of facilitating effective mathematical discussion through play can be attained (Bahr, D. L., & Bahr, K., 2017).

Can play in the senior primary classroom develop mathematical language?

Maebh explained how play may normalize mathematical language. Engaging in playful learning can encourage the widespread usage of mathematical terminology. There are essential phrases and terms for each class and classroom usually displayed. There is a noticeable improvement in the use of mathematical language in the classroom when the terms and structures are normalized through engaging activities. Children are provided with the opportunity to hear mathematical language in appropriate contexts. The child's aptitude for mathematical language is important for both pupils and teachers, as it makes the transmission of mathematical information simpler (Pimm, D. 2018).

The teachers in this study refer to the importance of teaching math vocabulary explicitly before it can be used in playful learning and this points to research that indicates that vocabulary lessons where new terminology is taught through the methodical and deliberate presentation, emphasizing the word's significance, making connections to existing information, and letting students interact with the word's many applications must be prioritized (Riccomini et al., 2015).

According to Miriam, playful learning facilitates the use of mathematical language because through play children interact with friends, acquire knowledge from peers, engage with one another, and listen to one another. These insights from Miriam link with research which states that because of the talking that is happening and, the interaction with one another, mathematical language is being used, repeated, and tested, as part of guided and independent practice during playful learning (Riccomini et al., 2015).

When students use mathematical language to explain their thinking and their methods, they sometimes used language they weren't aware they had, according to Mia. This insight

highlights how groups use their conversation as a platform to exchange and compile ideas as they interact with materials, images, and context that translate between various modalities (Cramer & Karnowski, 1995).

When Rhea highlighted how mathematical can be difficult because it is not used every day outside of the school context, she spoke about the importance of teaching mathematical language first, then using the language, focus on and emphasize the use of mathematical language when you are explaining mathematical concepts. Research concurs that students are unlikely to be reinforced with this terminology outside of the math classroom because they might only identify it in a mathematical context.

These findings are interesting because according to Sfard, specific instruction is necessary to transform daily conversation into mathematical discourse (Dunphy et al,2014).

The fact that children who struggle with mathematical language may not understand what is being asked or because they are not familiar enough with mathematical language reflects the research that vocabulary and mathematical language play a vital role in communicating and mathematical concepts (Dunphy et al,2014).

According to Rubenstein and Thompson's research, the eleven diverse types of challenges that exist with math vocabulary include: meanings that vary depending on the context, terms that are specific to mathematical contexts, precise mathematical meanings, multiple meanings, technical meanings specific to a discipline, homophones with familiar words, related words, difficulties with translated words, irregular spelling, concepts expressed in multiple ways, and colloquial terms used by students and teachers, must be taught through. exposure in rich, context-specific interactions (Riccomini et al., 2015). During playful mathematical learning some strategies to maximize students' acquisition of key vocabulary which were used by Miriam, Mark, Maebh, and Rhea including word games, word walls, and personal math dictionaries and journals, help to promote long-term memory and this finding aligns with research (Riccomini et al., 2015).

Play can normalize mathematical language, encouraging the widespread use of essential phrases and terms in classrooms. These teachers emphasize the importance of explicit teaching of math vocabulary before it can be used in playful learning. In their opinion, playful learning facilitates the use of mathematical language by allowing children to interact with friends, acquire knowledge from peers, engage with one another, and listen to one another. Students may use mathematical language to explain their thinking and methods, sometimes using language they weren't aware of. Overall, engaging in playful learning can significantly improve the use of mathematical language in classrooms.

The insights from the teachers highlight research agree that children must be able to express mathematical concepts in many ways, and mathematical language enables them to articulate connections between the many representations and encourage abstract thought. The development of mathematical literacy is paramount to acquire the skills of speaking and expressing, integrating, and linking, reasoning, implementing, comprehending, and recalling mathematical ideas and, the teachers in this study have indicated that playful learning is an engaging context for learning these skills (Dooley and Corcoran, 2007).

Conclusion.

This section will conclude the study by summarizing the findings relating to the research question and discussing its contribution to research around playful learning in senior primary mathematics classes. It will also review the limitations of the study and outline opportunities for future research. The thesis' direction has been to document the insights of five primary mathematics teachers on their experiences of playful learning in mathematics in senior primary classrooms. The thesis question focused the teachers' attention on the development of mathematical thinking and understanding through play and on the importance of choice and discussion during playful learning activities.

In this study, four of the teachers interviewed discussed the importance of choice in playful learning experiences in their classroom settings.

The teachers' insights that choice was associated with increased enjoyment and motivation as well as the provision of challenge and differentiation, may suggest that adding a choice of materials, tasks, and methods to pupils' playful learning in mathematics adds the essence of playfulness to their learning experience. The teachers also indicate that offering worthwhile, enjoyable, and accessible tasks will promote a positive mindset toward mathematics class and improve their student learning experiences.

Research corroborates their assertions and suggests further that the freedom to use a variety of resources to work independently or in groups will support the development of critical thinking skills to produce original ideas particularly when playful learning is enhanced by teacher intervention and scaffolding (Weisberg et al., 2015)**.** The teacher's actions during playful learning discussed by teachers in this study and how they monitor the learning activities, scaffolding, or questioning the mathematical relationships will further develop children's understanding of mathematical representations and ideas and provide deeper learning experiences (Palmer et al., 2023).

When two of the five teachers indicated that children throughout the school enjoyed and benefited from choices within cognitive play every week this evoked research findings that games provide valuable situations in which to apply mathematical knowledge(nrich.org.uk). When the teachers offer choices within cognitive it suggests their commitment to providing diversity within the playful approaches to mathematics and, provides evidence of their self-reflection on the playful learning experiences they offer to the children in their classrooms(Brookfield, 2006) One teacher in this study indicated that during playful learning the child's freedom to choose tasks, methods, and materials underpins the child's mathematical decision-making, empowering them to plan, track progress, and develop self-regulation.

Developing Thinking.

The teachers in this study were confident that the playful learning activities they employed facilitated engagement, mathematical thinking, and enjoyment. They agreed that play is important for enhancing learning and promoting cognitive development. The teachers also

indicated that they carefully choose playful mathematical activities that motivate and challenge students, and their pupils use resources and materials to represent their thinking.

The teachers in this study asserted the importance of using concrete materials playfully during mathematics class in the senior primary classroom. They emphasize the importance of children being able to explain their thinking and model it by using mathematical tools, which research suggests supports strategic thinking and adaptive reasoning.

Cross Curricular.

The integration of mathematics playfully in cross-curricular projects aligns with the research that suggests children should value and inquire about how mathematics applies to their daily lives (Dooley, 2019).

Three teachers emphasized the importance of incorporating mathematics into cross-curricular projects, such as orienteering, census and electricity meter reading, Green and Active Flags, and scientific investigations in their environment. The teachers in this study asserted that by bringing the census and other projects to the attention of students, recording, reading, and observing changes, they make mathematics real for children. They believe that children are empowered to learn when they find learning pleasurable and enjoy working together in teams. Their insights seem to align with research that highlights how playful mathematics learning is a crucial aspect of children's education, as it allows them to connect mathematical concepts with real-world experiences and activities (Dooley, 2019).

Discussion.

Research has shown that children can learn effectively through playful learning and mathematical discussion (Delaney,2019). The teachers in this study indicated that children in their classrooms learned from their peers during and after playful learning when

explanations of concepts were easily understood by others in the group. The teachers in this study described how encouraging children to discuss mathematical concepts during play can result in more insightful learning than when working individually in a classroom setting.

They emphasized that play facilitates diverse ways of learning, where children are actively engaged and learning to work out solutions with others. The peer interactions described by the teachers in the study, such as asking questions, responding, adding to each other's contributions, and explaining their viewpoints may align with research that indicates that students can through playful mathematics learning, create "new" common knowledge as part of a "natural pedagogy." (Zosh et al., 2018)

Mathematical Language.

The teachers in this study asserted that mathematics instruction which uses playful approaches involves assigning students meaningful assignments, allowing them to work in small groups, and encouraging peer engagement, questioning, sharing of ideas, and using mathematical vocabulary.

They emphasize the importance of teaching math vocabulary explicitly before it can be used in playful learning. Vocabulary lessons should be methodical and deliberate, emphasizing the word's significance, making connections to existing information, and letting students interact with the word's many applications according to one teacher. Student interaction with one another allows students to use mathematical language to explain their thinking and methods, sometimes using language they were not aware of according to a second teacher.

Another teacher in this study suggests that play can normalize mathematical language, encouraging the widespread use of essential phrases and terms in classrooms. They described how engaging in playful learning can significantly improve the use of mathematical language in classrooms as it allows children to interact with friends, acquire knowledge from peers, engage with one another, and listen to one another. These insights connect with research which highlights how mathematical language allows children to

articulate connections between many mathematical representations and encourage abstract thought. The teachers' perspectives also resonate with research when it outlines how mathematical literacy is paramount to acquiring the skills of expressing, integrating, linking, reasoning, implementing, understanding, and recalling mathematical ideas. Research suggests that the growth of mathematical competency depends on the teaching and learning of the mathematical language. As higher-level mathematical thinking can be communicated through mathematical terminology, students must regularly utilize, comprehend, and apply mathematical terms in their tasks.

Importance of teacher agency and planning.

The curriculum acknowledges the diversity of environments in which students learn and teachers impart knowledge. Consequently, the process of teaching and learning is dynamic, distinct, and specific to every setting. Teachers are in the greatest position to assess the learning requirements and skills of their class students and devise planning using the Learning Outcomes method in the New Primary Mathematics Curriculum. The teachers in the study articulated how planning underpins successful playful mathematics activities. While all the teachers in this study were positively predisposed towards play, four teachers believed that there were limits to the time they could dedicate to play and the need for playful mathematics learning to be connected meaningfully with the curriculum. Four teachers suggested that some mathematical areas work better for playful learning than others. One teacher expressed concern about the results-driven system, the pressure of standardized testing and that there is no practical element to the standardized mathematics test. One teacher indicated that the classroom environment could be more chaotic or noisy and teachers needed to monitor and be comfortable with students' movement, discussion, and noise during the playful learning activities. Could the teachers be reassured perhaps if a framework for play was created? Further research in this area may be required to address their concerns.

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Appendices.

Appendix 1: Letter of Consent.

Dear Principal/ Teacher,

I am writing to ask for your help with a study that investigates play-based learning in mathematics, in senior classes, in primary school. The research project involves learning more about teachers' insights into the use of play in teaching and learning mathematics and playful learning as a pedagogy in senior primary school mathematics. For the study, play-based learning is strongly related to constructivist learning theories and their pedagogies, which include inquiry-based learning, problem-based learning, project-based learning, guided discovery learning, active learning, collaborative learning, and cooperative learning. Playful learning may be defined as active engaging learning experiences that foster the development of cognitive, social, emotional, creative, and motor skills.

I hope the study's findings will encourage reflective practice about mathematical play in senior classes and potentially contribute new knowledge to the education field in terms of teachers' experiences and views.

There are two parts to the study: (i) a questionnaire and (ii) an interview based on the questionnaire. The questionnaire has two parts. The first part asks some broad questions about your background and teaching. In the second part, I ask you to respond to questions about your experience and insights on play. In total it takes between 15 and 20 minutes to complete the questionnaire. You are under no obligation to complete the questionnaire, or to answer all questions presented in it, but completing it may be of benefit to other primary teachers and student teachers. If you come to a question, you do not wish to answer, you can simply skip it.

When you have completed the questionnaire, I hope to carry out interviews about the answers you gave. I would like to ask you why you chose certain answers rather than others. This will help me determine if the questions written are as clear as possible and if the answers reflect your opinions. The interview would last for 60 minutes or less and it would be recorded using Zoom.

I hope you will be willing to participate because your responses are important and a valued part of the study. Your participation will remain strictly confidential. Your name will not be attached to any of the data you provide. You are welcome to discontinue participation in the study at any time, should you wish to do so. There are no risks in completing the questionnaire or participating in the interview. You will be asked to sign forms (below) indicating your agreement to participate in the various parts of the study.

If you agree to participate, please contact me by replying to this email as soon as possible. Your participation in this project is appreciated.

Should you have questions regarding your participation, please contact me at jomearampm22@momail.mie.ie

If you wish to contact my research supervisor, Seán Delaney, Ph.D. please email: sdelaney@mie.ie

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

Yours faithfully,

Josephine O Meara.

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

Statement of Consent: Please read the questions below and indicate if you would participate in the study as described.	Yes	No
Do you consent to participate in the study by completing the questionnaire described above?		
Do you consent to be interviewed based on your questionnaire answers and to have the answers recorded on Teams?	Yes	No

Signature: _____ Date: _____

Signature of Investigator: _____ Date: _____

Figure 3. Thematic Analysis.

Quote	**Code: Children make choices about their learning, for example: the use of materials, the task, and the roles within a group and methods.**
"They learn to take responsibility for their space, for the materials, for tidying up. They learn to take responsibility for their learning and their discussion".	**Children make choices**
The use of digital Math games and especially Scratch in my classroom would have had the biggest breakthrough. They could see the physical elements that were or were not working, they had to try and figure out the answer. And they found themselves trying to fix and correct and problem solve themselves rather than being told how to do it.	**Children make choices and decisions**

Quote	**Code: Children make choices about their learning, for example: the use of materials, the task, and the roles within a group and methods.**
The processes that they step through may involve following patterns and learning methods. Playful learning allows them to record their own process and report back. It allows them to have their own structure and ownership over their learning journey.	**Code: Children make choices about their learning, for example: the use of materials, the task, and the roles within a group and methods.** Children choose their own materials.
I think station teaching is important. The children can rotate from one table to another using concrete materials. In station teaching, children are presented with lots of choice, and they would even be given an opportunity to choose which stations to work at.	**Code: Children make choices about their learning, for example: the use of materials, the task, and the roles within a group and methods.** Children choose their own materials.
The conditions that enhance playful learning are those that allow choice, where children plan and devise their own methods. The children select their own materials.	**Code: Children make choices about their learning, for example: the use of materials, the task, and the roles within a group and methods.** Children choose their own materials.
The children would negotiate the	**Code: Children make choices about their**

station, there would be a leader who organizes the activity.	**learning, for example: the use of materials, the task, and the roles within a group and methods.** Children make choices.
"Another approach I have found useful is the math table. The children choose what they like, they move around, they pick the materials they like and that they think will support their problem solving. As they do, they're talking and discussing working things out together and having fun and enjoyment".	**Code: Children make choices about their learning, for example: the use of materials, the task, and the roles within a group and methods.** Children choose their own materials
Quote	**Code: Using concrete materials to make mathematical learning clear**
Materials are important: hands-on, games are crucially important, specific resources.	**Code: Using concrete materials is important**
The use of concrete materials is important, and it is important to use whatever is suitable.	**Code: Using concrete materials is important**
There is a need for plenty of opportunities for reinforcement and movement from concrete to pictorial, to abstract or written tasks.	**Code: Using concrete materials to make mathematical learning clear**
All areas can be explored using playful approaches. Concrete	**Code: Using concrete materials to make mathematical learning clear**

materials can be used to support all areas.	
Through playfulness, they are given the opportunity to use, to be hands on, to use physical materials and to represent what they're learning.	**Code: Using concrete materials to make mathematical learning clear**
It's very important, to use concrete materials, as the new curriculum emphasizes.	**Code: It is important to use concrete materials**
You would start off with concrete materials and I think that's where the real learning takes place, and so it's more meaningful and deeper learning.	**Code: Using concrete materials to make mathematical learning clear**
Quote	**Code: When children use their environment, it creates mathematical meaning**
The different activities that we engage in for the Green Flag, the Active Flag, can help introduce a playful way of learning mathematics. For example, recently we were recording and learning about the different heartbeats in birds, animals, and humans. These kinds of studies using heartbeats per second and so on showed how mathematics is a real	**When children use their environment, it creates mathematical meaning**

thing. It is in the world.	
If there is anything topical, it is important to bring that into the classroom, like for example the census. Bringing the census into the classroom makes it real. Looking at the new electricity meters introduced into the school, checking the measure, reading, and observing how it is increasing, these things make mathematics real for children.	**When children use their environment, it creates mathematical meaning**
Resources for playful learning: Teaching mathematics outside, being aware of mathematics in everyday things in the world around us. Undertaking treasure hunts develops situational awareness.	**When children use their environment, it creates mathematical meaning**
Quote	**Playful learning can involve children collaborating on cross curricular projects.**
"Math Trails were popular where they can team up with younger children, orienteering activities can include Math puzzles and they work it out	**Code: playful learning can involve children collaborating on cross curricular projects**

together".	
Children have freedom, flexibility and movement, teaching mathematics outside and being aware of mathematics in the world around us, undertaking treasure hunts and developing situational awareness	**Code: playful learning can involve children collaborating on cross curricular projects**
Quote	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
"Discussion is enriched during play. The children learn from each other. But they also need the stimulus of the teacher to support and enhance that learning.	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
"If there are children with mixed ability they often learn better in the group, from their peers and by bonding with others. Everybody in the group is learning in diverse ways, some will have ideas others will record, some will lead the group.	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
Children can often learn better from their peers. Another child may explain the concept in a way they can clearly understand.	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**

Children can learn in different ways and learn to work out solutions with each other	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
When children plan and devise their own methods, they use questioning and group discussion. They have their own questions.	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
Do playful approaches encourage Math discussions, yes. The results indicate that children are quicker to spot mathematical ideas to pick up on mathematics, and that they are more aware of mathematics in their environment having used playful approaches.	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
They're handling the materials and they're trying to work things out, working as team so absolutely it facilitates a discussion.	**Code: The children learn with and from their peers as they share thoughts, make observations, and discuss.**
Quote	**Code: Children choose how to represent and record their learning.** **Children present their findings to others.**
"Playful learning allows them to record their process and report back"	Children choose how to represent and record their learning. Children present their findings to others.

“Whether it involves showing or teaching the concept to a younger child, it is good for the older child's self-confidence to be able to teach or explain. They will need to know the topic well themselves and it reinforces the concept for themselves. Sometimes a child can surprise themselves with how well they can explain it to others.”	Children choose how to represent and record their learning. Children present their findings to others
Quote.	**Children are meaningfully engaged in learning**
“That concrete playful learning experience is where you start, to get to the abstract, but it is to do with engagement as well”	Children are meaningfully engaged in learning
“Playful learning helps children use mathematical language because we're asking them to explain their thinking and using language to explain their approaches and enjoying it. They lose themselves in it. Sometimes they use language they didn't realize they had.”	Children are meaningfully engaged in learning

When we had talked extensively as a staff about the CPA method and I went down through each chapter at the beginning of the year and I wrote out ideas for each chapter that I could introduce, some kind of game, practical activity, concrete materials, whatever that I could do for each topic that would be playful and be engaging.	
Quote	**Can play promote the use of mathematical language?**
The language of mathematics can be difficult. Sometimes it is not the kind of language that they use every day. It is important to teach mathematical language first. As a teacher you must use the language, focus on it, and emphasize the use of Mathematical language when you are explaining the concept. Then when children come to problem-solving, children finding difficulty with mathematics may not understand what is being asked. Some questions may be missed by children because they are not familiar enough with the Mathematical language.	**Can play promote the use of mathematical language?**
Playful learning can promote the	**Can play promote the use of mathematical**

common use of mathematical language. Every class and classroom have keywords and key phrases. The words and structures are displayed around the classroom and during playful activities, those words and structures are normalized. And there's a big improvement in the use of mathematical language in the classroom.	**language?**
The development of mathematical language takes place during playful learning because the children are discussing with their friends, learning from their peers, interacting with each other, learning from each other, and listening to each other.	**Can play promote the use of mathematical language?**
Playful learning helps children use mathematical language because we're asking them to explain their thinking and using language to explain their approaches and enjoying it. They lose themselves in it. Sometimes they use language they didn't realize they had	**Can play promote the use of mathematical language?**
.	
Quote	**Code: Impact upon social learning**

Group work boosts their self-confidence, and it is great for them socially. If children are enjoying how they are learning and understanding what they are learning, it helps boost their self-confidence and self-esteem.	**Impact upon social learning**
Socially it promotes communication and improves self-esteem.	**Impact upon social learning**
In those situations, you have children working together in groups which obviously facilitates social interaction and their social development, so I think that's a nice by product of what you're trying to do by introducing playful learning experiences.	**Impact upon social learning**
Quote	**Impact on cognitive development**
they have a greater ease with learning the concepts.	**Impact on cognitive development**
cognitively, it promotes their intellectual development and the development of mathematical	**Impact on cognitive development**

understanding.	
I think it is important for social learning and academic learning.	**Impact on cognitive development**
Quote	**Code: Math Strands or concepts that could be delivered through play.**
Topics that lend themselves well to play in mathematics are shape money. Indeed, there are many.	**Code: Math Strands or concepts that could be delivered through play**
Would they be able to learn everything through play? I'm not sure.	**Code: Math Strands or concepts that could be delivered through play**
All of them really.	**Code: Math Strands or concepts that could be delivered through play**
Yeah, definitely. I think shape space measures time data certainly they lend themselves to playful experiences.	**Math Strands or concepts that could be delivered through play**
Quote	**Code: Teacher Planning**
But play needs to be directed. It can sometimes be difficult to find the right material or the right approach. Or the material suited to the correct level. As a teacher, you don't want to use something too difficult. And sometimes it can be challenging to gauge the level of, or the appropriateness of the material to the level of the class.	**Code: Teacher Planning**

I think it takes a greater amount of planning. And you need to have. You need to be well resourced and that's a big part. But you know, being organized. I suppose teachers must be comfortable with their louder, slightly chaotic room. And you know, because there's movement, there's noise, there's chat,	**Code: Teacher Planning**
The activities in a school need to be well planned by the teacher. Teachers see what works and what does not. Activities need to be well-planned and well-organized.	**Code: Teacher Planning**
So I remember one year in particular when we had talked extensively as a staff about the CPA method and I had 6th class, I went down through each chapter at the beginning of the year and wrote out ideas for each chapter that I could introduce, a game, practical activity, concrete materials, for each topic that would be different from the book and would be playful and be engaging.	**Code: Teacher Planning**

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

Application for Ethical Approval of Research Proposals

1. Notes for Investigators Prior to Completing Application Form:

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

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

1. Quality assurance studies (e.g. assessment of one's own teaching practice)
2. Audits of standard practice (not involving identifiable records)

3. Research on publicly available information, documents, or data.
4. Historical research in education
5. Research that uses pre-existing data in the public domain (e.g. data from the Growing up in Ireland study)
6. Review of literature or research
7. Document analysis.

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

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

2. Level 1 Ethical Approval

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

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

3. Level 2 Ethical Approval

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

MODERATE RISK

1. Surveys asking questions of a sensitive or private nature.

2. Questionnaires or observational studies involving children or vulnerable adults.

3. Research where there is a risk of a participant feeling undue pressure to participate by virtue of his/her relationship with the researcher (e.g. student/supervisor; teacher/student; assessor/student).

4. Projects involving a justifiable degree of deception.

5. Some action researches.

HIGH RISK

1. Research involving children and vulnerable adults.

2. Research where identifiable information obtained may have legal, economic, or social consequences for research subjects.

3. Research that may identify illegal activity.

4. Projects where each subject is paid (over and above token gestures).

5. Research that may potentially endanger the subjects, and/or researchers, and/or third parties, and/or the environment.

6. Research that may have a direct military role.

7. Research conducted outside Ireland.

8. Research involving psychological intervention.

9. Research where a potentially beneficial or harmful treatment, information or learning method may be withheld from some participants.

10. Video recording or observation.

Additional notes:

i. In situations where research ethics approval has been granted by an appropriate research ethics committee elsewhere, the submission may qualify for fast-tracked approval processing in MIE.

ii. Unless otherwise noted, research involving adults assumes adults with a capacity to consent.

- Vulnerable groups/persons are described as: Individuals who face excessive risk of being enrolled in research, including those with limitations in their ability to provide informed consent to research because of factors such as immaturity, cognitive impairment, or language competence.
- Vulnerability can also stem from individuals' relationships with others, and it is imperative that coercive situations are avoided. Such cases may occur when an employee/student/dependent is asked to participate in research being conducted by a supervisor/mentor.

iii. Additional social factors, such as poverty and lack of access to health care, can also make individuals vulnerable to coercion, exploitation or other risks and need to be considered in reviewing applications.

1. The primary focus for approval is research involving people. Where the participants include **children or vulnerable adults**, research cannot proceed unless all researchers involved have obtained Garda vetting[2]. In principle, all research in MIE should be conducted in a manner that respects the rights of all participants (including to privacy of data, confidentiality and anonymity as appropriate), causes no harm to participants or researchers, and requires the active, fully informed consent of all participants and their parents, carers, guardians or relevant responsible others.

2. In the case of **Level 2 ethical approval applications**, consent forms, **must be attached to the application**, and therefore demonstrate clearly that prospective participants are being fully informed about the purpose of the research and their role in it, how their data will be gathered, the purposes to which their data will be put and how their right to privacy (confidentiality and anonymity) will be respected (for research involving children, use the ethics guidelines produced by the Department of Children and Youth Affairs.

3. Educational research undertaken outside Ireland must adhere to the same ethical standards as research Ireland. Any additional regulations (e.g. police clearance) and cultural sensitivities of the host country must also be observed.

4. Some **Level 2 ethical approval applications** may need to be referred to expertise beyond that available to MERC where proposals:

- have the potential to cause harm to participants or researchers, directly physical or psychological.
- may give rise to situations in which the researchers have to make statutory disclosure of illegal activity, whether on the part of participants or others.
- seek to deceive participants for any reason.
- may give rise to situations that may put the participants or researchers in any form of jeopardy.

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

5. If any changes to the approved research proposal are made:

i. **For Students**: these must be discussed with your supervisor, and may require additional ethical approval[3];

ii. **For Staff**: substantive changes need to be clarified with the MERC and may require additional approval.

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

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

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

4. Responsibility

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

5. Related Documents

1. MIE Privacy Policy
2. Ethics in Research Policy
3. Procedure for Ethical Approval of Research Proposals
4. Safeguarding Policy: Children
5. Safeguarding Policy: Vulnerable Persons
6. Child Safeguarding Statement
7. Garda Vetting for Students Procedure
8. Vetting Policy (Staff)

Appendix 1: Application for Ethical Approval of Research Proposals

Title of Research

Can play in the senior primary classes encourage mathematical thinking, develop mathematical understanding, promote mathematical discussion, and facilitate the use of mathematical language?

Research Reference Number[4]

22334986

Researcher's Name

Josephine O Meara

Email Address

jomearampm22@momail.mie.ie

Category of Proposer (please tick)

Student **Principal Investigator (Staff)**

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

_22334986

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

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

Level 0 **Level 1** **Level 2**

2. Please answer the following questions in relation to your proposed research. Questions (b), (c) or (d) will require detailed explanations if answered 'yes' and will be referred for additional scrutiny by the MERC.	**Yes**	**No**
a. Does the research involve work with children (under-18) or vulnerable adults? If 'Yes', has appropriate Garda clearance (or equivalent) been obtained (include details)?		**No** **N/A**
Please provide the date of issue on the Certificate of Garda Vetting.	**N/A**	
b. Does the research involve work with students on a module you coordinate, teach, or assess or a course you coordinate?		**No**
c. Could any aspect of the research give rise to any form of harm to participants, including the researcher(s)?		**No**
d. Could any aspect of the research produce information that could lead to criminal prosecution of the participants or others?		**No**
e. Is deception of the participants planned in any aspect of the research? If yes, provide details.		**No**
f. Does any aspect of the research involve patients (or their relatives or carers) or other users of health and social care services, the premises or facilities of such services, access to personal records or the participation of health or social care staff?		**No**
g. Does the Researcher plan to disseminate the work? If yes, provide details of how and where?		**Yes**

I may want to disseminate at a conference or by writing an academic or professional journal article.		

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

(b) What is your relationship with them? (If you are in a position of authority, for example, indicate how you will deal with the potential influences of such a relationship.) We communicate as a support group for teachers in a county in the West of Ireland and as teaching colleagues.

(c) What data will be used? Teacher opinion, insight, experiences

(d) How will the data be collected? Interview

(e) How will the data be used? To potentially contribute to the field of education by documenting insights and experiences of teachers in senior primary classes about playful learning in mathematics

3. **(a) How will you recruit participants?**

Write a letter to teachers and principals to request volunteers.

(b) Please detail any ethical aspects that must be considered, including the proposed use of any incentives. The only incentive may be the opportunity to discuss their ideas and to share information and teaching experiences with the researcher.

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

Online Forums such as Zoom.

b. **Describe any circumstances that might give rise to security concerns for participants or researchers.** Importance of using security features of Zoom to ensure confidentiality. Importance of protecting teacher data. Importance of clearly communicating how the research will be carried out, what it involves and how their input will be of benefit to the teaching community (while at the same time remaining anonymous, having their identity protected, and being able to withdraw from the interview process at any time)

c. **Describe any conflicts of interest where data might be critical of working practices, people etc. or disclosure of illegal activities.** Teachers' identities will be protected, and all interview information will be stored securely on a password-protected laptop.

6. Please indicate how informed consent of all participants will be gained. For participants under the age of eighteen, indicate how the informed consent of both the participant and the participant's parent/guardian will be gained. Not applicable. Participants are teachers.

b. **7. (a) Please indicate how the participants' rights to privacy (inc. confidentiality and anonymity) and the privacy of their data will be protected. Highlight potential limitations of confidentiality in the ethics form and information sheets for participants (e.g. for small samples or insider research and how this will be addressed).** Teachers' identities will be protected, and all interview information will be stored securely on a password-protected laptop.

(b) Please clearly outline what measures you will take for encrypting data.

All data will be stored securely on a password- protected laptop.

(c) Please also indicate how the data will be stored (and ultimately destroyed as appropriate). All data will be stored securely on a password-protected laptop. Data will be retained in keeping with the Institute's data retention schedule and then destroyed.

c. **Please outline what considerations you have taken in relation to GDPR and the potential GDPR implications for the proposed research.**

Teachers will remain anonymous, have their identity protected, and be able to withdraw from the interview process at any time.

8. Please complete the checklist below to confirm you have considered all ethical aspects of consent. **(Note that the consent forms that must accompany this application; any omission or inadequacy in detail will result in a request for amendments).**	**Please tick √**
I have attached (an) appropriate consent form(s) which include the freedom to withdraw at any stage without having to offer a reason.	**Yes**
Each consent form has full contact details of the researcher to enable prospective participants to make follow-up inquiries	**Yes**
Each consent form has full details, in plain non-technical language, of the purpose of the research and the proposed role of the person being invited to	**Yes**

participate	
Each consent form has full details of the purposes to which the data (in all their forms: text, oral, video, imagery etc.) will be put, including for research dissemination purposes	**Yes**
Each consent form explains how the privacy of the participants and their data will be protected, including the storage and ultimate destruction of the data as appropriate	**Yes**
Each consent form gives assurances that the data collection (questionnaires, interviews, tests etc.) will be carried out in a sensitive and non-stressful manner, and that the participant has the right to cease participation at any time and without the need to provide a reason	**Yes**
Please include here any other comments you wish to make about the consent form(s)	

Has your proposal been submitted to any other Research Ethics Committee? Yes / No

If yes, please provide details:

__No

Declaration by All Proposers:

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

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

Signed: Josephine O Meara Date: 17-12-23

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

Signed: Date:

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

Signed: **Date:**

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

Final Approval Signed-Off by Research Ethics Committee

Signed: **Date:**

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

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

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

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

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

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

Research Instrument.

Questions for Interview.

"For this thesis play is a creative solution-centered activity, where the children control the process, make use of their existing knowledge to create connections between their ideas, and support mathematical problem-solving, whose benefits hold regardless of the child's age (Sarama and Clements 2009).

The characteristics of playful learning settings in senior primary classrooms are ones in which under the guidance of teachers, children make choices about their learning, ask questions, and share thoughts or observations, can move freely inside the classroom to connect with other children and resources. Children in playful learning settings are allowed time to overcome "false starts" and make thoughtful decisions. Playful learning can be prompted by investigations where mathematics and science are integrated, by exploring solutions to problems in topics for example: space and shape, area, capacity, weight, and others using manipulatives of choice. or by creating mathematics trails."

Key Characteristics of Play:

Under the guidance of teachers:

- Children make choices about their learning, for example: the use of materials, the task, and the roles within a group.
- Children can move freely inside the classroom to connect with other children and resources.
- Children are free to make thoughtful decisions about their learning.
- Children can overcome false starts by deciding to take a different direction, for example using different tools for measurement and checking their findings.

- Children can ask questions of the teacher and other children in the classroom during learning.
- Children can share thoughts, make observations, and have group discussions during learning.
- Children choose how to represent and record their learning.
- Children present their findings to others.
- Children are meaningfully engaged in learning: communicating, observing, exploring, questioning, and estimating.
- All children are included in the mathematics space.

Group 1.

(i)How important would you say, is participating in play (as defined here, pointing to the card) in the senior students' mathematical learning?

(ii)What do you think would play-based learning in mathematics look like in 5th and 6th class?

(iii)Do you have classroom experience of playful learning in mathematics?

and what kind of mathematical learning takes place during play in 5th and 6th class, from your experience?

If not: Why do you think that is the case?

(iv) What kind of conditions contribute to the learning of 5th and 6th class students when they

engage in play-based mathematical learning?

(v)What impact does playful learning in mathematics have on students' social learning?

What impact does playful learning have on students' cognitive learning?

Group 2.

(i)How has playful learning in mathematics been beneficial to pupils in the senior classes you have taught?

(ii)What kind of playful approaches have you used in mathematics class?

What kind of playful approaches work in your opinion in the senior mathematics class?

(iii)Which ones do you think have worked best in your classes? Can you tell me about them?

(iv)What mathematical topics/ concepts have you engaged in with 5^{th} and 6^{th} class students using playful approaches? What resources have you used?

Group 3.

(i)How has the play-based approach to mathematics in your classroom supported students' development of mathematical language?

(ii)How has the play-based approach to mathematics in your classroom supported students' understanding of concepts?

(iii)Has the use of playful approaches encouraged math discussion?

(iv)How could a mathematics topic: number such as be delivered through the medium of play?