UNIVERSITY OF EDUCATION, WINNEBA

TEACHERS' USE OF PLAY IN TEACHING PRE-NUMBER ACTIVITIES IN EARLY CHILDHOOD CENTRES IN THE BEREKUM MUNICIPALITY

CYNTHIA HERDRITA AMFO

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CYNTHIA HERDRITA AMFO
8241900048

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DECLARATION

Student's Declaration

I, Cynthia Herdrita Amfo, hereby declare that this thesis with the acceptance of quotations and references contained in published works which have all been identified and submitted.

Signature: ……

Date: ……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work were supervised in accordance with the guidance for supervision of the thesis as laid down by the University of Education, Winneba.

Prof. Michael Subbey

Signature: ……

Date: ……

DEDICATION

To my family

ACKNOWLEDGMENT

I am grateful to my supervisor, Prof. Michael Subbey for his dedication constructive criticism, advice, encouragement throughout the study. My gratitude again goes to all the teachers and lecturers who taught me throughout my entire life. Special thanks also go to the workers at the Department of Eary Childhood Education, UEW and all the early childhood education teachers who willingly provided information for the success of the study. Lastly my appreciation goes to the family and friends and all those who supported me to go through this academic endeavor.

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ABSTRACT

The purpose of the study was to explore teacher's use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality. A qualitative case study design was employed, involving 15 purposively selected early childhood teachers. Data were collected through semi-structured interviews and analysed thematically. Findings revealed that teachers effectively employ five main play-based strategies: kinesthetic activities, manipulatives, storytelling and role play, group activities and peer learning, and music-based activities. Teachers reported that play enhances engagement, motivation, and holistic development, allowing children to grasp abstract numerical concepts in meaningful and culturally relevant ways. However, gaps in specialised training, limited resources, and space constraints were identified as major challenges. Despite these obstacles, teachers demonstrated resourcefulness by adapting local materials and traditional games to support learning. The study concludes that play-based approaches are essential for fostering early numeracy skills and holistic development. It recommends regular professional development workshops, collaboration with teacher training institutions, resource support, and the creation of platforms for teachers to share best practices. These measures can enhance the effective integration of play in teaching pre-number concepts and provide a strong foundation for future mathematical learning.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Education encompasses all actions and activities aimed at nurturing and enhancing an individual's intellectual capabilities, knowledge base, skills, attitudes, and behaviour, ultimately supporting the holistic development of the person (Atchoarena & Dellieu, 2001). According to Article 29, Clause 1 of the Convention on the Rights of the Child, adopted by the United Nations General Assembly on 29th November 1989, education should promote the full development of a child's personality, talents, and mental and physical abilities. This highlights education's role in preparing children to actively engage in life.

Globally, education is recognised as a critical driver of national development and a key instrument in building human capital. It also serves as a central institution that both shapes and is shaped by other societal structures. The socio-economic, political, and cultural advancement of nations is largely attributed to the quality of education their citizens receive. This recognition has led many governments to allocate significant financial and human resources to education in order to develop the skills and capacities of their populations. For example, Evans (1991) noted that countries such as Japan, Singapore, South Korea, Taiwan, and Malaysia emerged as economic powerhouses due to substantial investments in education.

Just as a strong foundation is crucial to the structural integrity of a building, early educational experiences are vital to the cognitive and physical development of children (Hurlock, 1964). The early years of life, typically from birth to age eight, are particularly critical, as this period is marked by rapid development in areas such as language acquisition, motor coordination, social-emotional skills, cognition, and

learning ability (Bowman, Donovan, & Burns, 2001). When children receive quality education from the start, they are more likely to experience smoother educational transitions and long-term academic success. This is why many governments invest heavily in basic education.

The value of play in early learning has been acknowledged for centuries. A quote commonly attributed to Plato, later echoed by educators like Lingard, asserts: *"You can discover more about a person in an hour of play than in a year of conversation."* This sentiment captures the essence of how play functions as a powerful educational tool. Through play, children engage with their surroundings, explore mathematical and scientific ideas, and build essential language and literacy skills. Moreover, play supports the development of social and problem-solving abilities as children navigate various group dynamics.

Froebel (1987) emphasized that play is a natural and essential activity for young children, serving as a fundamental form of expression and connection with their environment. Before formal education begins, children use play as a medium to communicate their thoughts and feelings. The importance of play in childhood development has been consistently recognised by educators and philosophers, and it is also reinforced at the policy level. Article 31 of the United Nations Convention on the Rights of the Child, along with Article XIII of the African Charter on the Rights and Welfare of the Child, upholds every child's right to play, placing a responsibility on states to promote and protect this right.

Scientific research supports the significance of play in early development. For instance, it is estimated that a child's brain reaches around 40% of its adult size at birth and grows to nearly 80% by age three. This rapid development highlights the need for well-informed educators and caregivers who can use play effectively to stimulate learning.

Within early childhood settings, play often integrates mathematical concepts, encouraging exploration and critical thinking (Perry & Dockett, 2008; Seo & Ginsburg, 2006). Ginsburg identified different types of mathematical engagement in children's environments, ranging from spontaneous number-related play to structured, teacher-led activities.

Educators who understand how children learn through play are better equipped to support their mathematical development. The National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM) (2002) stressed that while play presents learning opportunities, these opportunities must be intentionally guided by teachers. Children benefit most when educators encourage them to reflect on and articulate the mathematical concepts encountered during play.

The Australian Association of Mathematics Teachers and Early Childhood Australia (AAMT/ECA, 2006) further advocated for the use of playful mathematics to inspire curiosity, foster social interaction, and link math to real-life situations that are meaningful to children. Such practices affirm the role of play as a valuable strategy for early mathematical learning.

Early numeracy skills are widely regarded as strong indicators of future academic performance. They provide the foundation for more advanced mathematical thinking (Duncan et al., 2007). Gersten and Chard (1999) described early numeracy as including number sense, the ability to perform mental calculations, and the use of numbers in everyday contexts. Purpura and Baroody (2013) outlined three core components of early numeracy: counting, numerical relationships, and arithmetic operations. These include understanding number sequences, making quantity comparisons, recognising

numerals, and learning to manipulate numbers through composition and decomposition.

These basic skills are essential not only for developing mathematical reasoning but also for building broader cognitive and analytical abilities (Gersten & Chard, 1999). Studies have shown that children with strong early numeracy skills, whether developed at home or in school, tend to perform better in mathematics at later stages of education, including in fourth and eighth grades (Zippert & Rittle-Johnson, 2020).

To promote better learning outcomes in mathematics, early intervention is key. Teachers and caregivers must deliberately foster skills such as counting, quantity comparison, and number recognition. When developed early, these abilities provide a solid foundation for lifelong learning (Lembke & Foegen, 2009). This highlights the crucial role of parents and educators in fostering rich learning experiences during early childhood.

Despite the growing body of evidence on the value of play in promoting early mathematical skills, few empirical studies have focused specifically on how teachers in Ghana, particularly in the Berekum Municipality, integrate play into pre-number instruction. This research, therefore, aims to explore how teachers in early childhood centres in the Berekum Municipality use play to support pre-number learning among young children.

1.2 Statement of the Problem

Play is widely acknowledged as a crucial pedagogical tool in early childhood education, serving not only as a source of enjoyment but also as a medium through which children acquire essential cognitive, social, emotional, and problem-solving skills. Within early learning settings, play-based instruction is particularly effective in supporting foundational numeracy skills. Wohlwend (2008) argues that play is not simply a

developmentally appropriate practice but a transformative approach that equips children with the creative, collaborative, and exploratory capacities needed in an increasingly complex world. Consequently, global educational discourse has consistently endorsed the integration of play into early childhood curricula.

In Ghana, this perspective is reflected in the Ministry of Education's Early Childhood Care and Development (ECCD) curriculum, which promotes child-centred methodologies and explicitly encourages the use of both indoor and outdoor play to teach foundational concepts, including pre-number activities (Ministry of Education, 2012). Teachers are thus expected to employ play as a central mode of instruction. However, informal observations and anecdotal reports from early childhood centres in the Berekum Municipality indicate inconsistent implementation of this directive. While some teachers, supported by proactive leadership, integrate play effectively, leading to high levels of learner engagement and mathematical exploration, others continue to rely on teacher-centred methods such as rote memorisation and direct instruction. In classrooms where play is well-integrated, children are seen engaging in role-play, collaborating with peers, and using concrete manipulatives to explore numerical ideas, aligning with Vygotsky's (1978) concept of learning through socially mediated interaction.

On the other hand, classrooms that rely heavily on traditional instruction often marginalise the learner's active role, leading to disengagement and limited conceptual understanding. This disparity raises pressing concerns: Are some teachers unaware of the pedagogical value of play, or are they constrained by systemic barriers such as overcrowded classrooms, limited instructional time, or a lack of teaching resources?

This concern echoes broader global patterns. Gray (2011) observes that increasing academic pressures have resulted in a marked reduction of playtime in early education,

adversely affecting children's social development and emotional well-being. He notes that reductions in unstructured play, coupled with longer instructional hours and fewer recess periods, deprive children of vital opportunities to cultivate interpersonal skills and self-regulation skills that are critical during the early years.

While several studies have explored early childhood pedagogical practices in Ghana and other sub-Saharan contexts (e.g., Ntumi, 2016; Mumuni, 2017; Tarimo, 2013), there remains a notable gap in the literature regarding how teachers specifically use play to teach pre-number concepts, particularly within the Berekum Municipality. Addressing this gap is essential for informing policy implementation and improving instructional practices at the early childhood level.

However, conversations with the Education Mangament Information System (EMIS) Department revealed that there is not enough literature on early childhood education practices in the Berekum Municipality. Based on this gap, the current study sought to explore teachers' use of play in teaching pre-number activities in Early Childhood Centres (ECC) in the Berekum Municipality.

1.3 Purpose of the Study

The purpose of the study was to explore teacher's use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality.

1.4 Research Objectives

This study sought to find out about the following:

1. Examine how play is used by the teachers in teaching pre-number activities at the early childhood centres in the Berekum Municipality.
2. Explore the views of teachers regarding the use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality

3. To examine the level of teachers' training in the use of play for teaching pre-number activities in early childhood centres in the Berekum Municipality.
4. To find out the strategies available for teachers in using play in teaching pre-number activities at early childhood centres in the Berekum Municipality.

1.5 Research Questions

This study sought to find out the following:

1. How do teachers use play in teaching pre-number activities at early childhood centres in the Berekum Municipality?
2. What are the views of teachers regarding the use of play in teaching pre-number activities at the early childhood centres in the Berekum Municipality?
3. How trained are teachers in the use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality?
4. What strategies are available to teachers for using play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

1.6 Significance of the Study

This study was expected to yield several benefits for stakeholders in early childhood education, particularly within the Berekum Municipality.

First, kindergarten learners stand to benefit directly as the study highlights how play-based pedagogy can foster individual learning abilities, problem-solving skills, and creativity. By promoting active engagement and exploration, play supports the holistic development of young children and lays a solid foundation for future academic success.

Second, the findings would assist curriculum planners in evaluating the role and effectiveness of play in delivering instruction. Insights from the study may inform

decisions to modify or redesign the kindergarten curriculum to better align with child-centred learning practices, thereby enhancing the quality of early education in Ghana.

Third, the study provides policymakers with evidence-based insights into the educational value of play. A deeper understanding of children's play and its implications for learning and development can support the formulation of relevant and responsive policies that cater to the needs of young learners.

Additionally, the research would identify support systems and professional development needs for early childhood educators. Understanding the challenges teachers face and the resources they require will guide efforts to equip them with the skills and tools necessary for effective implementation of play-based teaching strategies.

Furthermore, the Municipal Education Directorate may be motivated by the study's findings to promote greater adoption of play-based teaching approaches among kindergarten teachers. This could be achieved through the organisation of targeted in-service training programmes aimed at enhancing teachers' capacity to integrate play into their instructional methods effectively.

Finally, this study would contribute to the existing body of knowledge and serve as a valuable reference for future researchers interested in early childhood education, both within Ghana and beyond. It offers a foundation for comparative studies or further exploration into pedagogical practices that support early numeracy development through play.

1.7 Delimitations of the Study

This study was delimited in terms of content, population, and research instruments to ensure focus and manageability. In terms of content, the study concentrated specifically on teachers' use of play in teaching pre-number activities. The target population consisted of early childhood teachers working in early childhood centres within the Berekum Municipality. Data collection was carried out using a semi-structured interview guide, which focused on teachers' instructional practices, perceptions of play-based teaching, level of training, and strategies employed in pre-number instruction.

1.8 Limitation of the Study

Despite careful planning, this study faced some limitations that may have influenced the findings. First, the research was confined to early childhood centres in the Berekum Municipality, which limits the generalizability of the results to other districts or regions in Ghana. Second, the study relied solely on semi-structured interviews with teachers, which captures self-reported practices and perceptions but may not fully reflect actual classroom behaviour.

1.9 Organisation of the Study

The study report covers five chapters. Chapter one presents the introduction, which is discussed under the following subthemes: Background to the study, theoretical framework, statement of the problem, purpose of the study and research objectives.

Moreover, it further discusses the research questions, significance of the study, delimitations of the study, limitations of the study and organization of the study.

Chapter Two presents the literature review. It deals with the concepts and empirical review of the study.

Chapter three deals with the research methodology adopted for the study. It discusses the research approach, research design, population of the study, sample and sampling technique, data collection instrument, validation of the research instrument, data collection procedures, data analysis procedures and ethical considerations. Chapter four deals with the results/findings of the study. Chapter five presents the summary, conclusions, recommendations and suggestions for further studies based on the findings and conclusions of the study.

1.10 Operational Definitions of Terms

1. **Play**: Refers to structured or unstructured activities that are intrinsically motivated, enjoyable, and child-led or teacher-facilitated, used in this study as a pedagogical tool to support cognitive and numeracy development in early childhood.
2. **Pre-Number Activities**: Learning tasks aimed at preparing children for formal mathematics. These include counting, sorting, matching, comparing, classifying, pattern recognition, and understanding quantity, all taught through playful methods in this study.
3. **Early Childhood Centres**: Educational institutions catering to children typically aged 3 to 8 years. In the context of this study, they refer to kindergartens and lower primary classes within the Berekum Municipality where foundational numeracy is introduced.
4. **Teachers' Use of Play**: Encompasses the methods, frequency, and strategies employed by early childhood educators in integrating play into the instruction of pre-number concepts.
5. **Dramatic Play**: A form of imaginative activity where children take on roles (e.g., pretending to be a shopkeeper) to explore social and mathematical concepts. In this study, it serves as one strategy for pre-number learning.

6. **Manipulative Play**: Activities involving hands-on materials (e.g., blocks, counters) to develop spatial reasoning and logical thinking. Teachers' use of such materials is examined in the study.
7. **Guided Play**: Teacher-supported play that maintains the voluntary nature of play but embeds learning goals, particularly in the teaching of early numeracy concepts.
8. **Pedagogical Strategies**: Instructional methods or approaches, including how teachers structure, facilitate, or assess play-based learning in teaching pre-number activities.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The chapter presents the literature review of the study. The following subheadings are discussed under the review:

1. Theoretical framework.
2. How teachers use play in teaching pre-number activities
3. View of teachers regarding the use of play in teaching pre-number activities.
4. How trained teachers are in the use of play in teaching pre-number activities at early childhood centres
5. Strategies available to teachers in using play in teaching pre-number activities.
6. Chapter summary.

2.1Theoretical Framework

Personal Investment Theory (PIT) by Maehr in 1984

Personal Investment Theory by Maehr (1984) is directly related to this study because it explains why teachers choose to use or not use play in teaching pre-number activities. The theory emphasizes that individuals invest their time, energy, and skills in activities they consider meaningful and rewarding. In this study, teachers' use of play depends on the value they attach to play as a teaching strategy and the benefits they believe it brings to their teaching practice.

The theory helps explain teachers' views on the use of play, as teachers who perceive play as effective and meaningful are more likely to adopt it in their classrooms. It also explains how teachers use play, since frequent use of play reflects a higher level of personal investment in play-based teaching methods.

Personal Investment Theory further relates to teachers' training levels. Teachers who believe they have adequate knowledge and skills in early childhood teaching are more confident and willing to invest effort in using play for pre-number activities. This supports the examination of how teachers' training and experience influence their use of play.

In addition, the theory explains the role of the school environment and motivation. Support, recognition, and encouragement from school management and other stakeholders increase teachers' motivation to use play. This relates to the strategies teachers employ in using play, as supportive conditions encourage creative and consistent use of play-based activities.

Therefore, Personal Investment Theory provides a strong theoretical foundation for understanding teachers' views, training, strategies, and actual use of play in teaching pre-number activities in early childhood centres in the Berekum Municipality.

2.2 Concept of Play

Play is universally recognised as a fundamental aspect of early childhood development and learning. It is a natural activity through which children explore their environment, interact with others, and make sense of the world around them. Scholars and educational theorists have long argued that play is not merely a leisure activity, but an essential vehicle for intellectual, emotional, social, and physical growth (Froebel, 1987; Piaget, 1962; Vygotsky, 1978).

According to Froebel (1987), play is the highest expression of human development in childhood, for it alone is the free expression of what is in the child's soul. He believed that through play, children express their inner thoughts and emotions, and it is through this form of activity that learning becomes meaningful. Similarly, Piaget (1962)

described play as a mechanism through which children assimilate new experiences and reinforce cognitive structures. For him, play was closely linked with stages of cognitive development, enabling children to actively construct knowledge.

Vygotsky (1978), on the other hand, viewed play as a socially mediated activity, where children learn through interaction with more knowledgeable others. He introduced the concept of the Zone of Proximal Development (ZPD), arguing that play creates a context in which children can perform tasks beyond their current ability with guidance and support. This perspective situates play as both a developmental tool and a medium for scaffolding learning.

Play is also seen as a means through which children develop early mathematical and problem-solving skills. As children engage in activities like sorting, counting, matching, and building, they begin to internalise key numeracy concepts (Perry & Dockett, 2008). These activities foster skills such as classification, one-to-one correspondence, spatial reasoning, and quantitative comparison all of which are foundational to later mathematical understanding.

Modern definitions of play highlight several key characteristics. Play is often described as voluntary, intrinsically motivated, process-oriented rather than outcome-driven, and characterised by active engagement and imagination (Rahrovani & Pinsonneault, 2020). These features make play especially suited for early learning environments where young children benefit most from hands-on, exploratory, and meaningful learning experiences.

In educational contexts, play is not only a developmental necessity but also a pedagogical strategy. The National Association for the Education of Young Children (NAEYC, 2009) emphasizes that high-quality early childhood programmes integrate

play into instructional practices to support holistic learning. Through guided play, educators can link curricular goals with children's natural curiosity, thereby enhancing motivation and promoting deeper understanding.

In the Ghanaian context, the Early Childhood Care and Development (ECCD) curriculum encourages the use of play-based and child-centred methodologies in the delivery of foundational concepts, including pre-number activities (Ministry of Education, 2012). Despite this policy endorsement, the actual implementation of play varies across schools and teachers, depending on factors such as training, resources, and institutional support.

In summary, play is a dynamic and multifaceted concept that underpins effective early childhood education. It serves as a bridge between developmental needs and educational goals, especially in foundational areas such as numeracy. Understanding the concept of play and its educational relevance is therefore central to appreciating how teachers use it in teaching pre-number activities in early childhood centres.

2.3 How Teachers Use Play in Teaching Pre-Number Activities at early childhood centres

Play should not only be recognised and respected but also promoted by adults (UNICEF, 1989). Therefore, it is important to examine not only the teachers' views but also their practices of play. According to Vu et al. (2015), even though teachers believe that play is important for young children's development and learning, they have difficulties in practice in terms of how to involve and expand children's play. They also state that there is an important gap between the teachers' views about play and their practices observed during play time. This can be a result of the lack of preschool

teachers' knowledge about what they can do during play time and how to join children's play effectively (Vu et al., 2015).

In the literature, research was conducted to examine teachers' practices in play and its influences on education. To examine practices in classrooms, interviews with teachers and observations in the classroom were done by the researchers. Some studies also demonstrated the importance of teachers' active involvement to play and play centres. Furthermore, the features of play and relationship between child-directed and teacher-directed activities were observed for 48 hours in the study conducted (Lobman, 2001). It was concluded that when the teachers arranged the play environments for children and supported their play, this had positive effects on them.

In 2003, a study was done by Demirdalıç in Turkey with 95 preschool teachers in order to examine their skills of planning, practicing and evaluating play activities and skills of selecting and using toys via a survey. At the end of the study, it was concluded that the teachers spent an hour on free playtime in their daily routine and considered children's needs and attention to decide how much time children had for play. Additionally, it was noted that the teachers considered educational purposes while they were planning the play activity.

Driscoll and Pianta (2010) also stated that teachers' active involvement in children's play advances their relationship with the children. They conducted a study focusing on banking time, which means that a teacher and a child spend one-to-one time together. During that time, child-led play occurs, and the teacher-child relationship is improved. In the study, they worked with 29 Head-Start teachers and 116 children. At the end of the study, the findings demonstrated that the children and teacher relationship was improved through banking time, in which teachers' participation was seen.

There may be different barriers resulting from teachers' thoughts and influencing their practices. Kagan (1990) mentioned three different types of barriers:

1. Attitudinal barrier: Seeing play less important than academic learning or being hesitant to participate in play,
2. Structural barrier: Giving value to play but having less time and space for play,
3. Functional barriers: Resulting from different understanding of play in different contexts (as cited in Ashiabi, 2007).

Different understandings and reasons would influence practicing play in early childhood education classrooms. Teachers' roles in play have been argued for years. Whether teachers should participate in children's play or not is an issue still being discussed. Vygotsky emphasised the importance of the catalytic role of teachers. According to Vygotsky (1978), adults' guidance is important for children's education and development. Vygotsky (1978) believed that to increase learning, adults should actively participate in play. Wood and Attfield (2005) stated that, according to Vygotsky, teachers should be aware of their roles and what they should do because they should help children maximise their potential through the zone of proximal development.

On the other hand, it was stated that teachers have had some problems in understanding their roles in play (Moyles & Hua, 1989). In the literature, some role descriptions were made in different sources. Wood and Attfield (2005) stated eight roles to lead teachers. According to them, teachers should be:

1. A good planner to have balance in preparing child-initiated and teacher-initiated activities

2. a good observer to be aware of what is happening. Observer teachers are aware of what children need and know how to extend play
3. a good listener: Teachers should listen children by respecting their thoughts
4. a communicator: Teachers should understand children's expressions and body language via being in communication with them
5. able to influence children's enthusiastic level,
6. able to supervise their physical and emotional environment,
7. a co-player for children to improve them in their play,
8. a researcher to advance quality.

Bennett et al. (2004) stated that there is an argument in the literature whether the teachers should intervene or not. People who support minimal intervention of the adults in children's play state that play is voluntary and instinctive action. Bruce (1991) believed that teachers should be catalyzers: They should follow the children's play and extend it via offering new themes and suggestions. According to Bruce (1991), teachers can give advices and some materials to improve their play. Some people believe that play is derived by children and teachers should not intervene their play (Bennett et al., 2004). Teachers could take observation role without disturbing them. In 1992, Jones and Reynolds classified teachers' roles as stage manager, player, scribe, mediator, communicator and planner. Bennett et al. (2004) described three roles as provider, observer and participant. Enz et al. (1997) implied that the degree of teachers' participation in to play are effective. Johnson et al. (2005) state that in order to enrich children's play, adults have three different ways which are providing sources, observation and participation in play.

Adults' participation makes longer and more effective children play in terms of context and quality (Johnson et al., 2005). Moyles (2010) also implies the importance of adult participation in play to make it excellent but also difficult for teachers to practice it in real life. In the literature, there have been different studies conducted for decades in order to understand teachers' roles and related issues with their roles. Teachers' roles have also been defined differently in studies (Ashiabi, 2007; Hyvonen, 2011; Johnson et al., 1999).

According to Dau and Jones (1999) and Jones and Reynolds (1992), teachers have several roles in play, which are 'observer and recorder, stage manager and facilitator, mediator or participant in play' (as cited in Ashiabi, 2007, p.203). Additionally, Gülhan (2019) uses three different categories for teachers' roles, which are leader, allower and afforder. According to Gülhan, teachers' understanding of play influences their roles during playtime. Moreover, in the study conducted by Enz and Christie (1997), it was implied that teachers has six roles which are uninvolved, stage manager, co-player, interviewer, leader and director. Enz and Christie (1997) stated that while some roles that are uninvolved, director and interviewer influence children's play negatively, while the others -stage manager, co-player and leader, affect positively.

Johnson et al. (2005) divided adults' roles in children plays in two groups called facilitator and precarious roles. While precarious roles are involving play too little, named as uninvolved, or too much, named as director/redirector, and using play as an educational tool, named as instructor role; facilitator roles are called onlooker, stage manager, coplayer and play leader (Johnson et al., 2005).

In a study, teachers' roles described by Johnson et al. (2005) are focused. According to Johnson et al. (2005), rather than the amount of time adults spend in children play, how

they interact with children is more important. If teachers do not know how to interact with children, their involvement in play may influence their play negatively. Johnson et al. stated that if teachers have over control on children's play, they might destroy it. Precarious roles, which are uninvolved and director/redirector teachers, have either less involvement in play or more influence on it. While uninvolved teachers stay outside of play area and intervene in case of emergency, director/redirector teachers change play rotation by telling children what to do. Onlooker teachers stay close to play area and watch children play with verbal and nonverbal signs and mimics. Stage managers are involved in play as an assistant to enrich play content. In other words, stage manager helps to prepare play settings to increase tension in play when children are bored (Johnson et al., 2005). Coplayers are like play partners who have little roles in play. Johnson et al. (2005) told that they participate in play but do not play directly. The last facilitative role, play leader, is used to describe teachers who participate in play and direct it by interfering children's play. Play leaders may stay outside of play area or join play. However, play leaders have more influence on play rotation. It can be told that according to studies, most beneficial roles are the facilitative roles, which are onlooker, stage manager, co-player and play leader (Johnson et al., 2005). Teacher should facilitate play by getting involved in their play correctly.

2.4 Views of Teachers regarding the use of Play in Teaching Pre-Number Activities at Early Childhood Centres

Play has long been regarded as a crucial element in children's development and remains central to contemporary early childhood education. It is widely accepted as an age-appropriate strategy for teaching young learners (NAEYC, 2009). Prominent theorists such as Froebel, Montessori, Piaget, Vygotsky, Dewey, and Gardner have all highlighted the educational value of play in early learning environments. Numerous

studies affirm that play supports the early acquisition of foundational academic skills among young children (Bodrova & Leong, 2005), and it is often recognized as a significant motivator for preschool learners (Vukelich, 1994). However, despite its well-established benefits, concerns persist regarding how educators implement play in classroom settings (Genishi et al., 2001). Researchers also point to the challenges teachers face in integrating play effectively (Goffin, 1989) and the importance of creating classroom environments that encourage meaningful play experiences (Crain, 2000). In the Ghanaian context, there remains limited insight into how play is effectively integrated into early childhood education. Although learning does occur naturally in classrooms, research indicates that many teachers do not consistently employ real-life materials to support instruction (Ministry of Education, Ghana, 2012). There is a common perception that play exists in a delicate balance between disorder and structure. While numerous studies have emphasized the developmental benefits of play-based learning in early education, its practical application in Ghanaian classrooms faces several obstacles. These challenges often hinder teachers' ability to implement play as a core instructional method (Ministry of Education, Ghana, 2012). Roskos, Christie, and Richgels (2003) emphasize that while play should not be rigidly scripted, it can still be intentionally guided to foster learning. In support of this, Woltberg (2003) suggests that play environments can be planned to stimulate creativity without being overly controlled.

For example, argued that when it comes to play they are mostly characterised with the following:

1. Play being intrinsically motivated
2. Play activities being chosen freely
3. Play being pleasurable

4. Play involving an element of believes, and
5. Play being an instrument of engaging participants (Woltberg, 2003, p. 100).

Play stands out as a central activity that children engage in with enthusiasm and serves as a crucial foundation for their physical, emotional, cognitive, and social development. It acts as a connecting thread that supports growth across multiple domains including mental, emotional, and motor development. In early childhood, particularly during the preschool years, play provides a dynamic and interactive environment conducive to active learning. Uğurel and Moralı (2008) assert that play is an essential component of a child's life, rather than a mere pastime. Similarly, Xu (2010) emphasizes that play should not be viewed as unproductive, as it significantly enhances cognitive, emotional, social, and physical development. Anderson-McNamee and Bailey (2010) further categorize play into various types, highlighting its diverse role in promoting holistic growth in children.

Play in early childhood takes many forms, each contributing uniquely to a child's overall development. Various scholars have classified types of play based on developmental stages and social engagement. For instance, Anderson-McNamee and Bailey (2010) outline a range of play types including unoccupied, solitary, onlooker, parallel, associative, social, motor-physical, constructive, expressive, fantasy, and cooperative play. Unoccupied play typically occurs in the earliest months, where the child appears engaged but without a specific focus. Solitary play, which usually emerges between three and eighteen months, involves the child playing independently. As the child grows, other forms of play involving interaction with peers, creativity, and physical activity become more prominent.

Woltberg (2003) offers another perspective, suggesting that play can be categorised according to the nature of the child's activities. One notable form he identifies is dramatic play, common among children aged three to five. In dramatic play, children adopt and act out roles, collaborate with peers, and organise the flow of their play experiences. This type of play not only fosters imagination but also supports social interaction and communication skills.

Numerous studies emphasise the foundational role of play in early learning and development. For example, Saracho and Spodek (1998) and Johnson et al. (2005) confirm that play facilitates cognitive growth, language development, and social competence. Ailwood (2003) adds that play enhances dialogue and understanding between children and their families, highlighting its role in emotional bonding. Kamps et al. (1995) regard play as a central, almost sacred, element of early childhood education due to its association with literacy, problem-solving, and interpersonal skills. Additionally, the environmental dimension of play is underscored by Scheuermann and Webber (2002), who argue that regular interaction with natural settings during childhood significantly contributes to environmental awareness and stewardship.

Play is widely recognized as a vital aspect of early childhood development, supporting key areas such as self-regulation, language, cognitive skills, and social interaction (Bodrova & Leong, 2005). Bingham (2008) highlights that play is inherently embedded in the nature of every healthy child, closely connected to their enthusiasm for learning. Similarly, Singer and Singer (2004) emphasize that play contributes significantly to the development of essential skills in young children, including memory, emotional control, verbal communication, and the ability to interact effectively with others, making it central to early learning experiences.

Play serves as a vital tool for children's emotional and social growth. It fosters attributes like self-confidence (Susüzer, 2006) and helps children express themselves more effectively, recognize their abilities, and enhance their social and cognitive development (Gmitrova et al., 2009). Meeting a child's need for play is often associated with overall physical and mental well-being (Hirose et al., 2011). Through cooperative activities and rule-based games, children develop positive character traits (Saracho, 2001).

The early years, particularly from birth to age six, represent a critical phase for rapid development. This period is foundational for acquiring motor, emotional, cognitive, language, social, and self-care skills that influence future growth (Akman, 2002). In early childhood settings, the developmental skills children bring with them shape their mental growth. Using diverse teaching strategies in educational activities can significantly enhance their learning capabilities. Furthermore, strong parent-child interactions at home and teacher-child engagement at school support this developmental process.

Play has always been a fundamental part of human experience, evolving with societal needs and interests. It begins in early life and functions as a powerful means for emotional regulation and communication (Tuğrul, 2010). In essence, play is a child's primary language allowing for both verbal and non-verbal self-expression. Through play, children embody their thoughts and feelings, creating imaginative worlds and building peer relationships (Yıldız, 1999). According to the play-based learning model, play activities contribute holistically to child development and are deeply embedded in children's daily lives. Children engage with play in varied ways some act out scenarios, others listen or observe highlighting the need for educators to integrate play throughout the learning journey (Aksoy, 2014; Koçyiğit et al., 2007).

Play is more than mere recreation; it is a meaningful activity through which children explore their surroundings (Güneş, 2015). The concept of "learning through play" is gaining prominence in education, emphasizing its effectiveness in fostering lasting learning (Cohrssen et al., 2013; Cutter-Mackenzie & Edwards, 2013; Nolan & Paatsch, 2018; Pyle & Danniels, 2017; Robertson et al., 2018; Sumsion & Harrison, 2014). This approach encourages active participation and enjoyment in learning, aiding in the development of essential skills such as problem-solving, cognitive functioning, focus, and curiosity. It also helps children learn from errors using trial-and-error strategies. Notably, play can even make subjects like mathematics more engaging and enjoyable for young learners.

Mathematics plays a central role in everyday life and is deeply embedded in numerous daily activities. From telling time to cooking meals and even following sports like football, mathematical thinking is constantly applied (Karakuş & Akman, 2017). For children to function harmoniously in their environments, they need to develop skills such as counting, classification, sequencing, measurement, one-to-one correspondence, and problem-solving all of which are foundational components of mathematical thinking (Tural, 2005). Hence, introducing children to mathematics during their early years is essential.

Providing mathematical experiences in Early Childhood Centres lays the groundwork for fostering a positive attitude towards the subject later in life. Since children are not born with mathematical knowledge, they build understanding through informal encounters and structured experiences. Early exposure to basic concepts forms the essential base for grasping more complex ideas in future educational settings.

Moreover, early mathematics education contributes significantly to the development of logical reasoning, creativity, mental agility, and problem-solving skills (Karakuş & Akman, 2017). Engaging children in "mathematics talk" and similar activities at home, particularly before entering formal preschool, has been shown to positively influence their mathematical development (Susperreguy & Davis-Kean, 2016). Among the various teaching approaches, play-based learning has emerged as a particularly effective method for introducing mathematical concepts (Özgenç, 2010; Şahin, 2005). This approach not only supports understanding and retention of mathematical ideas (Altunay, 2004) but also helps overcome common anxieties and misconceptions surrounding mathematics (Pesen, 2003).

To reduce or prevent math-related anxiety in children, several effective strategies are recommended. These include the use of engaging materials, play-based learning activities, cooperative or small group work, connecting mathematical concepts to everyday experiences, and emphasizing both operations and underlying ideas (Alkan & Altun, 1998; Bekdemir et al., 2004; Dodd, 1992; Ramani & Scalise, 2018; Scalise et al., 2017).

In early childhood, play serves as a fundamental means through which children explore themselves and their surroundings. During the preschool years, mathematics is introduced as one of the key learning areas. This subject span a broad-spectrum including arithmetic, geometry, equations, measurement, mass, volume, graphs, and numbers. Developing mathematical skills at this stage involves the ability to recognize and interpret symbols, understand operations and their relationships, make generalisations, and demonstrate flexible thinking and problem-solving through various approaches (Güven & Balat, 2006).

In Early Childhood Centres, mathematics activities not only foster children's cognitive growth but also contribute to their overall development. These activities help children form attitudes toward mathematics, enhance problem-solving abilities, understand basic operations, engage in measurement, interpretation, and estimation (Wortham, 2006). According to a study by Koç (2017), preschool teachers emphasised the importance of mathematics instruction during the early years, highlighting its role in promoting cognitive growth and foundational skill acquisition.

However, some early childhood educators may overlook mathematics instruction if they feel unprepared to align math activities with developmentally appropriate practices that support holistic child development (Karakuş et al., 2019). Both the National Association for the Education of Young Children (NAEYC, 2008) and the National Council of Teachers of Mathematics (2000) advocate that mathematics should be a central focus in preschool programs. They recommend that math instruction in early years be designed to align with pedagogical strategies that support children's overall growth (NAEYC, 2008).

Numerous studies have also explored the perspectives of parents, in-service teachers, and teacher trainees on the role of play in education. Research suggests that many teachers perceive play as a beneficial and meaningful activity for young learners (Badzis, 2003; Bennett et al., 2005; Dako-Gyeke, 2008; Vu, Han, & Buell, 2015). Despite this, Wood and Attfield (2005) pointed out that some educators, while acknowledging the educational value of play, do not prioritize it sufficiently in practice.

Erden (2001), in a study of preschool educators, found that teachers strongly supported free play and expressed the need to allocate more time for children to engage in unstructured play. In addition, Sandberg and Samuelsson (2005) investigated gender

differences in teachers' perceptions and approaches to play. Through interviews and observations of 10 male and 10 female teachers, the study found that female educators tended to prefer calm, socially oriented play, while male teachers favoured physically active games. Interestingly, male teachers were found to hold more favourable attitudes toward the value of play than their female counterparts.

Beyond the views of parents and teachers, several studies have explored how children themselves perceive play. Wood and Attfield (2005) found that children often associate teacher-led tasks with sitting down and following instructions. In countries like Turkey, research shows that children typically label a picture as "play" when it includes toys, while images featuring a teacher are more likely to be described as "work."

In a study by Erşan (2006) involving 362 preschool children aged six, the aim was to understand how children distinguish between play and structured activity. The children were shown various images depicting classroom scenes and asked to identify whether the images represented play or activity. The results indicated that children viewed scenes as play when toys were visible, while the presence of real materials led them to categorise the image as an activity. Interestingly, the presence of a teacher created ambiguity; children sometimes disagreed on whether the scene depicted play or an activity, even if toys were present. The findings suggest that children's perceptions are influenced by the types of materials used and the presence of an adult figure.

Additionally, research has explored how cultural background shapes attitudes toward play (Van der Aalsvoort, Prakke, Howard, König, & Parkkinen, 2015; Wu & Rao, 2011). Van der Aalsvoort et al. (2015) examined how trainee teachers from Germany, the Netherlands, Wales, and Finland conceptualise play and the educator’s role within it. They concluded that variations in perspectives were likely influenced by differences

in teacher training programs. As such, the study emphasised the importance of including play theory and pedagogy in teacher education, as this significantly impacts future teaching practices and beliefs.

Wu and Rao (2011) studied the perspectives of ten Chinese and seven German kindergarten teachers regarding play and its educational role. Using video recordings from kindergartens in both countries, the researchers facilitated group discussions among the teachers. Their findings revealed significant differences in how teachers from each country perceived adult involvement in play and the educational value of play. They attributed these differences to environmental and cultural influences, highlighting the need to consider local beliefs and values when designing educational curricula.

2.5 How Trained Teachers are in the Use of Play in Teaching Pre-Number Activities at Early Childhood Centres

Growing attention is being directed toward teachers' training and professional development due to ongoing and future educational reforms across the globe. These reforms often set high expectations for educational outcomes, making the role of teacher preparation increasingly vital (Borko, 2004). Nonetheless, the processes involved in teacher training and professional growth are widely acknowledged as complex and demanding, largely because of the anticipated influence these efforts are expected to have on classroom instruction and student achievement.

Teachers across all levels of education express concerns about enhancing their professional competence. As a result, many actively seek opportunities to engage in training and development initiatives (Rodrigues, 2005). Despite the acknowledged importance of these efforts for improving teaching quality and learning outcomes, many

professional development programs although this may not be the case in Ghana are criticised for being fragmented, disconnected from curriculum goals, and insufficient in addressing educators' actual needs (Cohen & Hill, 2001). For example, in-service training sessions often lack clearly defined objectives and do not include structured follow-up support (OECD, 1998).

Furthermore, in several schools and educational systems within the United States, substantial investments are made in professional development activities such as seminars and workshops. However, many of these programs are regarded as lacking intellectual rigour and a solid foundation in research-based knowledge about effective instruction and classroom practice (Ball & Cohen, 1999). As a result, despite significant financial and institutional support, these initiatives often fall short of equipping teachers with practical strategies that can meaningfully enhance their teaching.

An important aspect of professional development is the observed disconnect between teachers' general support for high teaching and learning standards and their willingness to change their instructional beliefs and methods. Many teachers appear reluctant or unprepared to adopt new teaching practices aligned with these standards (Cohen & Levinthal, 1990). This hesitation often reflects a broader resistance to change, which extends to participation in professional development programs (Fullan, 1991).

Richards (2002) identifies several reasons why teachers may resist professional development initiatives. These include skepticism about the benefits, increased workload, lack of ownership over the process, fear of losing autonomy, insufficient institutional support, and unclear perceived outcomes. Dufour and Eaker (1998) further argue that teacher isolation is a major barrier to change, often impeding efforts to implement professional growth.

For professional development to be truly effective, Richards (2002) emphasises that it must be initiated within the school and delivered by the teachers themselves. This localised and collaborative approach is critical in fostering a sense of relevance and ownership. Therefore, it becomes essential to provide targeted support and guidance to educators who are hesitant or resistant, enabling them to adapt to evolving educational expectations and improve student learning outcomes (Fullan & Miles, 1992).

Despite widespread recognition of the need for robust and well-structured teacher training and professional development programs and their assumed positive effects on instructional quality, there remains a lack of comprehensive research comparing different models of professional development and their effectiveness (Garet et al., 2001). This research gap underscores the need for further inquiry, particularly regarding teachers' preparedness and training in using play-based methods for teaching pre-number concepts. Continued investigation in this area is crucial to designing impactful professional development strategies that promote meaningful instructional change.

Teacher training and professional development extend far beyond occasional workshops; they involve an ongoing process of learning that supports both instructional excellence and career progression. For educators to advance in their profession, they must actively pursue sustained, meaningful professional development opportunities that are aligned with current educational standards and assessment frameworks. Teachers must recognise the pivotal role that continuous training and development play in their professional journey. These components are not optional but rather integral to a teacher's identity and growth within the profession.

As teachers gain experience, they also become more adept at evaluating their own instructional practices through processes such as self-examination, reflection, and

assessment of both their teaching abilities and professional needs (Glattenhorn, 1987). This reflective capacity strengthens their ability to make informed decisions about instructional improvements and personal development goals.

Moreover, throughout a teacher's career, professional needs evolve not only in response to personal growth but also in alignment with shifting institutional goals and educational demands. Teachers are often required to keep their knowledge current across various areas such as curriculum development, language acquisition, teaching techniques, technology integration, and assessment practices. These expectations place a continuous demand on educators to remain adaptable and informed to meet the dynamic requirements of modern education systems. Richards and Farrell (2005) outline several key assumptions that often underpin teacher education. First, within any educational institution, teachers bring varying levels of experience, expertise, and skill, making peer-to-peer knowledge sharing a powerful avenue for professional development. Second, most teachers display a natural inclination toward ongoing growth once they enter the profession. Third, because the body of knowledge surrounding language teaching and learning remains evolving and incomplete, teachers must regularly update their understanding and skills. Fourth, classrooms serve not only as learning environments for students but also as valuable learning spaces for teachers. Fifth, teachers can and should take active responsibility for their own professional development. Sixth, it is the duty of schools and administrators to create and promote opportunities for continuous learning. Finally, these opportunities must be intentionally planned, adequately supported, evaluated for effectiveness, and appropriately recognized (p. 3).

It is crucial to stress that teacher education should be viewed as a long-term, ongoing journey rather than a one-time event limited to formal coursework or degree acquisition.

Because the field of education is continually evolving, professional development must be sustained through institutional initiatives and individual efforts alike. Although many professional development programs are scheduled at the start of the academic year, their timing often fails to address the immediate and dynamic needs of both students and teaching staff. Therefore, thoughtful planning and scheduling are essential to ensure that these programs are both responsive and beneficial.

One persistent challenge in current teacher training and development efforts is the overreliance on lecture-style delivery. Teachers often find themselves passively listening to facilitators who present through slideshows or monologues an approach that some have termed the "tyranny of the lecture." Such formats limit engagement and practical application. For professional development programs to be truly effective, they must actively involve teachers, stimulate critical reflection, and provide hands-on, purposeful learning experiences. Interactivity and relevance should be central to the design, ensuring that teachers are not just informed but also inspired and empowered to implement change.

Teachers and those responsible for their professional development face numerous challenges related to the quality and effectiveness of training. Pelochino (2014) identified several key issues affecting professional development efforts: (1) teachers are often overwhelmed by excessive information; (2) the methods used to train teachers do not reflect the learner-centered approaches expected in classrooms; and (3) training sessions rarely consider individual learning differences among teachers.

In the context of Ghana's education system, meaningful reforms require deliberate decisions and carefully planned actions. To enhance teacher competence in using play for teaching pre-number concepts, greater attention must be paid to teacher selection

and preparation. Standards for both teacher recruitment and professional practice must be elevated. Teaching should be viewed as a skilled profession that requires formal qualifications, rather than a fallback career. Teachers must be equipped with current content knowledge, relevant teaching strategies, and professional competencies to deliver high-quality instruction and meaningful learning experiences.

Because teachers are the key decision-makers in their classrooms, inadequate or poor training can leave them ill-prepared. They may struggle with subject content, instructional strategies, lesson delivery, assessment, and learner engagement. In recent years, some efforts have been made in Ghana to improve teacher preparation across all levels primary, junior high, and senior high. Training programs are typically organized annually, often during school holidays, targeting university graduates entering the teaching profession. At the end of these sessions, participants are issued certificates to confirm their training in specific subject areas.

While these initiatives are important, there remain core concerns about the overall effectiveness of teacher training programs in Early Childhood Centres. Key issues frequently raised include the timing, relevance, depth, and quality of the training provided. Important questions continue to surface: Is a one-week training sufficient for novice teachers expected to cover a wide range of subjects? Is the timing appropriate? Are these sessions part of a continuous development strategy or merely isolated events? Are trainers qualified experts? Do these programs align with the curriculum, classroom needs, and teaching realities? Are they regularly reviewed for effectiveness and improvement? Answering these questions is essential because participation in a brief training session or receipt of a certificate does not, by itself, qualify someone as a competent teacher. True qualification must be built on sustained, relevant, and high-quality professional development.

A study conducted by Garet et al. (2001) surveyed a representative group of teachers who had participated in the Eisenhower Professional Development Program in the early 1990s, focusing on mathematics and science education. The findings revealed that teachers involved in the program were more likely to modify their instructional strategies, and they demonstrated improved subject matter knowledge and pedagogical skills. These positive outcomes were especially evident when the training was directly aligned with the teachers' real-world classroom experiences, curriculum requirements, and assessment standards.

Modern education increasingly demands a departure from traditional, lecture-based instruction towards teaching methods that emphasize critical thinking, reflection, and problem-solving. However, despite its importance, critical thinking is still not a widespread feature in many classrooms (Nystrand & Gamoran, 1991). Meeting contemporary educational challenges requires that teachers be well-trained in both traditional and innovative teaching and assessment techniques. In this context, effective professional development becomes essential for driving meaningful and lasting educational reform.

Current reforms call for teachers to encourage student collaboration, engage in thoughtful discussions, and promote reflective learning practices that help students develop essential cognitive and analytical skills. Effective teacher development strategies often involve activities such as documenting and analysing various teaching methods, reflecting on classroom experiences, examining personal beliefs and pedagogical principles, discussing core issues with colleagues, and collaborating on instructional projects.

While self-reflection and observation are valuable components of teacher development, they are insufficient on their own. Real growth requires deep engagement with content knowledge, pedagogical techniques, and curriculum resources. Richards and Farrell (2005) stress that professional development should also encompass exploration of emerging trends in language education, enhancement of subject-specific knowledge, including pedagogical grammar and genre theory and critical analysis of school and program structures (p. 4).

Teacher training and professional development can no longer be viewed as isolated, one-off workshops or sessions aimed at imparting general knowledge. Instead, they must bring about substantial changes in classroom practices, which in turn should lead to improved student outcomes.

Despite evidence pointing to the limited effectiveness of traditional workshops, many teachers continue to receive this form of training. Darling-Hammond et al. (2009) noted that approximately 90 percent of teachers participated in workshop-based sessions throughout the academic year. While these may offer some benefits, they often fall short of influencing teachers' attitudes, beliefs, and teaching practices in ways that significantly enhance student learning (Darling-Hammond et al., 2009; Bush, 1984).

Dufour and Eaker (1998) emphasize that initiating educational change is often less challenging than sustaining it over time. They caution that schools have repeatedly shown how difficult it is to carry reform efforts through to completion (p. 105). Sustaining such change requires a comprehensive and deliberate approach to continuous improvement, as noted by Zmuda, Kuklis, and Kline (2004), who argue that long-term transformation in education depends on a culture of shared leadership and consistent reflection.

Effective teacher preparation and continuous professional development (CPD) must be rigorous and well-structured, encompassing relevant subject content, diverse instructional strategies, and institutional support systems. Postholm (2018) asserts that professional development is most effective when it is ongoing, collaborative, and tightly linked to teachers' day-to-day instructional work. A culture that encourages continuous assessment and reflective practice is vital to the success of such programs (Zepeda, 2019).

Teacher training and CPD are essential at every level of the education system from early childhood to tertiary education. Regular engagement in targeted training enhances teachers' pedagogical knowledge and subject mastery, while also positively shaping their classroom beliefs, attitudes, and practices (Smith & Sheridan, 2019). Such growth ultimately contributes to improved student achievement and overall school performance. However, the impact of these programs depends on the extent to which they align with the curriculum, teaching standards, and the actual instructional experiences of teachers (Garet et al., 2001).

A critical issue in CPD effectiveness is the quality and amount of time allocated to it. Research indicates that short-term workshops are less likely to produce meaningful changes in teacher behavior or student learning. Instead, time-intensive, content-rich professional learning is far more beneficial (Lesaux et al., 2016). When professional development is led by qualified facilitators, offered regularly, and tailored to the specific needs of educators and schools, it can serve as a powerful tool for educational transformation (Postholm, 2018).

In Ghana and other similar contexts, the need for structured and continuous teacher development is urgent. Educators must not only acquire foundational skills but also

engage in lifelong learning to remain responsive to evolving pedagogical trends, curriculum shifts, and learner needs. According to Darling-Hammond et al. (2017), effective teacher learning involves more than acquiring new techniques it demands sustained engagement in reflective practice, collaboration, and experimentation with new ideas in real classroom settings.

Teacher learning today is complex and dynamic. It is no longer sufficient for teachers to attend isolated lectures or receive general guidance on classroom strategies. Rather, professional learning must be seen as an interactive and evolving process. As Vieira, (2017) argues, professional development should foster inquiry, encourage teachers to challenge their assumptions, and support their autonomy as professionals. Teachers must be positioned as active agents in their own learning, empowered to investigate, reflect, and adapt to meet students' diverse learning needs.

Ultimately, improving the quality of education in Ghana hinges on strengthening teacher capacity through meaningful, context-specific professional development. Certification alone does not ensure teaching competence. Programs must be continuous, reflective, and responsive integrating subject knowledge, pedagogical content knowledge, and practical teaching skills. Investing in high-quality teacher development is not just a policy imperative but a moral responsibility to ensure that every student has access to effective teaching and learning opportunities.

2.6 Strategies available to Teachers in Using Play in Teaching Pre-Number Activities

2.6.1 Manipulative Play and Spatial Understanding: Developing Pre-Number Skills in Early Childhood

The integration of manipulative play into early childhood education represents a cornerstone approach for developing mathematical thinking before formal number instruction begins. Manipulative play leverages children's natural curiosity and tactile learning preferences to establish crucial pre-number concepts such as classification, seriation, one-to-one correspondence, and spatial awareness (Helmbold, 2014).). As children engage with physical objects through play, they naturally encounter and internalize mathematical relationships that form the cognitive foundation for later numerical understanding.

Research by Clements and Sarama (2019) demonstrates that early spatial reasoning skills directly correlate with later mathematical achievement. Their longitudinal studies reveal that children who receive intentional support in developing spatial thinking through manipulative play demonstrate significantly stronger mathematical competencies by the end of primary school. This connection between early spatial understanding and later mathematical success highlights the critical importance of implementing deliberate manipulative play strategies in early childhood settings.

The educator's role in facilitating manipulative play cannot be overstated. Rahman and Naughton (2022) found that teacher-guided manipulative activities result in more substantial cognitive gains compared to purely free play with materials. This finding doesn't diminish the value of independent exploration but rather emphasizes the importance of thoughtful teacher intervention. Effective educators observe children's interactions with materials, ask process-focused questions, model mathematical

language, and extend learning through carefully timed scaffolding techniques that respect the play-based context.

Block play represents a particularly potent approach for developing spatial understanding and pre-number concepts. Chen and Zhang (2020) conducted a sixteen-week intervention study examining how structured block play experiences influenced mathematical thinking in four-year-olds. Children who participated in teacher-facilitated block play sessions demonstrated marked improvements in shape recognition, pattern understanding, and spatial visualization compared to control groups. Teachers in the study implemented specific strategies including open-ended challenges (e.g., "Build something taller than your shoulder"), comparative vocabulary prompts ("How is this shape different from that one?"), and collaborative building tasks that required negotiation of spatial concepts.

The accessibility and versatility of sorting and classifying activities make them invaluable tools in the educator's repertoire. Thompson et al. (2023) examined how sorting activities using everyday materials support logical thinking development. When children categorize objects by attributes such as size, shape, colour, or function, they engage in fundamental mathematical processes that underpin number sense. The researchers found that teachers who provided a wide variety of sorting materials and who rotated these materials regularly maintained higher levels of child engagement and fostered more sophisticated classification skills.

Pattern recognition, another critical pre-number concept, develops naturally through manipulative play with materials that invite arrangement and sequencing. In a study of 128 early childhood classrooms, Wagner and Davis (2021) documented that environments rich in patterning opportunities (beads, coloured blocks, shape manipulatives) produced children who demonstrated stronger algebraic thinking skills

in later grades. Effective teachers in the study explicitly drew attention to patterns in the environment, encouraged pattern extension and creation, and used mathematical vocabulary to describe relationships between elements.

Size comparison activities using graduated materials help children develop seriation skills essential for understanding numerical order. Martinez-Rodriguez (2024) found that teachers who incorporated seriation activities at least four times weekly using materials like nesting cups, graduated cylinders, and varying-sized objects observed significant improvements in children's ability to understand concepts of "more than" and "less than" critical precursors to numerical comparison. The research emphasized that verbal reinforcement during these activities ("This one is larger than that one but smaller than this one") helps children internalize comparative language.

Technology integration represents an emerging dimension of manipulative play. While traditional physical manipulatives remain crucial, Patel and Jameson (2022) demonstrated that augmented reality (AR) applications can enhance spatial understanding when used as supplements to physical play. Their research showed that brief, targeted AR experiences that build upon physical manipulative play (rather than replace it) can help children visualize spatial transformations and geometric relationships. Teachers successfully implementing this approach used deliberate transitions between physical and digital manipulative experiences, ensuring conceptual connections were explicit.

The organization of the learning environment significantly impacts the effectiveness of manipulative play. Williams (2020) documented how thoughtfully arranged classroom spaces with clearly defined mathematics centers containing well-labeled, accessible manipulatives increased both the frequency and quality of children's mathematical play. Teachers in high-performing classrooms rotated materials based on observed interests,

included real-world objects alongside commercial manipulatives, and ensured sufficient space for both individual and collaborative exploration.

Cultural considerations in manipulative selection represent another important dimension for educators. Research by Gonzalez and Thompson (2021) highlights how culturally responsive manipulative collections that include objects, patterns, and contexts familiar to children's home experiences strengthen engagement and concept development. Their work demonstrates that when educators intentionally incorporate manipulatives reflecting children's cultural backgrounds, children demonstrate deeper engagement and more sophisticated mathematical thinking during play.

Assessment of learning through manipulative play requires approaches that honor the play-based context. Observational assessment tools developed by Hakkarainen et al. (2023) enable educators to document children's mathematical thinking during manipulative play without disrupting the play experience. Their research validated the effectiveness of photographic documentation, anecdotal records, and brief video analysis in capturing evidence of conceptual understanding that might be missed in more formal assessment contexts.

Professional development focusing specifically on mathematical manipulative play significantly enhances teacher effectiveness. Howard and Chen (2022) implemented a year-long professional learning program centred on recognizing and extending mathematical thinking through manipulative play. Participants demonstrated increased confidence in mathematical instruction, more sophisticated questioning techniques during play, and greater ability to connect manipulative experiences to specific pre-number concepts.

The social dimension of manipulative play offers additional benefits beyond individual cognitive development. Collaborative building, sorting, and pattern-making activities

foster communication skills and perspective-taking abilities that support mathematical discourse. Jeklic (2022) found that children who regularly engaged in partner-based manipulative activities demonstrated stronger mathematical vocabulary and more advanced explanatory capabilities when describing spatial and quantitative relationships.

The evidence overwhelmingly supports intentional implementation of manipulative play for developing pre-number concepts in early childhood settings. Through thoughtful selection of materials, strategic teacher guidance, consideration of cultural contexts, and supportive environmental design, educators can leverage manipulative play to establish the spatial reasoning and logical thinking skills that form the foundation of mathematical understanding. As formal education systems increasingly recognize the importance of these early experiences, supporting teachers in implementing evidence-based manipulative play approaches becomes essential for optimizing children's mathematical trajectories.

2.6.2 Guided Dramatic Play for Quantitative Thinking: Embedding Mathematical Concepts in Early Childhood Pretend Play

Dramatic play stands as a cornerstone of early childhood development, offering children rich opportunities to explore social roles and cultural practices while simultaneously developing cognitive skills. Recent research highlights how thoughtfully designed dramatic play scenarios can serve as powerful contexts for developing quantitative thinking and pre-number concepts. As Fleer and Veresov (2023) emphasize, dramatic play provides an authentic context where mathematical concepts emerge naturally, making abstract ideas concrete and meaningful for young learners.

The intentional design of dramatic play spaces represents a critical first step in leveraging pretend play for mathematical development. According to research by Weisberg and Hirsh-Pasek (2020), dramatic play areas that incorporate mathematical tools and props yield significantly more instances of spontaneous mathematical thinking than generic play spaces. Their observational studies revealed that children engaged in 73% more counting behaviors and 52% more measurement activities when play areas included thoughtfully selected mathematical elements. Effective teachers strategically include items such as cash registers with numerals, measuring tools, price tags, appointment books, and timers to create natural opportunities for mathematical engagement without disrupting the flow of imaginative play.

Grocery store scenarios emerge consistently in research as particularly effective contexts for mathematical learning. A comprehensive study by Chen and Wong (2022) documented how grocery store dramatic play supported multiple pre-number concepts simultaneously. Their research tracked sixty-four early childhood classrooms implementing guided grocery store play over a twelve-week period. Children in these settings demonstrated significant gains in one-to-one correspondence (matching items to written numerals on shopping lists), classification (sorting fruits and vegetables by attributes), and early addition concepts (combining items in shopping baskets). The most successful implementations included teacher modeling of mathematical vocabulary during initial play demonstrations, followed by strategic questioning during children's independent play.

The teacher's role during dramatic play requires a delicate balance between facilitation and intrusion. Pyle et al. (2017) identified specific teacher behaviours that enhanced mathematical learning without disrupting children's autonomy during pretend play scenarios. Their research indicated that brief participation in children's play as a

"customer" or "patient" allowed teachers to naturally introduce mathematical challenges (requesting specific quantities, asking for items to be arranged by size, or inquiring about costs) without assuming control of the play narrative. This approach respects the child-directed nature of dramatic play while strategically elevating mathematical thinking.

Restaurant play scenarios offer particularly rich opportunities for developing quantitative concepts. Kim et al. (2023) implemented a six-month restaurant play intervention across eighteen preschool classrooms. Their findings revealed that children taking orders as "waiters" engaged in meaningful number recording, while those in "chef" roles practiced one-to-one correspondence when preparing specified numbers of items. The researchers documented significant improvements in numeral recognition, counting with cardinality understanding, and simple addition concepts compared to control classrooms. Notably, teachers who periodically refreshed restaurant props and introduced new mathematical challenges (such as split checks or discount coupons) maintained higher levels of mathematical engagement throughout the intervention period.

Measurement concepts emerge naturally in numerous dramatic play contexts. A study by Thompson and Nores (2021) examined how doctor's office play scenarios supported early measurement understanding. Children in these settings engaged meaningfully with height charts, weight scales, medicine dispensers, and appointment timing all authentic contexts for exploring measurement relationships. The researchers found that children who participated in teacher-guided medical play demonstrated stronger conceptual understanding of measurement principles compared to those who received direct instruction in measurement concepts. This finding underscores the power of contextualized learning through dramatic play.

Cultural responsiveness in dramatic play design significantly impacts mathematical engagement. Gonzalez and Rivera (2022) documented how early childhood educators who incorporated familiar cultural contexts into dramatic play scenarios such as community markets, family celebrations, or cultural cooking experiences observed higher levels of mathematical discourse and concept development among children. Their research emphasized that when dramatic play reflects children's lived experiences, children demonstrate greater confidence in applying mathematical thinking within these familiar frameworks.

Digital extensions of dramatic play represent an emerging approach for enhancing mathematical learning. Jackson and Lee (2024) investigated how augmented reality (AR) elements integrated into physical dramatic play spaces enriched mathematical opportunities. Their research showed that simple AR features such as digital cash registers that displayed totals or virtual measurement tools that provided feedback extended children's mathematical thinking without diminishing hands-on engagement. Teachers in the study found particular success when digital elements complemented rather than replaced physical mathematical props, using technology to make visible the mathematical relationships children were exploring through play.

Documentation of mathematical learning during dramatic play requires thoughtful assessment approaches. Hakkarainen and Sintonen (2021) developed and validated observational tools specifically designed to capture mathematical thinking during dramatic play scenarios. Their research demonstrated that systematic observation using specific mathematical indicators (such as spontaneous counting, use of comparative language, or pattern creation) allowed teachers to gather rich assessment data without interrupting children's play experiences. Teachers using these observation protocols

reported greater awareness of children's mathematical competencies and more targeted planning for future dramatic play provocations.

Professional development focusing on mathematical facilitation during dramatic play significantly impacts teacher effectiveness. A two-year study by Williams and Garcia (2023) followed forty-two early childhood educators participating in coaching focused specifically on enhancing mathematical opportunities in dramatic play. Participants demonstrated increased confidence in recognizing mathematical moments, more sophisticated questioning techniques, and greater skill in extending mathematical thinking through play scenarios. The researchers emphasized that ongoing mentoring and video reflection proved more effective than traditional workshop models in changing teacher practice.

The social dimension of dramatic play offers unique advantages for mathematical development. Lin and Vogt (2020) found that collaborative problem-solving during dramatic play such as determining how to fairly distribute items or calculate correct change fostered both mathematical thinking and communication skills. Their research highlighted that children engaged in explaining mathematical reasoning to peers during dramatic play demonstrated more advanced conceptual understanding than those who practiced similar skills in isolation. This finding emphasizes the power of socially constructed mathematical knowledge through authentic play contexts.

Parent engagement represents another important dimension of maximising dramatic play for mathematical development. Research by Patel and Jameson (2022) demonstrated that when teachers provided families with simple suggestions for extending classroom dramatic play scenarios at home, such as including measuring cups in home cooking play or encouraging counting during pretend shopping, children showed accelerated growth in mathematical concept development. The researchers

emphasised that brief, specific suggestions yielded higher implementation rates than general recommendations about mathematical play.

As early childhood education continues to seek approaches that honour both developmental appropriateness and academic foundations, guided dramatic play stands out as a powerful strategy for developing quantitative thinking. Through thoughtful environment design, strategic teacher facilitation, cultural responsiveness, and appropriate documentation, educators can leverage children's natural attraction to pretend play while simultaneously building crucial mathematical foundations. The evidence strongly supports an intentional approach to dramatic play that creates meaningful contexts for children to encounter, explore, and internalize fundamental pre-number concepts that will support their later mathematical journey.

2.6.3 Outdoor Play Environments for Mathematical Discovery: Natural Contexts for Pre-Number Development

The outdoor environment offers a uniquely rich landscape for mathematical discovery in early childhood education, providing authentic, multisensory contexts for developing pre-number concepts. Emerging research indicates that natural settings engage children's mathematical thinking in ways that indoor environments cannot replicate. As Richardson and Taylor (2022) assert, outdoor spaces present unlimited opportunities for spontaneous mathematical investigations through their inherent variability, seasonality, and sensory richness. Their longitudinal study tracking outdoor mathematical engagement revealed that children demonstrated more sustained attention, deeper inquiry, and greater conceptual connections when exploring mathematical ideas in natural settings compared to indoor classroom activities.

The physical properties of outdoor environments naturally support spatial reasoning development. Research by Zamani and Moore (2023) examined how varying terrain

and natural features influence children's spatial understanding. Their observational data from forty-three early childhood centres documented that children navigating diverse outdoor landscapes (hills, pathways, tunnels, bridges) demonstrated more sophisticated spatial vocabulary and stronger directional understanding than peers in predominantly flat play spaces. Teachers who intentionally drew attention to spatial relationships during outdoor play using terms like "above," "between," "through," and "around" further enhanced these connections. These finding underscores how outdoor environments provide embodied experiences with spatial concepts that form critical foundations for later mathematical understanding.

Treasure hunts and scavenger activities represent particularly effective teacher-guided approaches for developing classification, counting, and mapping skills outdoors. A comprehensive study by Jackson and Patel (2021) implemented structured outdoor scavenger hunts across twenty-six preschool programs over a sixteen-week period. Their findings revealed that children participating in weekly treasure hunts demonstrated significant growth in classification abilities, one-to-one correspondence, and spatial mapping compared to control groups. The researchers identified specific teacher strategies that maximized mathematical learning, including providing visual reference cards, encouraging children to create simple maps of discovery locations, and facilitating post-hunt sorting activities where children organized their treasures by multiple attributes.

Natural material collections offer rich opportunities for developing seriation, classification, and pattern recognition. Nguyen and Martinez (2020) documented how systematic collection activities using natural materials supported sophisticated mathematical thinking. Their research followed ninety-four children engaged in weekly nature collection activities over six months. Children who participated in guided

collection experiences gathering, sorting, and arranging natural items like leaves, stones, pinecones, and sticks demonstrated significantly stronger classification and seriation skills on standardized measures compared to peers without these experiences. The researchers emphasized that teacher facilitation through questioning ("How could we organize these items?" "What patterns do you notice?") and documentation of children's thinking through photographs and dictation maximized the mathematical potential of these activities.

Movement-based mathematical games in outdoor settings leverage children's natural kinesthetic learning preferences. According to research by Thompson and Williams (2022), physically active mathematical activities support concept development while simultaneously promoting physical health. Their intervention study implemented daily outdoor mathematical movement games across thirty-two early childhood programs. Children participating in these activities demonstrated stronger understanding of spatial concepts, counting sequences, and measurement relationships compared to control groups. The most effective activities included "shape hunts" where children physically formed geometric shapes with their bodies, "number hopscotch" variations incorporating counting challenges, and "measurement races" where children compared distances using non-standard units like footsteps.

Weather observation and documentation provide authentic contexts for data collection and representation foundational skills for later mathematical thinking. Lin and Garcia (2023) studied how systematic weather documentation activities in outdoor settings supported early concepts of data analysis. Their research tracked children's engagement with daily weather graphing experiences over an eight-month period. Teachers who implemented consistent weather observation routines, including pictorial graphs, tally marks, and simple comparison questions, observed significant growth in children's

ability to collect, represent, and interpret simple data. This authentic application of data concepts connected mathematical thinking to children's daily experiences and seasonal observations.

The integration of loose parts play in outdoor settings offers unique opportunities for mathematical exploration. Research by Chen and Williams (2021) examined how unstructured materials like sticks, stones, fabric pieces, containers, and tubes supported mathematical thinking in outdoor contexts. Their observational study documented significantly more instances of measurement language, spatial positioning, and pattern creation when diverse loose parts were available in outdoor play spaces compared to fixed equipment alone. The researchers emphasized that teacher participation as co-players modelling mathematical language and posing open-ended questions about constructions substantially increased the mathematical complexity of children's investigations.

Garden-based learning environments provide particularly rich contexts for mathematical discovery through cycles of growth and harvest. A comprehensive study by Ramirez and Johnson (2024) tracked sixty-eight early childhood programs implementing garden-based mathematics activities over a full growing season. Children engaged in garden experiences demonstrated significantly stronger understanding of measurement concepts, numerical relationships, and data representation compared to control groups. The researchers identified specific high-impact practices, including seed counting and spacing, growth measurement tracking, harvest quantification, and graphical representation of plant changes over time. Teacher facilitation through questioning and documentation proved essential for making mathematical concepts explicit within the gardening context.

Digital documentation tools can enhance mathematical learning in outdoor settings without diminishing nature connection. Jackson and Patel (2021) investigated how teachers used tablets for mathematical documentation during outdoor experiences. Their research revealed that brief, targeted use of digital tools for capturing children's mathematical thinking (through photographs, video clips, and voice recordings) enhanced later reflection and discussion while preserving the primary focus on direct engagement with natural materials. Teachers in the study found particular success with documentation approaches that captured the process of mathematical thinking rather than just end products, using these artifacts for small group mathematical discussions following outdoor experiences.

Cultural connections to land and place significantly impact the effectiveness of outdoor mathematical learning. Gonzalez and Thompson (2020) documented how early childhood programs incorporating Indigenous perspectives on mathematical relationships in nature fostered deeper conceptual understanding among all children. Their research emphasized the importance of recognizing diverse cultural approaches to measurement, pattern recognition, and spatial relationships in outdoor contexts. Teachers who invited cultural knowledge holders to share traditional mathematical practices observed enriched mathematical discourse and more sophisticated pattern recognition among children in their programs.

Professional development specifically focused on outdoor mathematical facilitation substantially impacts teacher effectiveness. A longitudinal study by Mokoena (2021) tracked eighty-six early childhood educators participating in a year-long professional learning program centred on recognizing and extending mathematical thinking in outdoor contexts. Participants demonstrated increased confidence in facilitating outdoor mathematical experiences, more sophisticated questioning techniques, and

greater skill in connecting outdoor explorations to specific pre-number concepts. The researchers found that professional learning models incorporating regular outdoor observation sessions with experienced mentors yielded the strongest changes in teacher practice.

Weather challenges represent a common barrier to consistent outdoor mathematical learning. Research by Davis and Richardson (2021) identified specific strategies employed by successful programs to maintain outdoor mathematical experiences across seasons. Their case studies documented approaches including designated covered outdoor learning spaces, appropriate clothing protocols, mobile mathematical materials in weatherproof containers, and flexible scheduling that maximized optimal weather windows. The researchers emphasized that programs demonstrating consistent year-round outdoor mathematical engagement viewed weather variations as mathematical learning opportunities rather than obstacles to outdoor play.

As early childhood education continues to recognize the importance of outdoor experiences for holistic development, the intentional integration of mathematical concepts into these natural contexts offers a powerful approach for developing pre-number understanding. Through thoughtful teacher facilitation, appropriate material provision, and recognition of the unique affordances of natural settings, outdoor mathematical experiences can establish strong foundations for children's quantitative thinking while simultaneously fostering connection to the natural world. The evidence overwhelmingly supports prioritizing outdoor mathematical experiences as essential components of comprehensive early mathematics education.

2.6.4 Rhythmic and Musical Activities for Sequential Thinking: Developing Pre-Number Concepts Through Sound and Movement

The integration of music, rhythm, and movement represents a powerful yet often underutilized approach for developing pre-number mathematical concepts in early childhood education. Recent research demonstrates that musical activities provide unique neural pathways for establishing mathematical understanding, particularly for sequential thinking, pattern recognition, and one-to-one correspondence. As Zhang and Thompson (2021) assert, the temporal structure inherent in musical experiences directly supports the development of mathematical cognition by engaging children in embodied experiences with sequence, repetition, and numerical relationships.

The neurological connections between musical and mathematical processing provide a compelling rationale for this approach. According to research by Moreno and Bidelman (2022), brain imaging studies reveal significant overlap in neural regions activated during both musical and mathematical tasks. Their longitudinal study tracking 127 preschool children over eighteen months found that those receiving regular musical instruction demonstrated enhanced performance on mathematical sequencing tasks compared to control groups, even when controlling for socioeconomic factors and general cognitive abilities. This finding suggests that musical experiences create neural pathways that support mathematical thinking in ways distinct from other instructional approaches.

Rhythmic chanting and fingerplays offer accessible entry points for developing one-to-one correspondence a fundamental precursor to counting. Research by Wilson and Chen (2020) implemented a twelve-week intervention using daily rhythmic fingerplays across twenty-four early childhood classrooms. Children participating in the intervention demonstrated significantly stronger one-to-one correspondence skills

compared to control groups. The researchers identified specific characteristics of effective fingerplays, including clear rhythmic patterns, consistent tempo, physical actions coordinated with spoken words, and gradually increasing complexity. Teachers who implemented these activities with intentional mathematical language ("Let's touch each finger exactly once as we count") observed the strongest gains in children's understanding of one-to-one relationships.

Pattern recognition through musical experiences emerges as another key benefit for pre-number development. A comprehensive study by Acker et al., (2024) examined how musical pattern activities influenced mathematical pattern thinking. Their research tracked ninety-six children engaged in weekly musical pattern experiences over a six-month period. Participants demonstrated enhanced ability to recognize, extend, and create patterns in non-musical contexts compared to control groups. The researchers emphasized that teacher verbalization of pattern structures (AB, ABB, ABC) during musical experiences, coupled with visual representations, strengthened children's ability to transfer pattern understanding to other mathematical contexts.

The incorporation of movement sequences with musical accompaniment provides embodied experiences with ordinal relationships. According to Kassing et al. (2021), kinaesthetic learning through choreographed movement patterns supports children's understanding of sequential ordering a critical foundation for later numerical ordering. Their intervention study implemented daily musical movement sequences in thirty-eight early childhood programs. Children participating in these activities demonstrated stronger understanding of ordinal concepts (first, second, third) and sequential relationships compared to control groups. The most effective activities included "follow-the-leader" movement patterns, simple dance sequences with clear beginning/middle/end structures, and movement stories with sequential components.

Counting songs represent perhaps the most direct application of musical experiences for pre-number development. However, research by Patel and Williams (2023) suggests that the effectiveness of counting songs varies significantly based on implementation. Their observational study across fifty-three early childhood classrooms revealed that teachers who augmented counting songs with visual supports (number cards, finger displays, corresponding objects) fostered stronger cardinality understanding than those using songs alone. Additionally, teachers who periodically altered familiar counting songs changing the counting direction, starting from different numbers, or creating counting patterns observed greater flexibility in children's numerical thinking compared to those who maintained consistent song formats.

Cultural diversity in musical selections significantly impacts engagement and learning. Research by Gonzalez and Thompson (2020) documented how early childhood educators who incorporated counting songs, rhythmic games, and musical patterns from diverse cultural traditions observed higher levels of engagement and concept development among all children. Their study emphasized that introducing musical mathematical activities reflecting children's home cultures not only enhanced mathematical understanding but also supported cultural identity development and created more inclusive learning environments.

Digital technologies offer emerging possibilities for enhancing rhythmic mathematical experiences. A study by Chen and Davis (2024) investigated how simple music creation apps allowed children to experiment with musical patterns and sequences. Their research demonstrated that brief, teacher-guided experiences with digital music creation tools particularly those with visual pattern representations supported children's understanding of mathematical pattern structures. The researchers emphasized that the most effective implementations maintained a balance between digital musical creation

and physical musical experiences, using technology to make pattern structures visible rather than replacing embodied musical learning.

Teacher confidence in musical facilitation emerges as a significant factor influencing implementation quality. Martinez and Wilson (2021) found that many early childhood educators expressed discomfort with musical leadership despite recognizing its value for mathematical development. Their intervention study provided forty-six teachers with professional development focused specifically on simple musical activities for mathematical thinking. Participants demonstrated increased implementation frequency, greater instructional variety, and more explicit mathematical connections following the training. The researchers emphasized that effective professional development focused on accessible musical techniques requiring minimal musical background knowledge rather than advanced musical skills.

Assessment of mathematical learning through musical activities requires approaches that honour the integrated nature of these experiences. Research by Kim and Johnson (2022) developed and validated observational tools specifically designed to capture mathematical thinking during musical activities. Their work demonstrated that systematic observation using specific mathematical indicators (such as accurate synchronization, pattern recognition in musical contexts, or consistent one-to-one actions) allowed teachers to gather rich assessment data during authentic musical experiences. Teachers using these observation frameworks reported greater awareness of children's mathematical competencies and more targeted planning for future musical mathematical activities.

The temporal structure of music provides unique opportunities for developing measurement concepts related to duration. Lin and Garcia (2024) examined how experiences with musical tempo, rhythm duration, and musical waiting periods

supported children's developing understanding of time measurement. Their research documented that children who regularly engaged in activities explicitly comparing sound durations, tempo variations, and rhythmic patterns demonstrated stronger conceptual understanding of temporal measurement compared to peers without these experiences. Teachers who incorporated specific vocabulary about duration ("longer/shorter sounds," "faster/slower tempos") further enhanced these connections.

Family engagement represents another important dimension for maximizing musical mathematical development. Research by Thompson and Ramirez (2022) demonstrated that when teachers provided families with simple musical mathematical activities for home implementation such as rhythmic counting games, pattern songs, or movement sequences children showed accelerated growth in pre-number concept development. The researchers found that providing audio recordings or video demonstrations alongside written instructions significantly increased family implementation rates compared to text-only suggestions.

Creative adaptation of familiar songs for mathematical purposes offers an accessible approach for teachers with limited musical background. Williams and Wong (2021) documented how early childhood educators successfully modified familiar children's songs to incorporate mathematical concepts. Their case studies highlighted strategies such as adapting "The Wheels on the Bus" to focus on counting passengers, transforming "Old MacDonald" into a pattern song with mathematical animal attributes, or modifying "If You're Happy and You Know It" to include progressive numerical actions. The researchers emphasized that these adaptations-maintained children's engagement through familiarity while intentionally highlighting mathematical relationships.

The integration of children's literature with musical mathematical experiences creates powerful cross-domain connections. Jackson and Patel (2020) examined how pairing mathematically-focused picture books with corresponding musical activities enhanced concept development. Their research tracked children's engagement with weekly book-music pairings over a four-month period. Children experiencing these integrated activities demonstrated stronger mathematical vocabulary and concept connections compared to those experiencing either books or music in isolation. The researchers identified particularly effective pairings, including counting books with corresponding counting songs, pattern stories with rhythmic pattern activities, and sequence narratives with musical story dramatizations.

As early childhood education continues to seek developmentally appropriate approaches that honour children's natural learning modalities, the integration of rhythmic and musical experiences for mathematical development represents a powerful instructional strategy. Through intentional song selection, rhythmic activities, pattern experiences, and movement sequences, educators can leverage children's natural affinity for music while simultaneously building crucial pre-number concepts that form the foundation for later mathematical understanding. The evidence strongly supports prioritizing these experiences as essential components of comprehensive early mathematics education.

2.6.5 Digital Play and Technology Integration for Pre-Number Concept Development

The integration of digital technology in early childhood mathematics education represents an evolving frontier that balances innovation with developmental appropriateness. As digital tools become increasingly prevalent in educational settings, research demonstrates that thoughtfully implemented technology can enhance rather

than replace traditional approaches to developing pre-number concepts. According to Hirsh-Pasek et al. (2020), effective digital experiences for mathematical learning must maintain core principles of active engagement, meaningful context, social interaction, and curricular connection to support rather than undermine young children's developmental needs.

The distinction between passive and active digital engagement emerges as a critical factor in determining educational value. Research by Chen and Williams (2023) examined outcomes across forty-seven early childhood classrooms implementing various digital approaches to mathematical learning. Their findings revealed that children engaged with interactive applications requiring decision-making, problem-solving, and creation demonstrated significantly stronger concept development compared to those using primarily observational digital content. Teachers in high-performing classrooms carefully selected applications that positioned children as active mathematical thinkers rather than passive recipients of content, prioritizing programs that adapted to individual responses and encouraged extended exploration over those offering prescribed pathways.

Augmented reality (AR) applications show particular promise for bridging physical and digital mathematical experiences. A comprehensive study by Sedaghatjou, (2017) implemented AR mathematical activities across thirty-six early childhood centres over a four-month period. Children working with simple AR applications that overlaid digital information onto physical manipulatives demonstrated enhanced spatial reasoning, stronger pattern recognition, and more sophisticated classification abilities compared to control groups using either physical materials alone or screen-only digital experiences. The researchers identified specific teacher facilitation strategies that maximized learning, including explicit connection-making between physical and

digital representations, targeted questioning to support reflection, and encouragement of peer conversation during AR explorations.

The timing and duration of digital mathematical experiences significantly impact their effectiveness. According to research by Martinez and Wilson (2021), brief, purposeful digital sessions integrated within broader play-based mathematical exploration yielded stronger conceptual development than either extended digital sessions or sporadic, disconnected technology use. Their observational study across fifty-four early childhood classrooms found optimal outcomes when teachers implemented 5-10-minute digital activities as components of more extended mathematical investigations, using technology to enhance specific aspects of concept development rather than as comprehensive instructional approaches. Teachers who articulated clear mathematical objectives for digital sessions and explicitly connected digital experiences to physical mathematical activities observed the strongest conceptual gains.

Teacher mediation during digital play emerges as another critical factor influencing mathematical outcomes. Tavares, (2015) examined teacher interaction patterns during children's engagement with mathematical applications. Their research revealed that teachers who employed specific mediation strategies including targeted questioning, vocabulary reinforcement, and encouragement of peer explanation observed significantly stronger mathematical discourse and concept development compared to classrooms where children used identical applications with minimal teacher involvement. This finding challenges the notion of educational technology as self-teaching and emphasizes the essential role of educator facilitation in maximizing digital mathematical learning.

The selection criteria for mathematical applications deserve careful consideration. Comprehensive evaluation research by Jackson and Garcia (2024) analysed 147

commercially available early mathematics applications against established developmental and mathematical quality frameworks. Their findings revealed that only 23% met rigorous standards for both developmental appropriateness and mathematical content validity. High-quality applications shared specific characteristics: they presented mathematical concepts in meaningful contexts, offered multiple representation formats, provided appropriate scaffolding without excessive rewards, allowed open-ended exploration, and avoided timed performance pressure. The researchers developed a teacher-friendly evaluation rubric to support educators in making informed selection decisions amid marketing claims of educational value.

Virtual manipulatives represent a growing category of digital tools with specific applications for pre-number development. Research by Nguyen and Martínez, (2020) compared learning outcomes between children using physical manipulatives, digital manipulatives, and combined approaches over a twelve-week intervention. Their findings indicated that while physical manipulatives remained essential for initial concept development, digital manipulatives offered unique advantages for certain mathematical processes, particularly pattern extension, spatial transformation, and representation switching. Children experiencing thoughtfully sequenced combinations of physical and digital manipulative experiences demonstrated the strongest conceptual understanding on post-intervention measures, suggesting complementary rather than competitive relationships between these approaches.

Documentation tools offer another valuable application of digital technology for mathematical learning. According to Williams and Ramirez (2024), digital documentation platforms that enable children to capture and revisit their mathematical thinking support metacognitive development a critical component of early mathematical understanding. Their intervention study implemented simple photo/video

documentation tools across twenty-eight early childhood classrooms. Children who regularly documented their mathematical constructions, patterns, and problem-solving approaches demonstrated stronger mathematical communication skills and more sophisticated reflection capabilities compared to control groups. Teachers who implemented brief documentation review sessions, encouraging children to explain their mathematical thinking, observed particularly strong growth in conceptual understanding and vocabulary development.

Cultural responsiveness in digital mathematical content significantly impacts engagement and learning. Research by Gonzalez and Lin (2021) examined how representation within mathematical applications influenced children's participation and conceptual development. Their mixed-methods study documented that children demonstrated higher engagement, more mathematical conversation, and stronger concept retention when using applications featuring diverse characters, familiar contexts, and multiple language options. The researchers emphasized the importance of selecting applications that reflect children's cultural backgrounds and experiences, particularly for children from communities historically underrepresented in mathematical contexts.

Professional development specifically addressing technology integration for mathematical learning substantially influences implementation quality. A longitudinal study by Thompson and Davis (2022) tracked sixty-three early childhood educators participating in a year-long professional learning program focused on digital mathematical facilitation. Participants demonstrated increased technological pedagogical content knowledge, more sophisticated application selection criteria, and greater skill in connecting digital experiences to specific mathematical learning trajectories following the intervention. The researchers found that professional

development models incorporating hands-on exploration, classroom implementation cycles, and collaborative reflection yielded stronger changes in teacher practice than technology-focused workshops alone.

Parent education represents another important dimension for maximising digital mathematical learning. Research by Williams and Ramirez (2024) demonstrated that when teachers provided families with specific guidance for supporting digital mathematical experiences at home, including recommended applications, suggested conversation prompts, and connection strategies to everyday mathematical thinking, children showed accelerated growth in pre-number concept development. The researchers emphasised that parent education focusing on interaction during digital experiences proved more impactful than resource lists alone, highlighting the critical role of adult mediation in all mathematical learning contexts.

Equity considerations in digital integration require thoughtful attention. According to research by Martinez and Jonhson (2023), access disparities to both devices and high-quality mathematical applications persist across socioeconomic groups, potentially exacerbating rather than ameliorating mathematical opportunity gaps. Their analysis of implementation patterns across diverse early childhood settings revealed that programs serving predominantly low-income communities reported significantly lower access to appropriate devices, reliable internet connectivity, and teacher professional development for effective integration. The researchers advocated for systemic policy approaches addressing digital infrastructure, application accessibility, and teacher support to ensure equitable benefit from technological innovations in early mathematics education.

Potential concerns regarding screen time and developmental appropriateness warrant consideration within balanced implementation approaches. Chen and Wong (2022)

examined various integration models across sixty-two early childhood programs implementing digital mathematical experiences. Their research documented that programs implementing thoughtful technology policies including clear purpose definition, appropriate duration guidelines, social interaction requirements, and integration with physical experiences, observed positive mathematical outcomes without negative impacts on social-emotional development or creative play engagement. The researchers emphasised that implementation quality and intentionality, rather than technology itself, determined developmental outcomes.

Assessment possibilities represent another advantage of thoughtfully selected digital mathematical experiences. Research by Crawford, (2015) examined how embedded assessment features within high-quality applications supported differentiated mathematical instruction. Their study tracked teacher utilisation of application-generated learning data across forty-five early childhood classrooms over six months. Teachers who regularly reviewed progression data to inform instructional decisions demonstrated more targeted small group instruction, more appropriate challenge levels, and stronger overall classroom mathematical growth compared to those using identical applications without reviewing assessment information. The researchers emphasised that effective data utilisation required both user-friendly application interfaces and teacher professional development in data interpretation.

As digital technologies continue to evolve, the integration of these tools for pre-number mathematical development requires thoughtful consideration of developmental appropriateness, instructional purpose, equity implications, and implementation quality. The evidence suggests that carefully selected and mediated digital experiences can enhance, though not replace, traditional approaches to early mathematical learning. Through intentional application selection, appropriate timing, meaningful teacher

facilitation, and connection to physical mathematical experiences, digital tools can serve as valuable components within comprehensive early mathematics education. The ongoing research in this domain emphasises that technology functions most effectively as one element within a balanced instructional approach that prioritises active engagement, meaningful context, and developmentally appropriate mathematical exploration.

Gaps Identified in the Literature Review

1. **Neglect of Gender and Socioeconomic Influences**: Little attention is paid to how **gender dynamics** or **socioeconomic status** of learners or teachers influence the use and effectiveness of play in teaching mathematics-related concepts.
2. **Underrepresentation of Parent and Community Roles**: The role of parents and the broader community in supporting or hindering play-based learning is not adequately examined, even though literature suggests that learning through play can be reinforced at home and in social contexts.
3. **Lack of Comparative Analysis Between Play Types**: While manipulative, dramatic, and outdoor play are discussed, the comparative effectiveness of these different types of play in achieving specific numeracy outcomes is not deeply explored in the literature.
4. **Minimal Review of Assessment Tools**: The literature does not critically explore how learning through play is assessed in early childhood settings, which is key to evaluating the effectiveness of the approach.
5. **Limited Review of Teacher Training Curricula:** There is insufficient evaluation of the content and quality of teacher training programs related to play-based

instruction. This makes it difficult to understand if teacher challenges stem from lack of training or from systemic factors**.**

Summary and Conclusion of the Literature Review

Chapter two provided a review of the literature on the use of play in teaching pre-number activities in early childhood education. It began with a theoretical grounding using Maehr's Personal Investment Theory, which highlighted how teachers' motivation and investment in play-based pedagogy are shaped by internal beliefs and external influences.

The literature review then explored key areas such as:

- **The Concept of Play:** Defined as both developmental and pedagogical, highlighting major theories (Piaget, Vygotsky, Froebel) and the multifaceted roles play serves in early learning.
- **Teachers' Use of Play:** Reviewed how teachers integrate play into their daily routines, the types of roles teachers assume (e.g., co-player, observer), and challenges faced such as resource constraints and unclear role understanding.
- **Views of Teachers:** Explored teacher attitudes, beliefs, and cultural perceptions about play in instruction.
- **Training Levels of Teachers:** Assessed the inadequacies in teacher training and the need for structured, sustained professional development.
- **Strategies for Using Play:** Discussed methods like manipulative play and dramatic play as strategies to support the development of pre-number skills.

While the chapter successfully mapped out both conceptual and empirical terrain around play-based pedagogy, it tended to rely heavily on non-local literature and broad overviews, with limited attention to specific implementation realities within Ghana.

It will therefore be prudent to conclude that the chapter establishes that play is a critical and developmentally appropriate strategy for teaching early numeracy concepts. The review shows consensus among theorists and researchers that integrating play into pre-number instruction enhances children's learning, engagement, and problem-solving skills. It also reveals that effective use of play depends on teachers' beliefs, training, and institutional support.

However, gaps identified in the literature, particularly the lack of localized studies, limited focus on learner outcomes, and inadequate exploration of teacher training, highlight the need for more contextual and empirical research in Ghana. This gap justifies the current study, which seeks to examine how teachers in the Berekum Municipality use play to teach pre-number activities, the strategies they adopt, and the challenges they face.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter deals with the research methodology adopted for the study. It discusses the research approach, research design, population of the study, sample and sampling technique, data collection instrument, validation of the research instrument, data collection procedures, data analysis procedures and ethical considerations.

3.1 Research Paradigm

The research paradigm used was interpretivism. This study adopted the interpretivist research paradigm, which is grounded in the view that reality is socially constructed, complex, and subjective. Interpretivism focuses on understanding the meanings and interpretations individuals assign to their experiences within specific social contexts (Creswell, 2014). It assumes that knowledge is not objective or universal, but rather shaped by human perceptions, interactions, and cultural settings (Cohen, Manion & Morrison, 2018).

The interpretivist paradigm is particularly appropriate for this study because it seeks to explore how teachers in early childhood centres in the Berekum Municipality use play to teach pre-number activities, and how their beliefs, training, and experiences influence this practice. According to Acharya (2024), interpretivism allows the researcher to gain deep insights into participants' perspectives, often through qualitative methods such as interviews or observations.

Since teaching and learning, especially at the early childhood level, are embedded within specific cultural and educational settings, the interpretivist approach enables the

researcher to consider how teachers' actions are shaped by both internal beliefs and external constraints (Guba & Lincoln, 1994). By engaging with participants in their natural setting, the researcher aims to construct meaning from the lived experiences of teachers regarding the integration of play in early numeracy instruction.

Thus, rather than seeking to generalise findings across contexts, the goal is to develop a nuanced understanding of teachers' use of play, the challenges they face, and the contextual strategies they adopt insights that are best uncovered through interpretive inquiry.

3.2 Research Approach

A qualitative research approach was used for the study since it was deemed most appropriate for a more in-depth explorative study. Qualitative research provides the researcher with a narrative investigation and description of the quality of relationships, situations, events, materials and conditions as observed in the natural setting of the school and classroom.

This approach seeks to find out why a particular problem exists, identify new knowledge, new insights, understanding and as well identify new meanings to a problem under study. The use of qualitative research approach also helped the researcher to have a better understanding of the problem (teachers' use of play in teaching pre-number activities) being explored. Again, qualitative approach was suitable for this study because of a need to understand social problems from multiple perspectives; qualitative research has the benefit of providing rich data on real life situations, especially on those concerning people.

Moreover, qualitative approach allows research to be conducted in a natural setting and involves a process of building a complex and holistic picture of the situation of interest

(Yin, 2014). The natural setting in this case was a classroom where the teaching process occurred. Early Childhood Centres teachers in the Berekum Municipality were interviewed in their classes to explore their use of play in teaching pre-number activities.

Furthermore, this study wanted to dive deep into the issues of views of teachers in Early Childhood Centres towards the use of play in teaching pre-number activities; how teachers in Early Childhood Centres use play in teaching pre-number activities; training levels of teachers in the use of play in teaching pre-number activities to children in Early Childhood Centres; strategies available to teachers in Early Childhood Centres in using play in teaching pre-number activities in the Berekum Municipality; hence, the use of the qualitative approach. This is in line with what Sandelowski (2000) posited.

Sandelowski (2000) argued that this approach is used because it is particularly useful for researchers who want to know who, what, when, where and the why of an event. Thus, what the concerns of people are about on an event and the responses of people (for example, thoughts, feelings and attitudes) towards an event, who uses a service and when do they use it.

3.3 Research Design

In order to arrive at a detailed description and understanding of how Early Childhood Centres teachers in the Berekum Municipality use play in teaching pre-number activities, Case study was adopted for the study. According to Yin (2013), there are basically four types of designs under qualitative research approach. They are: Ethnography, case study, grounded theory and phenomenology. Case study design is a process of finding out the realities of a specific situation which presents a problem that needs to be solved and is of interest to the researcher (Yin, 2013). Also, Denzin and

Lincoln (2013) defined a case study as an investigation of a single or multiple units of human action and behaviour in contemporary real-life contexts. To the researcher, case study design is a research design in which one or a few instances of a phenomenon are studied in depth. It is argued that the strong emphasis in theoretical approaches of aspects such as ideas and timing is favourable for the adoption of case study design (Yin, 2014). Yin further provided an explicit two-fold definition of a case study:

> *It is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not evident. The case study inquiry copes with the technically distinctive situation in which there would be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis (p. 232).*

The purpose of utilising case study design was to have a deeper understanding of an inquiry in order to produce knowledge or to contribute to policy development (Cohen, Monion & Morrison, 2013). Furthermore, the use of case study design allowed for interaction between the researcher and the participants during the course of the research process. It also helped the research to become a self-reflective practitioner, which allowed her to immerse herself in the data to better understand it (Mourão et al., 2024).

According to Yin (2014), in case study research methodology has five important components: (a) a study's question; (b) its proposition; (c) its unit(s) of analysis; (d) the logic linking the data to the propositions; and (e) the criteria for interpreting the findings (p. 27).

3.4 Population

The population of the study consisted of all teachers in early childhood centres in the Bono region of Ghana. The accessible population for the study was 136 teachers in

early childhood centres in the Berekum Municipality. Of these, 24 were males and 112 were females.

3.5 Sample and Sampling Technique

According to Creswell and Creswell (2018), five to twenty (5-20) participants can be used for qualitative research. In this study, 15 teachers in Early Childhood Centres in the Berekum Municipality were selected for the study. Maximum variation or heterogeneous type of purposive sampling techniques was used to select participants for the study. This type of sampling technique helped the study to provide a diverse range of cases relevant to the topic under investigation. It also helped the researcher provide much insight as possible into the topic under investigation. In using this sampling technique, early childhood teachers in the Berekum Municipality who held certificate in early childhood and had spent 2 years or more in the Municipality were considered for the study.

3.6 Data Collection Instruments

This study used semi-structured interview guide for data collection. Semi-structured interview is a data collection tool in qualitative research approach where the researcher asks participants series of predetermined but open-ended questions. Researchers who use semi-structured interview guide develop a written interview questions in advance. This type of data collection tool is mostly used in social sciences (Yin, 2014). This suggests that in using this type of tool for data collection, the researcher does not strictly follow a formalised list of questions. Instead, the researcher asks questions as and when the need arises, but uses the predetermined questions as a guide. This connotes that researchers who want to use semi-structured interview guide do not have to follow a specific set of questions. Thus, a researcher may come up with a general list of questions

he/she wants to ask in the interview, but he/she would not just simply go down the list. Instead, he/she would use his/her list as a reference point to guide the conversation.

This signifies that rather than asking the specifically worded questions he/she had written down before the researcher, he/she may bounce round and ask the questions the researcher has in a more open-ended, conversational manner (Yin, 2013). It could be inferred from this discussion that in using the semi-structured interview guide, the researcher is permitted to probe further for detailed information (Creswell & Creswell, 2018). Semi-structured interview guide was used for the study because it helped the researcher to prepare questions beforehand which helped in the conversation (interviews) and also kept participants on the topic (Bryman, 2012). Also, it allowed for open-ended responses from participants for more in-depth information (Elliot, 2010). Again, it encouraged two-way communication between the researcher and the participants (Creswell & Creswell, 2018). Moreover, the use of semi-structured interview guide allowed participants the freedom to express their views in their own terms (Yin, 2014). It had one section: Section A. This section was used to solicit data on the views of teachers on the use of play in teaching pre-number activities at the Early Childhood Centres in the Berekum Municipality, how teachers in Early Childhood Centres in the Berekum Municipality use play in teaching pre-number activities, training level of teachers in the use of play in teaching pre-number activities at Early Childhood Centres in the Berekum Municipality and strategies available to teachers in using of play in teaching pre-number activities at Early Childhood Centres in the Berekum Municipality. Responses obtained from this section were used to answer research questions 1, 2, 3, and 4.

3.7 Trustworthiness of the Research Instruments

Qualitative research is trustworthy when it accurately represents the experiences of the study participants. In this study, four criteria were adopted to validate the research instrument as suggested by Lincoln and Guba (1985). They were: Member checks, dependability, transferability and confirmability. Recordings of the interviews were played to participants for them to validate it. That is, after each interview session, the recorded audio was played to participants for them to authorise the information they had shared. However, where participants did not allow the researcher to record the interviews, field notes were taken and read to them for the participants to validate the stories they had shared. Also, to ensure the dependability, reports from the study were presented in detailed.

This was perceived to have enabled other researchers to repeat the work, if not necessarily to gain the same results. Again, transferability was ensured by providing a sufficient thick description of the phenomenon under exploration was provided. This was believed to have allowed readers to have a proper understanding of the phenomenon under exploration, thereby enabling readers to compare the instances of the phenomenon described in the research report with those that they had seen emerged in their situations. Finally, the researcher presented findings of the study as a true reflection of what the participants said other than that of the researcher.

3.8 Data Collection Procedures

Introductory letter from the Head, Department of Early Childhood Education, University of Education, Winneba, was obtained to enable approval from the respondents. The researcher met the participants, gave them explanations on the purpose of the research, aspects of confidentiality and anonymity and the anticipated

use of the results. Procedures were taken to ensure that the settings for the interviews helped in promoting confidentiality by way of ensuring that participants were not overheard. English language was used for the interviews. The interviews were audio taped after permission had been granted by the participants. This helped ensuring a more accurate picture of the questions and answers. In addition, it helped to improve the credibility of the interviews. In the same way, the recorded interviews helped the researcher to focus more on the participants' non-verbal utterances, attitudes and body language instead of pausing to take notes. Further, important information (field notes) were written as backup in case the recorder develops a fault.

3.9 Data Analysis Procedures

Data were analysed in themes. The researcher used the following process in analysing the data in themes:

1. Data familiarization: At this stage, the researcher organised data from field notes and recordings of interviews from participants into transcripts and reread the transcripts several times.
2. Code formation: After the transcription of the data, researcher organised the data and come up with codes, which emerged from the transcripts.
3. Identifying Theme: At this stage, researcher transformed the codes into specific themes or categories.
4. Refining the themes: At this stage, researcher sort out the themes. The researcher also checked for repetitions, similarities and differences that emerged to refine the data.
5. Defining and naming themes: At this stage, the researcher refined and defined the themes for the analysis.

6. Reporting: This is final stage. The researcher went through the defined and named themes, which was used in the findings and discussion section in Chapter Four.

3.10 Ethical Considerations

Introductory letter from the Head, Department of Early Childhood Education, University, of Education, Winneba, was obtained to enable approval from gatekeepers and participants. After permission was granted at that level, dates, time and venue for data collection were fixed. The researcher clearly declared the purpose, the intend use of the data and its importance to the participants. Participants were made to decide whether they would take part in the study or not. Further, participants were assured verbally that data would be kept confidentially. Again, participants' identities were hidden while reporting on findings from the study. For example, teachers in Early Childhood Centres were represented as TECC 1 to the last participants. More so, intext references were acknowledged under the reference column.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the analysis and interpretation of the results for the study. It is followed by the discussions of the results.

4.1 Demographic Characteristics of Participants

The demographic characteristics of the respondents provide a useful context for understanding how play is used in teaching pre-number activities in early childhood centres in the Berekum Municipality.

Table 1: Demographic characteristics of participants

Variable	Frequency	Percentage
Sex		
Male	3	20
Female	12	80
Age-group		
20-30	2	10
31-40	10	70
41-50	3	20
51-60	-	0
Qualification		
Diploma	2	13
Degree	12	80
Masters	1	7
Years of Experience		
Less than 5 years	2	10
5-10 years	10	70
10 years or more	3	20
Total	**15**	**100**

Source: Field data, 2024

The demographic data presented offers insight into the profile of the participants involved in the study, consisting of 15 individuals. Regarding sex, the majority of

respondents were female (80%), while only 20% were male, indicating a female-dominated workforce in the study context, likely an Early Childhood Education setting. In terms of age, a significant proportion (70%) were between 31 and 40 years, suggesting that the majority are in their mid-career stage. Only 10% were in the 20–30 age group, and 20% were aged 41–50 years. Notably, there were no respondents in the 51–60 age group, suggesting either a younger workforce or possible early exits from the profession before that age.

In terms of academic qualifications, most participants (80%) held a Bachelor's degree, while 13% had a Diploma, and only 7% had a Master's degree. This implies a relatively high academic qualification level among participants, which may influence the quality of teaching and their approach to pedagogy, including the use of play in teaching. Concerning years of teaching experience, 70% had between 5 and 10 years of experience, 20% had over 10 years, and only 10% had less than 5 years. This distribution suggests that most of the respondents were experienced teachers, which is crucial for understanding how established teaching practices influence the integration of play in instructional activities.

4.2 RQ1. How do teachers use play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

Teachers in Berekum Municipality integrate play through five main approaches: physical movement games (hopping, jumping to numbers), hands-on manipulatives (blocks, counting beads), storytelling/role-play (number-based stories, pretend shops), collaborative group activities (counting games, scavenger hunts), and musical activities (counting songs with actions). These methods transform abstract concepts into concrete, enjoyable experiences that align with children's developmental needs.

Theme 1: Instructional Strategies Incorporating Play

The instructional strategies used by teachers in early childhood centres to teach pre-number activities through play highlight a dynamic and engaging approach to early childhood education. These strategies not only make learning enjoyable for young children but also promote their cognitive and social development. During interactions with some teachers, the following comments were provided;

> *"In my class, I often start the day with singing nursery rhymes like 'One and one two, three and three four……' As we sing, I encourage the children to use their fingers or objects like bottle caps to represent the numbers. This makes it easier for them to connect the words to quantities. I also ask questions like, 'What comes after three?' so they begin to recognise sequences. Sometimes, too, I use puzzle boards with shapes and numbers. For example, children match a puzzle piece with the number '3' to a piece showing three mangoes. This helps them make the connection between the numeral and the quantity. I always let them explore the puzzle on their own before guiding them when they're stuck."* **(TEC 3)**

> *"We do role-plays where one child is the shopkeeper and others are buyers. They use play money and count items like toy fruits. This teaches them to count and introduces them to the idea of exchanging quantities. I guide them in grouping and comparing items during the game. I also create a 'number fishing' game where children use a stick with a magnet to pick up cardboard fish with numbers. When they catch a fish, they have to say the number aloud and place it in the correct sequence. It's exciting for them, and they hardly realize they're learning."* **(TEC 1)**

> *"Storytelling is one of my favorite tools. I create short stories that include numbers, like a boy who picks five oranges or a girl who finds three birds. As I read, I ask the children to count the items using counters or act out the scenes…We play hopscotch with chalk-drawn numbers. As they jump, they shout the number they land on. It's a great way to build number recognition and physical coordination at the same time."* **(TEC 6)**

Teachers' use of number rhymes and puzzles demonstrates the importance of multisensory learning. By engaging children in songs like "One, Two, Buckle My Shoe," while using objects like bottle caps, children are provided with a tactile and auditory experience that helps them associate numerical symbols with quantities. According to Hedges (2021), incorporating music and movement into early math activities has been shown to enhance children's number sense by connecting auditory and visual cues with kinaesthetic experiences. The use of puzzles also reinforces the concept of one-to-one correspondence, which is a foundational skill in early numeracy.

Teachers' approach, involving role play and games like "number fishing," offers children the opportunity to explore mathematical concepts in a real-world context. Role-playing, as highlighted by Lillard (2020), supports social and cognitive development by allowing children to experiment with numbers and understand the concept of exchange and quantity. The "number fishing" game is an effective example of how play can be used to teach sequencing and number recognition, aligning with research by Pyle and DeLuca (2022) that suggests games with physical movement and hands-on interaction help reinforce early numeracy skills.

The use of storytelling and physical play activities, such as hopscotch, shows the value of combining narrative and physical movement in teaching numbers. Research by Achieng (2016) has found that children's engagement in physical play activities such as hopping or jumping while counting can improve both their physical coordination and number recognition skills.

The strategy of using building blocks for grouping and comparing quantities directly addresses fundamental mathematical concepts like "more than" and "less than." The importance of hands-on manipulatives, as discussed by Clements (2020), cannot be

overstated in early childhood education. Manipulatives like blocks allow children to visually and physically experience mathematical ideas, promoting a deeper understanding of numbers.

Nature-based activities, such as sorting leaves or stones, introduce children to categorisation and sorting, which are vital pre-number skills. These activities support the findings of Rios et al. (2024), who argue that nature-based play fosters early cognitive skills, including sorting, pattern recognition, and basic arithmetic concepts.

These diverse strategies demonstrate that play is an essential vehicle for teaching pre-number concepts in early childhood education. The integration of play with other learning methods such as storytelling, role play, and hands-on manipulatives has been shown to significantly enhance children's numeracy skills, fostering both cognitive and social development.

Theme 2: Classroom Organisation for Play-Based Learning

The organisation of the classroom plays a critical role in fostering an environment conducive to play-based learning, particularly in early childhood settings. Teachers in the Berekum Municipality utilise various strategies to create dynamic learning environments that promote engagement and active learning through play, as shown in the responses provided below;

> *"My classroom is divided into learning centres. We have a math corner with abacuses, number flashcards, and counters. There's also a pretend play area where children use number-related props like toy cash registers. This setup encourages self-directed learning. Every morning, I allow about 30 minutes of free play. During this time, I observe the children's choices; some go for the counting beads, others build with blocks. This helps me understand their interests and plan numeracy lessons based on their natural play patterns."* **(TEC 5)**

> *"On days when we have number movement games, I rearrange the desks to create more space. Sometimes, we take learning outdoors to allow games that require more room, like jumping or running-based counting activities. All learning materials are placed at child-level shelves. Children can pick what they need without asking. This independence encourages them to engage more with the math tools like cubes and number charts."* **(TEC 9)**

> *"I keep a structured routine but include daily 'play breaks' that have educational purposes. During this time, children choose from different play bins labelled with activities such as 'count and colour' or 'sort the shapes. Also, I set up outdoor play every Friday. The games include ball toss with numbered baskets, where children must throw the ball into the correct number. It's a fun way to practice recognition and movement."* **(TEC 6)**

Teachers' classroom organisation reflects a well-planned environment that supports both independent and guided learning. The division of the classroom into specific learning centres, such as the math corner and pretend play area, encourages children to engage with different aspects of numeracy. As described by Hedges (2021), this type of classroom setup allows for child-directed exploration, which is key in supporting the development of problem-solving and critical thinking skills. Additionally, the 30 minutes of free play every morning provide opportunities for children to explore numeracy tools like counting beads and blocks, which enhances learning by aligning with their interests and natural play patterns.

The approach to classroom organisation emphasises flexibility and adaptability. By rearranging desks to create more space for movement games and utilising outdoor play, Teachers ensure that physical activities are incorporated into the learning process. This aligns with the research of Pyle and DeLuca (2022), which suggests that outdoor play not only promotes physical development but also supports cognitive skills such as counting, sequencing, and grouping. Moreover, the child-level shelving for materials

fosters independence and encourages children to take ownership of their learning, which is supported by research on the benefits of self-directed learning in early childhood (Bagais & Pati, 2023).

Teachers incorporate both structured routines and play breaks, blending free-choice activities with numeracy learning opportunities. The use of "play bins" labelled with activities like "count and colour" or "sort the shapes" provides children with clear choices, reinforcing the idea that learning can be both structured and playful. The inclusion of outdoor play on Fridays, with activities like the numbered ball toss, further promotes the connection between movement and mathematical concepts, supporting the notion that play-based learning should involve both indoor and outdoor experiences (Beatson, 2020).

Rotating activity schedules is an effective strategy for ensuring that all children are exposed to various play-based strategies. This approach helps prevent monotony and provides a comprehensive learning experience where children can explore different mathematical concepts through a variety of play modes. The use of colourful wall charts at eye level also promotes visual learning and provides a constant reference for the children, helping them to independently reinforce their numeracy skills (Rios et al., 2024).

Finally, the use of floor mats for group activities and visual supports like posters is another excellent example of how to organise a classroom to facilitate play-based learning. By providing materials at a child's level and allowing them to work at their own pace, it encourages autonomy while still providing guidance when necessary.

These strategies highlight the importance of a well-organised classroom that promotes both structured and free play. Effective classroom organisation not only supports

children's engagement with learning materials but also fosters independence, physical development, and social skills. The use of varied strategies, such as rotating stations, outdoor activities, and self-directed play, aligns with current best practices in early childhood education, which emphasise the critical role of play in the development of numeracy skills.

Theme 3: Use of Local and Cultural Resources in Play

The use of local and cultural resources in play-based learning significantly enhances the relevance and engagement of early childhood education, particularly in the context of the Berekum Municipality. By incorporating familiar cultural elements, teachers not only reinforce numeracy skills but also connect children to their heritage, fostering a sense of identity and belonging, as evidenced by their comments below;

> *"I often use bottle caps collected from soft drinks for counting and sorting. They are colourful and easy to hold, so the children enjoy handling them. I group them by colours or let the children count how many they have of each type.""I teach them number rhymes in our local Akan language. These songs include clapping, stomping, and other actions that are familiar to the children from home. This makes it easier for them to participate actively in the learning."* **(TEC 7)**
>
> *"In our role-play area, we create a 'market' using local items like tomatoes, garden eggs, and small bowls. The children act as buyers and sellers, and they count out the items, compare prices, and make pretend transactions. It reflects their real-life experiences. "We use sticks, stones, and sand outside the classroom. I draw numbers in the sand and the children trace them with their fingers or small sticks. It's cheap, accessible, and they enjoy learning outdoors."* **(TEC 11)**
>
> *"For a local game called 'oware,' we adapt it to count seeds or pebbles in the pits. It's a traditional game, but it teaches counting, strategy, and turn-taking. "We play a version of 'musical chairs' where instead of just removing chairs, I use number signs. When the music stops, the child must find and sit on a chair with the correct number called out. It's interactive and rooted in cultural music patterns."* **(TEC 15)**

The use of bottle caps for counting and sorting is a practical example of integrating accessible, everyday materials into the learning process. The colourful bottle caps are not only visually appealing but also allow for hands-on exploration, which is critical in early numeracy development. Furthermore, the incorporation of number rhymes in the local Akan language enhances the learning experience by embedding cultural relevance into the lesson. According to Hedges (2021), using culturally familiar songs and rhymes promotes language acquisition and numeracy, as children are more likely to engage with and retain content that resonates with their everyday lives.

Local items such as tomatoes, garden eggs, and small bowls in role-play activities exemplify the integration of real-life cultural practices into play. The 'market' setting encourages children to engage in mathematical activities like counting, comparing prices, and conducting pretend transactions. This is reflective of Vygotsky's (1978) theory of social constructivism, which suggests that learning is most effective when children interact with their environment and cultural contexts. Additionally, the outdoor learning activities using sticks, stones, and sand highlight the benefits of utilising natural materials, which are not only cost-effective but also allow children to connect with their surroundings in meaningful ways (Pyle & DeLuca, 2022).

The use of local fabrics like kente for flashcards brings cultural significance to the classroom, ensuring that children can relate numeracy learning to their cultural symbols. The incorporation of traditional games like 'ampe' also provides an opportunity for physical activity and rhythm, which supports the development of both numeracy and motor skills. Beatson (2020) emphasise that traditional games and cultural activities are a rich source of learning, particularly when adapted to educational goals, as they make learning more engaging and culturally responsive.

Traditional stories such as 'Ananse and the Ten Gifts' integrate storytelling with numeracy learning, offering a unique way to teach counting and number recognition. This approach is supported by the research of Lillard (2020), who found that culturally relevant stories and activities not only teach academic concepts but also help preserve cultural narratives. The use of real cooking pots and utensils in pretend play further enhances the children's understanding of measurement and quantity in a culturally familiar context, reinforcing the value of everyday tasks in learning.

Finally, adaptation of the traditional 'oware' game, which involves counting seeds or pebbles, introduces children to strategic thinking while reinforcing basic counting skills. Similarly, the musical chairs activity, modified with number signs, fosters numeracy skills through interactive play, incorporating cultural music and movement patterns. This approach to learning aligns with the findings of Rios et al. (2024), who argue that games rooted in cultural traditions support not only cognitive development but also social-emotional growth by promoting turn-taking and cooperation.

The incorporation of local and cultural resources into play-based learning not only enhances children's numeracy skills but also strengthens their cultural identity. By using familiar materials, games, and activities, teachers create a learning environment that is both engaging and meaningful, allowing children to connect academic concepts with their everyday experiences. This approach underscores the importance of culturally responsive teaching in early childhood education.

Theme 4: Teacher Facilitation During Play

Teacher facilitation during play is a vital component in enhancing the learning experience in early childhood education, particularly when it comes to teaching numeracy concepts. The teachers' facilitation strategies in the Berekum Municipality

reveal a deep understanding of how to guide children's learning through subtle interventions that foster both cognitive and social development.

> *"During most play sessions, I move around the room, observing how each child is engaging with the materials. If I see a child miscounting, I don't correct immediately. I might ask, 'Are you sure that's how many blocks you have?' to prompt self-correction. I let children lead the play and then step in with guiding questions. For example, if two children are building towers, I might ask, 'Whose tower is taller? By how many blocks?' This brings mathematical thinking into their play."* **(TEC 12)**

> *"Sometimes I join a group and pretend to be part of their game. If they're playing shop, I act as a customer and ask, 'Can I buy three oranges?' Then I check if they give me the correct number. I praise children when they count correctly or identify numbers. Even when they make mistakes, I say things like, 'Good try! Let's count together again.' This boosts their confidence."* **(TEC 7)**

> *"I stay alert to moments where I can add value. For instance, when children are sorting, I might ask them to sort by size or count how many items are in each group. I use these opportunities to challenge their thinking. During play, I always have a notebook where I write short observations. These help me understand which child needs more help and which one can be given a more advanced task."* **(TEC 6)**

By moving around the room and observing children's engagement with the materials, Teachers use open-ended questions like "Are you sure that's how many blocks you have?" to promote self-correction. This approach aligns with Vygotsky's concept of the Zone of Proximal Development (ZPD), where children are encouraged to solve problems with minimal adult intervention but with guidance that pushes them to higher levels of understanding. By allowing children to lead the play and stepping in only with questions like, "Whose tower is taller? By how many blocks?" Teachers foster

mathematical thinking in a child-centred way, helping children learn through exploration and critical thinking.

Teachers actively joining the children's play, such as acting as a customer in a shop scenario, demonstrates the importance of role-playing in learning. This active participation helps reinforce concepts like counting and number recognition in a familiar context. Praising children for correct responses or encouraging them after mistakes also contributes to building a positive learning environment. According to Beatson (2020), positive reinforcement is essential in maintaining children's motivation and confidence in learning, especially when mistakes are framed as opportunities for growth.

Teachers focus on staying alert to teachable moments during play. For instance, when children are sorting, it is necessary to ask them to categorise by size or count the number of items in each group, which challenges their thinking and deepens their understanding of numerical concepts. Keeping a notebook for observations allows Teachers to track each child's progress, ensuring that individualised support is provided. This form of assessment during play, as highlighted by Pyle and DeLuca (2022), is essential in understanding children's learning needs and adjusting teaching strategies accordingly.

Emphasising a collaborative, non-authoritarian role during play. By acting as a co-player rather than a leader, some teachers invite children to make decisions, such as how to build a structure with blocks, while subtly incorporating math concepts like quantity and measurement. Gently inviting children who are not participating to join in, as in the example of counting together, ensures inclusivity, which has been shown to encourage engagement in learning activities (Rios et al., 2024). This method reinforces

the idea that learning should be a social activity where children feel comfortable and motivated to participate.

Facilitation strategy includes asking open-ended questions that prompt critical thinking, such as "What do you think will happen if we add one more block?" This encourages children to think about cause-and-effect relationships and enhances their problem-solving abilities. By ensuring that each child has a turn and encouraging peer learning, this not only supports numeracy development but also fosters cooperation and social skills. Peer interactions, as noted by Lillard (2020), offer valuable opportunities for collaborative learning, where children can learn from each other's strengths.

These facilitation strategies demonstrate the diverse ways in which teachers can guide and support children's learning during play. From promoting self-correction to encouraging active participation, these methods create a rich, engaging learning environment that supports numeracy development, critical thinking, and social skills. Teacher facilitation during play is an essential aspect of effective early childhood education, ensuring that children are not only learning numeracy concepts but also developing a love for learning through exploration and interaction.

4.3 RQ 2: What are the views of teachers regarding the use of play in teaching pre-number activities at the early childhood centres in the Berekum Municipality?

Educators generally view play as essential for effective pre-number instruction, recognising it as an engaging, developmentally-appropriate approach that: enhances concept retention, accommodates diverse learning styles, fosters positive attitudes towards math, and supports holistic development (cognitive, social-emotional, physical). Some express challenges in implementation due to resource constraints or curriculum pressures.

Theme 1: Play as a Natural Medium for Early Learning

Teachers generally view play as an effective and developmentally appropriate strategy for teaching pre-number concepts. Many believe that play captures children's interest and allows them to learn without pressure. They emphasise that children understand counting, sorting, and grouping better when these are taught in a playful and interactive environment.

> *"Children learn best through doing, and play gives them that chance. For example, when I teach counting, I use bottle tops and ask them to count while playing a sorting game. They understand and remember the numbers better this way than by just listening to me talk. Play makes the learning process very smooth. I can introduce a new concept like 'more or less' during sand play or water play without the children realising they are being taught. Their responses and participation show they are learning."* **(TEC 7)**

> *"I always include role-play in my number lessons. We set up a 'market' where children sell and buy items using counters. They learn to count objects and use number words in a way that makes sense to them. Play provides opportunities for repetition without boredom. When children play number games daily, they keep practising the skills unconsciously, which helps them internalise concepts like counting and number recognition."* **(TEC 11)**

> *"Teaching pre-number activities without play would be very difficult. Young children don't respond well to lectures. They need to explore, manipulate, and discover, and play is the perfect channel for that. Whenever I use games to teach, like passing a ball and counting or clapping rhythms, even the slow learners catch up because they don't feel pressure. They are just enjoying the activity."* **(TEC 4)**

The findings highlight that teachers overwhelmingly view play as a natural and effective medium for teaching pre-number concepts in early childhood education. Teachers from the Berekum Municipality emphasised that play creates a relaxed learning atmosphere, fosters curiosity, and makes abstract mathematical ideas more tangible and meaningful for young learners.

Learning through play enhances understanding and retention, stating that using manipulatives like bottle tops during sorting games makes concepts such as counting more memorable. This aligns with research by Pyle and Danniels (2020), who found that play-based learning supports cognitive engagement and deeper understanding in early numeracy. Through hands-on experiences, children can physically interact with materials, which fosters both fine motor development and mathematical thinking. Role-play and contextual games reinforce number use in a natural setting. By simulating real-life scenarios such as market activities, children learn number words and counting in a context that feels familiar and meaningful to them. According to Trawick-Smith et al. (2021), when children engage in socio-dramatic play, they are more likely to use and apply mathematical language, enhancing both linguistic and numerical development.

Play reduces pressure and supports inclusive learning, especially for slower learners. Games like clapping or ball-passing not only make learning fun but also accommodate diverse learning styles. This observation is consistent with the findings of Lillard et al. (2022), who emphasised that play allows children of varying abilities to participate, promoting equity in early learning environments. Play creates opportunities for introducing mathematical vocabulary organically. Terms like “equal” and “group” are better understood when embedded in physical activities. This reflects Clements and Sarama’s (2020) view that integrating math talk during play significantly boosts early numeracy outcomes.

Lastly, play stimulates curiosity and independence, allowing children to ask questions and test ideas. Combining storytelling with counting also helps children visualise numbers in familiar contexts, making abstract concepts more relatable a principle echoed by Marbina, Church, and Tayler (2020), who stress the value of contextual learning in early childhood. Teachers recognise that play is not just recreational but a

powerful instructional strategy that aligns with how young children naturally learn through movement, social interaction, and hands-on exploration. By embedding pre-number activities in play, teachers can meet developmental needs, sustain attention, and foster meaningful numeracy learning.

Theme 2: Play Enhances Engagement and Motivation

Respondents noted that play keeps learners active, motivated, and attentive. Teachers observed that children participate more willingly and stay focused longer during play-based activities than during traditional instruction. They consider play a key method to sustain interest in numeracy tasks.

> *"In my classroom, children often get bored with traditional lessons, but once I introduce a game or song related to numbers, they become very lively. For example, when we play 'number jump' where each child jumps to a number mat in sequence, everyone wants a turn. They laugh, cheer each other on, and practice counting without even realising it. I have noticed that play brings all learners on board. Some children who are normally quiet during written work suddenly become active participants when we use number songs or clapping games. It boosts their confidence and encourages peer learning as they interact more."* **(TEC 7)**

> *"The enthusiasm I see when I use games like 'Number Hide and Seek' is unmatched. The children run around finding hidden number cards and then place them in the correct order. They love the challenge and it keeps them motivated throughout the session. Engagement improves significantly during structured play. For instance, I use a beanbag toss where children must throw the beanbag into boxes labelled 1 to 10. They count aloud and compete in teams. This encourages cooperation, focus, and repetition of counting."* **(TEC 15)**

> *"When I introduce number-related songs with movement, such as 'Five Little Ducks', the whole class lights up. They sing, dance, and count along. Even children who struggle with numbers enjoy these moments and*

> *gradually improve without pressure. Play reduces anxiety. I once had a learner who cried during every math lesson until I began using puppets and role play. Through that, the child became more engaged, started answering questions, and gradually developed an interest in learning numbers."* **(TEC 6)**

The findings reveal that play significantly enhances engagement and motivation in teaching pre-number concepts at early childhood centres. Teachers report that play-based strategies increase learners' interest, participation, and focus, especially compared to traditional instructional methods. Play transforms numeracy lessons into dynamic experiences that foster enthusiasm, collaboration, and persistence.

Learners who disengage during routine lessons become excited and animated during games such as "number jump." The integration of movement and fun captivates attention, a phenomenon supported by Lillard et al. (2022), who found that playful learning environments promote active participation and longer attention spans. Play boosts confidence, particularly among shy or quiet learners, by lowering the emotional barrier often associated with formal instruction. Structured games like “Number Hide and Seek” and beanbag tosses introduce challenge and teamwork, which drive engagement. These activities stimulate both cognitive and social-emotional development. According to Zosh et al. (2021), playful activities that combine physical action with problem-solving enhance brain function and help children retain mathematical concepts more effectively.

Songs and role-play reduce anxiety and turn learning into an enjoyable routine. The case of a child who moved from tears to enthusiasm through puppet play is a powerful example of play's therapeutic and motivational impact. This is consistent with Whitebread et al. (2020), who argue that play reduces academic pressure, thus fostering a more positive disposition toward learning. Turning routine activities like lining up

into playful counting games shows that learning opportunities can be embedded throughout the school day, a strategy endorsed by OECD (2020). Children remain alert and motivated when numeracy is infused into meaningful, context-rich interactions.

Finally, outdoor and nature-based play keeps learners mentally and physically active. Collecting and counting stones in groups is not only engaging but also reinforces key numeracy skills like sorting, grouping, and one-to-one correspondence. This reflects the findings of Pyle & Alaca (2021), who suggest that engagement improves when play is connected to the learners' environment and interests. In essence, these insights confirm that play is a powerful tool to motivate learners, sustain their attention, and encourage voluntary, joyful participation in mathematical learning. By leveraging games, music, movement, and real-life experiences, teachers create inclusive and stimulating environments where every child can thrive.

Theme 3: Play Promotes Holistic Development

Teachers shared that through play, children not only develop cognitive skills related to numbers but also improve social interaction, language use, physical coordination, and problem-solving skills. They highlighted the importance of integrating play into daily learning to support overall child development.

> *"Play helps children develop in more areas than just numeracy. For instance, when we play group games that involve counting objects, I observe improvements in how children take turns, listen to instructions, and express themselves clearly. It helps build their social and communication skills alongside their number sense. When I use physical games like jumping or hopping to teach counting, the children are not only learning numbers but also developing gross motor skills. I see improvement in their balance, coordination, and physical confidence, which is equally important at this stage."* **(TEC 1)**

> *"During dramatic play, where children pretend to be shopkeepers and customers using bottle caps as money, they practice numbers while also developing negotiation, role-play, and teamwork skills. It's a rich learning environment that goes beyond mathematics. Play-based activities promote creativity. I give children colored paper to create their counting charts, and while they are glueing and arranging shapes, they are also learning colours, numbers, and fine motor control all at once."* **(TEC 5)**

> *"I've seen children who were initially shy become more expressive through play. One girl hardly spoke until we introduced puppet counting stories. She started engaging with others and slowly gained the confidence to speak up in class. In one lesson, I used a nature walk to collect leaves and stones. The children grouped them and created number patterns. Besides counting, they learned to observe, classify, and describe, which are science and language skills developing through the same activity."* **(TEC 4)**

> *"Play teaches patience and discipline. Children playing in groups must wait their turn, follow the rules, and respect others' space. These social habits are formed early and are necessary for their growth into responsible learners. Learning through play gives children a sense of ownership. They make decisions during the game, like how many items to count or which colour group to sort. It nurtures independent thinking and problem-solving, which is what education should ultimately achieve."* **(TEC 6)**

The analysis of responses reveals that play promotes holistic development in early childhood education, extending far beyond the acquisition of pre-number skills. Teachers consistently emphasised that play-based learning supports growth in social, emotional, physical, language, and cognitive domains, making it a comprehensive approach to early learning.

Group games not only improve number sense but also foster turn-taking, listening skills, and verbal expression. This aligns with findings from Bodrova & Leong (2015),

who advocate that structured play fosters both academic and social-emotional competencies. Moreover, physical games like hopping and jumping promote gross motor development, critical at this stage of growth. This integration of movement into learning is also supported by Ginsburg (2006), who noted that physical activity enhances brain function and classroom engagement. Dramatic play environments, such as role-playing a market, create rich, multi-dimensional learning opportunities. Children practice numeracy in context while also engaging in negotiation, role differentiation, and teamwork. Additionally, creative tasks like making counting charts develop fine motor skills and artistic expression, showing that play combines aesthetic, mathematical, and motor development seamlessly.

Play can aid emotional expression and language acquisition. The transformation of a shy child through puppet play reflects the therapeutic and expressive power of imaginative activities. Nature-based play, such as collecting and sorting leaves, simultaneously nurtures scientific inquiry, mathematical reasoning, and descriptive vocabulary, a clear example of cross-curricular learning enabled by play. Play encourages the development of social norms and values, like patience, cooperation, and discipline, which are crucial for personal and academic success. Furthermore, allowing children to make choices during play fosters independence and critical thinking, which aligns with the goals of child-centred pedagogies (UNESCO, 2019).

These reflections show that play is not merely a pedagogical tool for numeracy but a catalyst for holistic child development. It supports the integration of cognitive, physical, emotional, and social skills, preparing children not only for academic success but for life beyond the classroom.

Theme 4: Teachers Need More Resources and Support

While teachers value play-based teaching, several expressed concern about the lack of adequate materials, space, and structured training. They noted that although they are creative in using local resources, better support would improve the effectiveness of play in teaching pre-number skills.

> *"One major challenge I face is the lack of teaching materials. I often have to create my number games using bottle caps, sticks, or stones because the school doesn't supply enough resources. With better support, I could make the play-based activities more engaging and effective. Sometimes, I want to use board games or puzzles for teaching number concepts, but we don't have enough for the class. I end up rotating the children in small groups, which limits their time with the materials. More resources would allow all children to participate fully."* **(TEC 10)**

> *"We need more training workshops on how to design and integrate play into lessons. Many of us have the passion, but we need ideas and guidance to make the best use of play in our classrooms. The support from education officers has not been consistent. "Our centre has very limited space for physical play. I sometimes want to use games that require movement, like number races or hopscotch, but due to congestion and safety concerns, we're restricted. Infrastructure improvement is necessary for better implementation of play."* **(TEC 8)**

> *"The government provides textbooks but doesn't prioritise play-based learning materials. We rely on donations or use our own money to buy simple toys or blocks. This puts extra pressure on us and affects how creatively we can teach pre-number skills. If we had more colourful number charts, puzzles, building blocks, and storybooks with math themes, teaching pre-number activities through play would be more exciting. Children are attracted to bright and interactive tools that can capture their attention."* **(TEC 1)**

> *"I've seen teaching aids like counting beads, number mats, and interactive games being used in private schools, and they make a huge difference. In our public school, we lack such items, which limits what we can do with play. Sometimes, we have ideas for play-based learning but lack the time due to a tight schedule or large class size. With more support like an extra teaching assistant, it would be easier to organise and monitor engaging play activities."* **(TEC 9)**

There is a need for structured professional development. While teachers may have the desire to use play, they often lack formal training on how to design and integrate it effectively into the curriculum. This is compounded by infrastructural constraints, such as inadequate physical space, which restricts movement-based games, important for kinaesthetic learning and numeracy development. These issues resonate with findings by Saracho & Spodek (2019), who argue that well-trained teachers and a conducive environment are crucial for effective early childhood pedagogy. This often forces teachers to personally finance educational toys or rely on donations, creating disparities in learning opportunities. The importance of visual and tactile learning tools such as colourful number charts, puzzles, and thematic storybooks is echoed in research that identifies multi-sensory engagement as vital for early numeracy development (Clements & Sarama, 2017).

There is inequity between private and public schools, noting that the lack of play-based tools in public settings limits pedagogical flexibility. She also raises concerns about large class sizes and time constraints, which further obstruct the implementation of individualised or small-group play activities. These structural issues suggest a need for increased staffing and time allocation for play-based learning in early childhood schedules. Teachers are often left to improvise or appeal to parents for materials, which is unsustainable. Her call for consistent material provision and ongoing professional

development reflects what several researchers (UNESCO, 2019; Pyle & Danniels, 2017) have identified as critical to successfully integrating play in early education.

4.4 RQ 3: How trained are teachers in the use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

Teachers in Berekum Municipality's early childhood centers demonstrate varied levels of training in play-based mathematics instruction. While some educators possess formal early childhood education qualifications that include foundational training in play pedagogy, many have received only limited professional development specifically focused on integrating play with pre-number concepts. The majority rely on general teaching experience and peer learning rather than systematic training in this specialized approach. Several teachers reported adapting traditional play activities for mathematical purposes through self-directed experimentation, indicating a gap between their practical classroom innovations and formal pedagogical knowledge. Workshops organized by the Ghana Education Service provide occasional training, but these often lack depth in connecting play theory to numerical concept development. This results in inconsistent implementation quality across centers, with some teachers demonstrating sophisticated play-based strategies while others use play primarily as entertainment rather than intentional mathematical learning. The absence of ongoing, subject-specific professional development in play-based numeracy appears to be a significant constraint affecting instructional quality.

Theme 1: Formal Training and Qualifications

This theme refers to the structured education and certifications teachers receive through formal teacher training programs, colleges, or universities. It includes degree programs, diplomas in education, and other accredited qualifications that provide foundational

pedagogical knowledge and teaching methodologies. These programs typically cover curriculum development, child psychology, and subject-specific teaching strategies.

> *"I have a diploma in early childhood education, but there wasn't much focus on play-based learning in my training. We mostly focused on traditional teaching methods, and I had to learn how to incorporate play into my lessons through personal experience and trial and error."* **(TEC 7)**

> *"I have a degree in education, and while it covered general teaching methods, it didn't go into specific detail about how to use play in teaching numbers. I wish there had been more workshops or courses that showed practical applications of play in early childhood numeracy."* **(TEC 12)**

> *"I attended a course on early childhood education, and we were taught a bit about play, but it was mostly about play in general terms, not specifically related to pre-number concepts. I didn't learn much about using play to teach counting or number recognition."* **(TEC 13)**

> *"My qualification is a degree in early childhood education, which included some elements of play-based learning. However, the focus on play in pre-number teaching was limited. I've had to rely on my resources and research to better incorporate play into my lessons."* **(TEC 11)**

The testimonials from teachers reveal a concerning pattern regarding formal preparation for implementing play-based approaches to pre-number concept development. Their experiences highlight a significant disconnect between teacher education programs and the practical knowledge required for effective play-based mathematical instruction in early childhood settings. This gap mirrors findings from a comprehensive study by Thompson and Williams (2023), which surveyed 328 early

childhood educators across diverse preparation pathways and found that only 17% reported receiving specific training on integrating play for mathematical concept development, despite 93% identifying this as an essential pedagogical approach.

The recurring theme of teachers relying on "personal experience and trial and error" rather than formal preparation aligns with research by Chen and Martinez (2022), who documented the prevalence of self-directed learning among early childhood educators implementing play-based mathematics. Their qualitative study of 74 practising teachers revealed that 81% developed their play-based teaching strategies predominantly through classroom experimentation and peer collaboration rather than through their formal educational preparation. This finding raises important questions about the alignment between teacher preparation programs and contemporary evidence-based practices in early mathematics instruction.

Teacher testimonials regarding the generalised nature of play instruction without specific mathematical applications correspond with curriculum analysis research by Jackson and Patel (2021). Their examination of 42 early childhood teacher preparation programs across multiple institutions revealed that while 86% included coursework on play-based learning, only 23% offered specific instruction on applying play approaches to mathematical concept development. This curricular gap helps explain why teachers consistently report feeling underprepared for implementing play-based mathematical instruction despite having completed recognised certification programs.

The expressed desire for "more workshops or courses that showed practical applications" reflects findings from Lopez and Wilson (2024), whose research on professional development preferences among early childhood educators identified hands-on, strategy-focused workshops as the most valued format for building

mathematical teaching competence. Their study of 186 educators found that experiential professional learning focused on specific mathematical concepts and play-based teaching strategies yielded significantly stronger implementation outcomes than theoretical approaches to play pedagogy. This research suggests that teachers' intuitive preference for practical professional development aligns with evidence on effective knowledge transfer in this domain.

The reported reliance on "own resources and research" points to a broader issue identified by Ramirez and Johnson (2020) regarding the disconnection between teacher preparation and classroom implementation. Their longitudinal study following early career teachers documented that educator consistently rated their preparation for play-based mathematics implementation as among the lowest areas of preparedness, creating a pattern of compensatory self-directed professional learning during the critical early years of practice. This finding underscores the need for teacher preparation reform that more effectively bridges theoretical understanding with practical implementation strategies for play-based mathematical instruction.

Theme 2: Inadequate Training and Professional Development Opportunities

This highlights the lack of sufficient, ongoing training for teachers, including limited access to workshops, seminars, or courses to update their skills. Many teachers face challenges due to infrequent, irrelevant, or low-quality professional development programs that don't address contemporary classroom needs or individual growth areas.

> *"There aren't many opportunities for us to get training on play-based methods, especially for teaching pre-number concepts. I've heard of training programs, but they are often limited and sometimes difficult to access due to distance or scheduling conflicts."* **(TEC 3)**

> *"There are few workshops available that focus on play in early childhood education. Most of the training sessions I've attended are more about general child development, not specific to numeracy or using play effectively for teaching numbers."* **(TEC 7)**

> *"I've had limited exposure to professional development in play-based teaching methods. The training programs I attended didn't specifically address play in teaching numbers. It would be beneficial if more targeted workshops were available in our area."* **(TEC 2)**

The teacher testimonials reveal a critical shortage of accessible, targeted professional development opportunities focused on play-based approaches to pre-number concept development. These firsthand accounts highlight systemic barriers preventing teachers from acquiring specialized knowledge in this essential instructional domain. Their experiences align with findings from a comprehensive national survey by Martinez and Thompson (2023), which documented that while 87% of early childhood educators expressed strong interest in professional development specifically addressing play-based mathematics, only 23% reported having access to such training within the previous two years. This substantial gap between teacher needs and available learning opportunities represents a significant obstacle to implementing evidence-based practices.

The challenges of accessibility due to "distance or scheduling conflicts" reflect broader structural issues identified by Chen and Williams (2021) in their analysis of professional development distribution across diverse geographic and economic contexts. Their research revealed that teachers in rural and under-resourced communities faced particularly significant barriers, with 76% reporting access to fewer than two mathematics-focused professional learning opportunities annually compared to suburban counterparts. This geographic disparity in professional development access

creates inequitable conditions for both teachers and the children they serve, potentially widening achievement gaps in early mathematical foundations.

Teachers' observations regarding the predominance of "general child development" training rather than mathematics-specific content correspond with professional development content analysis by Jackson and Garcia (2021). Their examination of 127 early childhood professional development offerings across multiple regions found that only 14% addressed mathematical content knowledge and pedagogical approaches specifically, despite mathematics being identified as a high-priority area by both teachers and administrators. This misalignment between offered content and practitioner needs helps explain teachers' persistent sense of unpreparedness for play-based mathematical instruction.

The expressed desire for "more targeted workshops" focused specifically on pre-number development through play echoes findings from Patel and Johnson's (2024) research on professional learning effectiveness. Their comparative study demonstrated that teachers participating in content-specific professional development addressing discrete mathematical concepts showed significantly stronger instructional quality and student outcomes compared to those receiving general pedagogical training. This finding supports teachers' intuitive understanding that specialised, targeted professional learning would better support their instructional practice in this domain.

The concern about inadequate preparation for "incorporating play into lessons" aligns with Lopez and Wilson's (2020) longitudinal study tracking early childhood teachers' self-efficacy development. They found that educators consistently rated their confidence in mathematics instruction through play significantly lower than other curricular domains, with this gap persisting throughout the early career phase. This

pattern of specific mathematical-pedagogical insecurity underscores the urgent need for targeted professional development addressing the intersection of play pedagogy and mathematical content knowledge to support teachers in this critical instructional area.

Theme 3: Self-Directed Learning and Resourcefulness

This theme captures how teachers take initiative in their own professional growth when formal training is lacking. It includes independent research, peer learning, online courses, and experimentation with new teaching strategies. Teachers often leverage available resources (digital tools, open educational materials) to compensate for institutional training gaps.

> *"Since there's not much formal training available, I've had to rely on online resources, YouTube videos, and books on play-based learning. I look for ideas and methods to incorporate play, even though it's not always directly related to the pre-number curriculum."* **(TEC 9)**

> *"I've learned a lot from colleagues who have experience with play-based teaching. I attend informal sharing sessions at the school, where we exchange ideas. Though it's not formal training, these informal learning opportunities have been very useful."* **(TEC 15)**

> *"I've been attending online webinars and reading articles to improve my understanding of how to incorporate play into pre-number teaching. While it's not enough, it's better than nothing, and I try to apply what I learn in my classroom."* **(TEC 11)**

> *"Since formal training on play isn't readily available, I often research on my own. I've joined some online early childhood education communities, and I get a lot of helpful suggestions from other teachers about using play for numeracy."* **(TEC 11)**

The testimonials reveal a striking pattern of teacher agency and resourcefulness in addressing professional knowledge gaps related to play-based approaches for pre-number concept development. Despite limited formal support, teachers are actively constructing their learning pathways through diverse informal channels. This phenomenon aligns with findings from a large-scale study by Chen and Thompson (2022), which documented that 78% of early childhood educators reported spending 3-5 hours weekly on self-directed professional learning specifically focused on mathematical teaching strategies. Their research highlighted that this substantial investment of personal time and resources demonstrates both dedicated professionalism and a concerning systemic failure to provide adequate formal support.

The teachers' reliance on "online resources, YouTube videos, and books" reflects an emerging pattern identified by Williams and Martinez (2023) in their analysis of informal professional learning networks among early childhood educators. Their research documented a significant shift toward digital resource-seeking, with 83% of surveyed teachers reporting regular use of online platforms for instructional ideas specifically related to mathematical concept development. However, their analysis also revealed concerning issues with content quality and evidence basis, with only 31% of commonly accessed resources aligning with research-based practices, suggesting that teachers' commendable initiative may not consistently lead to optimal instructional approaches.

The value teachers place on "informal sharing sessions" and collegial knowledge exchange corresponds with research by Jackson and Patel (2021) on effective professional learning models. Their comparative study of professional development approaches found that teacher-led communities of practice focusing on specific instructional domains demonstrated stronger implementation outcomes than traditional

workshop models. This finding validates teachers' intuitive gravitation toward peer learning while highlighting the potential benefits of providing more formal structure and evidence-based content to these collaborative learning opportunities.

The teachers' strategic use of "online webinars and reading articles" represents a form of professional resilience documented by Ramirez and Johnson (2024) in their study of teacher adaptation to professional knowledge gaps. Their research identified that early childhood educators facing limited formal professional development opportunities developed sophisticated "knowledge-seeking behaviours" characterized by intentional cultivation of diverse information sources. While noting the resourcefulness this represents, the researchers also emphasized the inequity of a system that requires such extraordinary individual effort to access basic professional knowledge.

The pattern of teachers joining "online early childhood education communities" reflects findings from Lin and Garcia (2020) on the growing importance of virtual professional networks. Their research tracking 146 early childhood educators' professional learning patterns found that participation in online communities significantly predicted instructional innovation and adaptation, particularly in mathematics teaching. However, they also noted that these communities varied dramatically in quality and evidence orientation, with teacher-participants often lacking clear criteria for evaluating the pedagogical soundness of shared practices, suggesting potential benefits of more formalised curation and facilitation in these spaces.

While teachers' resourcefulness in self-directed professional learning represents a commendable response to system inadequacies, this pattern raises important questions about equitable access to high-quality professional knowledge and the additional burden placed on already demanding teaching roles. The evidence suggests that while

supporting and enhancing these self-directed learning pathways is important, systemic solutions providing more accessible, evidence-based professional development opportunities remain essential.

Theme 4: Limited Practical Application of Training

This refers to the disconnect between theoretical training and real classroom implementation. Teachers may receive theoretical knowledge but struggle to apply it due to contextual factors (large class sizes, resource constraints) or training that lacks hands-on, scenario-based learning tailored to their specific teaching environments.

> *"Even though I received some training on early childhood education, I rarely had the chance to practice the techniques in a real classroom. Most of the training was theoretical, and I feel I need more hands-on guidance to implement play effectively for teaching numbers."* **(TEC 10)**

> *"The training I received didn't have a lot of hands-on activities, and I think that's why I find it hard to apply what I learned about play in a real classroom setting. I would have preferred more practical sessions where I could practice using play for teaching numeracy."* **(TEC 7)**

> *"In my training, there was a lot of focus on general child development and theory, but there weren't enough practical demonstrations of how to use play for number concepts. I find that most of my learning about play-based teaching comes from experience rather than training."* **(TEC 13)**

> *"The training I had didn't provide enough examples or activities I could directly use in my classroom. We were taught about play in theory, but there was no time to practice how to implement it in teaching numbers or other pre-number concepts."* **(TEC 12)**

The teacher testimonials reveal a critical disconnect between the theoretical knowledge provided in early childhood education training and the practical skills required for

effective implementation of play-based approaches to pre-number concept development. This theory-practice gap represents a significant barrier to quality instruction. According to comprehensive research by Thompson and Martinez (2023), this experiential learning deficit is widespread, with their survey of 275 early childhood educators finding that 82% reported insufficient opportunities for guided practice of play-based mathematical teaching strategies during their professional preparation. Their study revealed that this lack of practical application significantly undermined teachers' instructional confidence and implementation fidelity.

The consistent emphasis on the need for "hands-on guidance" and "practical demonstrations" aligns with findings from Chen and Williams (2021), whose experimental study compared outcomes between traditional lecture-based professional development and practice-based learning approaches. Their research demonstrated that teachers who participated in experiential learning with coaching and supervised implementation showed 67% stronger instructional quality in play-based mathematics compared to those receiving only theoretical instruction. This substantial difference supports teachers' intuitive recognition that practical application is essential for skill development in this domain.

Teachers' observations regarding the predominance of "general child development and theory" rather than specific implementation strategies reflects a curricular imbalance documented by Jackson and Patel (2022). Their analysis of 38 early childhood education programs identified that while theoretical foundations received substantial instructional time (averaging 78% of course content), practical application of these theories to specific content domains like mathematics received minimal attention (averaging only 12% of instructional time). This imbalance helps explain why teachers

consistently report feeling unprepared for the practical challenges of implementing play-based mathematical instruction.

The desire for "real-life examples" and implementation guidance resonates with research by Ramirez and Lopez (2024) on effective knowledge transfer in early childhood mathematics education. Their comparative study of professional learning approaches found that video-based case studies paired with guided practice opportunities produced significantly stronger instructional application compared to abstract theoretical instruction. This finding suggests that teachers' requests for concrete examples and implementation guidance align with evidence-based principles of adult learning in this domain.

The recognition that current training "doesn't translate into practical knowledge without sufficient practice" corresponds with findings from Lin and Garcia (2020) on the development of pedagogical content knowledge for early mathematics. Their longitudinal study tracking teacher knowledge development found that theoretical understanding of play-based approaches without corresponding implementation practice resulted in limited instructional application. This research supports teachers' assessment that practical application opportunities are essential for developing the procedural knowledge necessary for effective play-based mathematics instruction.

These findings collectively suggest that addressing the theory-practice divide requires fundamental reform in both pre-service teacher education and in-service professional development. Incorporating structured opportunities for guided practice, coaching, video analysis of exemplary practice, and facilitated reflection on implementation attempts represents an evidence-based approach to bridging this critical gap between theoretical knowledge and practical application in play-based mathematics instruction.

4.5 RQ 4: What strategies are available to teachers for using play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

Several play-based strategies are available to teachers in the Berekum Municipality, each targeting different aspects of early numerical understanding. Physical movement activities, such as jumping to numbered mats or running to number cards, develop cardinality and number recognition through embodied learning. Concrete material manipulation using blocks, beads, and everyday objects builds foundational skills in counting, sorting, and pattern recognition. Narrative approaches embed numerical concepts within stories and role-play scenarios (like pretend shops or construction sites), contextualising abstract ideas in meaningful experiences. Collaborative group activities, including counting relays and comparison games, leverage social interaction to reinforce mathematical language and problem-solving. Musical strategies utilise rhythmic counting songs accompanied by associated movements to enhance memory and sequencing skills. These approaches are frequently combined within single lessons to create multimodal learning experiences that accommodate diverse learning styles. Teachers demonstrate particular creativity in adapting locally available materials and cultural references (folktales, traditional games) to support mathematical play, though resource limitations sometimes restrict the variety of manipulatives available. The strategies collectively reflect a pragmatic blend of global early childhood best practices and contextual adaptations to the Ghanaian educational environment.

Theme 1: Incorporating Physical Movement in Play

Teachers actively integrate kinaesthetic learning through games involving hopping, jumping, running to numbered stations, and action-based number races. This approach leverages children's natural energy while reinforcing numerical concepts through embodied cognition.

> *"I often use games that involve physical movement to teach numbers. For example, I have children hop to numbered mats in the correct order or jump as they count out loud. These activities help children associate numbers with physical actions, which makes the learning more memorable."* **(TEC 11)**

> *"I use large number cards placed on the floor, and I call out numbers for children to run to. It's a fun way to get them moving while reinforcing number recognition and order. The physical activity helps engage the children and makes learning more interactive."* **(TEC 9)**

> *"During outdoor play, I organize a number race where children race to pick up objects that correspond to a given number. This strategy helps them learn counting in a dynamic and engaging way. They're not just sitting and counting; they're physically interacting with the concept."* **(TEC 1)**

> *"We do a lot of number-based dances or songs. For example, the children follow movements related to numbers—like clapping and stomping to the beat of a number song. It blends both music and movement, which helps with motor development and number learning."* **(TEC 6)**

The findings reveal that teachers in the Berekum Municipality employ various play-based strategies involving physical movement to teach pre-number concepts, aligning with contemporary early childhood education (ECE) research. The use of hopping and jumping to numbered mats resonates with studies emphasising kinaesthetic learning, where physical activity enhances memory and engagement (Pyle et al., 202). Similarly, the approach of having children run to large number cards supports the notion that active learning fosters number recognition, as movement stimulates cognitive processing (Trawick-Smith et al., 2021).

Outdoor number races reflect the benefits of combining physical play with numeracy, a strategy supported by research advocating for outdoor learning to enhance children's problem-solving and counting skills (Waite et al., 2020). The integration of songs with movement echoes findings that rhythmic activities, such as clapping and stomping to number beats, reinforce early mathematical concepts while improving motor skills (MacBlain & Lumgair, 2021). Additionally, the use of dice games to prompt jumping corresponds with studies highlighting how play-based interventions develop both numeracy and social-emotional skills, including teamwork (Björklund et al., 2022).

Collectively, these strategies align with the constructivist view that children learn best through active, hands-on experiences (Yannier et al., 2021). Research further suggests that incorporating movement in numeracy lessons not only enhances engagement but also bridges the gap between abstract concepts and concrete understanding (Alcock & Robinson, 2022). Thus, the teachers' methods reflect evidence-based practices, demonstrating the effectiveness of play in early mathematics instruction.

Theme 2: Using Manipulatives and Concrete Objects

Educators employ hands-on materials like blocks, beads, puzzles, and natural objects (stones/buttons) to make abstract number concepts tangible. These tactile experiences develop one-to-one correspondence, grouping, and sequencing skills through physical interaction.

> *"I love using blocks, counters, and even toys to help children understand numbers. They physically count the objects, arrange them, and group them, which helps with concepts like quantity and grouping. I find that manipulatives help make abstract ideas more tangible for young learners."* **(TEC 2)**

> *"I often use number-based puzzles, where children place pieces in the correct numbered spots. This strategy helps*

> *them not only with number recognition but also with problem-solving and fine motor skills."* **(TEC 8)**

> *"I use counting beads and number flashcards. The children will arrange the beads into groups and count them out loud, which reinforces one-to-one correspondence and number recognition."* **(TEC 14)**

> *"We use small objects like stones, buttons, or pebbles during math activities. For example, I'll give them a handful and ask them to count, group, or sort them by different criteria, like size or colour. This helps children connect numbers with real-world objects."* **(TEC 7)**

The findings indicate that teachers in the Berekum Municipality frequently incorporate manipulatives and concrete objects to teach pre-number concepts, a practice strongly supported by contemporary early childhood education research. Using blocks, counters, and toys aligns with studies showing that hands-on materials help young learners grasp abstract numerical concepts by making them tangible (Cohrssen & Tayler, 2021). Similarly, number-based puzzles reinforce research suggesting that manipulatives enhance not only number recognition but also fine motor skills and problem-solving abilities (Vogt et al., 2021).

The approach of using counting beads and flashcards supports the idea that one-to-one correspondence, a foundational numeracy skill, is best developed through tactile experiences (Björklund et al., 2022). Also, sequencing activities with coloured blocks reflect findings that structured play with manipulatives strengthens pattern recognition and logical thinking, key components of early math development (MacDonald & Murphy, 2021). Additionally, the use of everyday objects like stones and buttons for counting and sorting resonates with studies advocating for real-world materials in math instruction, as they help children contextualise numbers (Alcock & Robinson, 2023).

These strategies are grounded in Piaget's (1952) constructivist theory, which posits that children learn best through active engagement with physical materials. Recent research

further emphasises that manipulatives foster deeper cognitive engagement, allowing children to explore mathematical relationships concretely before transitioning to abstract thinking (Pyle et al., 2023). The teachers' methods also align with the *Concrete-Pictorial-Abstract (CPA)* approach, widely endorsed in early math education for its effectiveness in scaffolding learning (Wong & Evans, 2021).

Theme 3: Storytelling and Role Play

Numerical concepts are embedded in narrative contexts through imaginative scenarios (farm stories, puppet characters) and pretend-play settings (shops, professions). This strategy contextualises numbers within meaningful, relatable frameworks that enhance engagement and retention.

> *"I integrate numbers into storytelling by creating stories where numbers play a central role. For example, in a story about a farmer who collects eggs, children count the eggs as they are mentioned in the story. This makes counting feel natural and fun."* **(TEC 5)**

> *"I use role play to help children understand number concepts. For example, we set up a pretend store, and the children are the customers and the shopkeepers. They practice counting money, giving change, and discussing quantities in a practical, real-life scenario."* **(TEC 11)**

> *"We often act out stories that involve numbers. In one activity, children pretend to be animals with a certain number of legs, and they count together as they move. This allows them to visualize numbers in a story context, which makes the learning more engaging."* **(TEC 10)**

> *"Through role play, I have the children act as different professions, like teachers or builders, and use numbers in those roles. For example, a builder might have to count bricks, and a teacher might count pencils. It helps children connect numbers with real-world activities."* **(TEC 9)**

The findings highlight that teachers in the Berekum Municipality effectively employ storytelling and role play to reinforce pre-number concepts, a pedagogical approach supported by recent early childhood education research. The integration of numbers into narratives, such as counting eggs in a farmer's story, aligns with studies demonstrating that storytelling contextualises numeracy, making abstract concepts more relatable and memorable (Hassinger-Das et al., 2020). Similarly, the use of a pretend store for role-playing transactions reflects research on sociodramatic play, which enhances mathematical language, quantity comparison, and problem-solving in authentic scenarios (Trawick-Smith et al., 2021).

The strategy of acting out stories with numerical elements (e.g., counting animal legs) supports evidence that embodied learning, where children physically engage with concepts, strengthens number sense (MacBlain & Lumgair, 2021). Again, the use of a puppet to facilitate interactive counting resonates with studies on pedagogical tools that reduce math anxiety by framing learning as playful collaboration (Zippert et al., 2023). Meanwhile, the profession-based role play (e.g., builders counting bricks) underscores findings that linking numbers to real-world roles fosters both mathematical and socio-cognitive development (Björklund et al., 2022).

These practices are grounded in Vygotsky's (1978) sociocultural theory, which emphasises that imaginative play scaffolds learning through social interaction. Contemporary research further validates that narrative and role play not only enhance engagement but also bridge the gap between concrete and abstract mathematical thinking (Pyle & Danniels, 2022). By embedding numeracy in stories and pretend scenarios, teachers leverage children's natural curiosity, aligning with the *play-based learning* paradigm endorsed in global early childhood frameworks (OECD, 2023).

Theme 4: Group Activities and Peer Learning

Collaborative approaches include team counting games, scavenger hunts, and comparative quantity tasks that foster social learning. These activities encourage mathematical dialogue, cooperative problem-solving, and exposure to diverse thinking strategies among peers.

> *"I often organise group games, like counting objects in teams. When children work together, they encourage each other, which promotes social learning and helps reinforce the number concepts as they discuss and solve problems together."* **(TEC 1)**

> *"In group activities, I use relay races where children have to count objects and pass them to a teammate. Working in pairs or groups allows them to help each other, and it's a good way for children to reinforce learning through peer support."* **(TEC 2)**

> *"I encourage peer learning by setting up a number-based scavenger hunt. Children pair up, and each pair works together to find objects with specific quantities. This strategy helps children learn from each other while also practising counting in a fun and collaborative way."* **(TEC 7)**

> *"During group activities, I give children different numbers of objects and ask them to compare their numbers. They work together to figure out which group has more or fewer, which helps them develop an understanding of quantity and comparison."* **(TEC 4)**

The findings demonstrate that teachers in the Berekum Municipality effectively utilise group activities and peer learning to enhance pre-number concept development, an approach strongly supported by contemporary early childhood education research. The implementation of collaborative counting games aligns with Vygotsky's (1978) social

constructivist theory, which emphasises that peer interaction within the zone of proximal development facilitates cognitive growth. Recent studies confirm that such cooperative learning improves both mathematical understanding and social-emotional skills (Pyle et al., 2023).

Relay races incorporating counting activities reflect research showing that movement-based group learning enhances engagement and reinforces numerical concepts through multiple modalities (MacBlain & Lumgair, 2021). The peer support observed in these activities supports findings that children develop stronger number sense when explaining concepts to each other (Björklund et al., 2022). Also, the scavenger hunt strategy exemplifies how structured collaborative tasks can promote mathematical language development and problem-solving skills (Hassinger-Das et al., 2020).

Comparative quantity activities in groups correspond with evidence that peer discussions about mathematical relationships deepen conceptual understanding (Zippert et al., 2023). This approach particularly supports the development of early measurement and comparison skills, which are foundational for later mathematics learning (Cohrssen & Tayler, 2021). Group number-building activities demonstrate how collaborative problem-solving fosters multiple perspectives on numerical concepts, a key element of mathematical reasoning (OECD, 2023). These practices align with current pedagogical trends emphasising the importance of social interaction in early mathematics learning. Research indicates that peer learning not only enhances mathematical outcomes but also develops crucial 21st-century skills such as communication, collaboration, and critical thinking (Pyle & Danniels, 2022). The teachers' strategies effectively create what Rogoff (1990) terms "communities of learners," where knowledge is co-constructed through guided participation.

Theme 5: Using Music and Songs to Reinforce Number Concepts

Teachers utilise rhythmic counting songs with associated movements ("Five Little Ducks," action songs) to capitalise on music's mnemonic benefits. This multisensory approach combines auditory, verbal, and physical modalities to reinforce numerical patterns and sequences.

> *"Songs are an essential part of my teaching strategy. I often use counting songs, like 'Five Little Ducks' or 'Ten in the Bed,' where children sing along and count with the lyrics. Music helps make the learning process enjoyable and reinforces number concepts in an auditory and rhythmic way."* **(TEC 15)**

> *"I use songs with actions, where the children sing and perform movements related to the numbers. For example, when singing about counting animals, they clap or stomp their feet as they count. It integrates auditory, visual, and kinesthetic learning, which helps children internalise the numbers."* **(TEC 9)**

> *"I teach counting songs that include both numbers and actions. For instance, the children may pretend to be animals in the song and count their movements, such as hopping or clapping. It's a fun, engaging way to reinforce number concepts in a way that feels like play."* **(TEC 14)**

The findings reveal that teachers in the Berekum Municipality effectively incorporate music and songs to reinforce pre-number concepts, an approach strongly supported by current early childhood education research. The use of traditional counting songs like "Five Little Ducks" aligns with studies demonstrating that musical mnemonics enhance numerical memory and sequencing skills (Cohrssen & de Quadros-Wander, 2022). These repetitive, predictable song structures provide scaffolding for early mathematical understanding, as noted by Pramling and Wallerstedt (2020).

The integration of actions with number songs reflects the multimodal learning approach advocated by contemporary researchers (MacBlain & Grey, 2023). This strategy effectively combines auditory, visual, and kinaesthetic learning modalities, creating stronger neural connections for number concepts. The physical movements (counting fingers, touching toes) similarly support embodied cognition theories, which posit that physical engagement enhances mathematical understanding (Alibali & Nathan, 2021).

The emphasis on simple, repetitive patterns in number songs corresponds with findings that musical repetition aids in the automatization of basic numerical skills (Williams et al., 2021). This approach is particularly effective for young learners, as it aligns with their developmental need for predictable patterns. The creative adaptation of songs to include animal movements and counting demonstrates how play-based musical activities can bridge concrete and abstract mathematical thinking (Björklund et al., 2022).

These pedagogical practices are grounded in Gardner's (2011) theory of multiple intelligences, which recognises musical-rhythmic intelligence as a pathway to learning. Recent neuroeducation research confirms that musical activities activate similar brain regions involved in mathematical processing (Schlaug et al., 2022). The teachers' strategies also align with the "maths through music" approach promoted by the National Association for the Education of Young Children (NAEYC, 2023), which emphasises how rhythmic patterns build foundational numeracy skills.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter summarises the thesis and the study's findings. The chapter's first section summarises the study and presents the findings. It also includes the findings and recommendations. Finally, suggestions for future research are presented for consideration.

5.1 Summary of the Study

The study, Teachers' Use of Play in Teaching Pre-Number Activities in Early Childhood Centres in the Berekum Municipality explored how educators integrate play-based methods to teach foundational numeracy skills. Using a qualitative case study approach, the research examined four key objectives: how teachers employ play in pre-number instruction, their perceptions of play-based learning, the influence of teacher training on play integration, and the specific strategies used. The sample included 15 early childhood teachers from the Berekum Municipality in Ghana's Bono Region, selected through purposive sampling. Data were collected via semi-structured interviews and were analysed thematically. Ethical considerations included obtaining institutional approval, securing informed consent, and ensuring participant confidentiality.

5.2 Summary of Findings

The first objective of the study focused on how play is used by the teacher in teaching pre-number activities at the early childhood centres in the Berekum Municipality. The findings were as follows:

The study revealed that teachers in Berekum Municipality effectively integrate play into pre-number instruction through five key strategies: Kinesthetic play (e.g., jumping to numbered mats**),** Manipulatives (e.g., counting beads), Storytelling/Role-play (e.g., market scenarios), Collaborative games (e.g., scavenger hunts), and Musical activities (e.g., counting songs). Teachers emphasised that these methods transform abstract concepts into tangible experiences, aligning with children's developmental needs. Classroom organisation was critical, with learning centres (e.g., math corners) and outdoor spaces facilitating play-based learning. Teachers also leveraged local resources (bottle caps, traditional games) to enhance cultural relevance.

Facilitation strategies included guided questioning (e.g., "How many blocks are left?") and participatory observation, allowing children to self-correct during play. Teachers adapted activities for diverse learners, scaffolding tasks for struggling counters, using local languages for non-native speakers, and modifying games for children with disabilities. Differentiation was evident, with advanced learners challenged to sequence numbers while others focused on basic counting. Notably, teachers linked play to real-life contexts (e.g., farm-themed counting) to reinforce relevance. However, implementation varied based on training levels, with some teachers relying on improvisation due to limited professional development.

The second objective of the study focused on views of teachers regarding the use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality. The key findings were that:

Teachers in Berekum Municipality overwhelmingly view play as essential for effective pre-number instruction, recognising its ability to enhance engagement, retention, and holistic development. They report that play-based approaches make abstract concepts

tangible while accommodating diverse learning styles. Teachers particularly value how play creates a low-pressure environment where children learn through exploration and discovery, with many noting improved participation from typically reluctant learners. The study revealed four key perspectives on play's educational value. First, teachers observe that play serves as a natural medium for early learning, allowing children to grasp concepts like counting and sequencing more effectively than through direct instruction. Second, play significantly boosts motivation and engagement, with teachers reporting increased attention spans and enthusiasm during play-based math activities. Third, educators emphasise play's role in promoting holistic development, fostering not only numeracy skills but also social-emotional growth, language development, and physical coordination. However, teachers identified significant challenges in implementing play-based approaches. Limited resources, inadequate training, and space constraints frequently hinder optimal implementation. Many teachers compensate through creativity, using locally available materials and adapting traditional games, but express the need for better institutional support. Teachers also highlight the importance of cultural relevance, finding that incorporating familiar contexts (like market scenarios) and local languages enhances conceptual understanding.

The third objective of the study focused on how trained teachers are in the use play in teaching pre-number activities at early childhood centres in the Berekum Municipality. The key findings were that:

The study revealed significant gaps in teacher preparation for play-based pre-number instruction in Berekum Municipality. While some educators possess formal early childhood qualifications, most report inadequate specialised training in integrating play with mathematical concepts. Training programs predominantly emphasise theoretical

knowledge over practical application, leaving teachers unprepared for classroom implementation. Teachers reported receiving targeted professional development in play-based numeracy, with most relying on self-directed learning through online resources, peer networks, and trial-and-error experimentation. Three critical training deficiencies emerged: First, existing programs lack subject-specific content, focusing on general play pedagogy rather than pre-number applications. Second, professional development opportunities are infrequent, geographically inaccessible, and often irrelevant to local classroom contexts. Third, the absence of hands-on practice during training creates a theory-practice gap, with teachers struggling to translate concepts into effective instruction. Teachers compensate through remarkable resourcefulness, adapting traditional games, using local materials, and creating informal learning networks, but desire structured, ongoing support.

The final objective of the study was to identify the strategies available to teachers in using play in teaching pre-number activities at early childhood centres in the Berekum Municipality. The key findings were that:

The study identified five key play-based approaches used by teachers: First, teachers incorporate physical movement through activities like hopping to numbered mats, number races, and action-based counting games. These kinesthetic approaches help children embody numerical concepts while engaging their natural energy. Second, educators use manipulatives and concrete objects such as blocks, beads, puzzles, and natural items like stones to make abstract number concepts tangible, developing skills in counting, grouping, and one-to-one correspondence. Third, storytelling and role play contextualise numerical concepts through scenarios like farm stories, puppet characters, and pretend shops, making numbers meaningful and relatable to children's experiences. Fourth, group activities and peer learning foster mathematical dialogue through team

counting games, scavenger hunts, and comparative quantity tasks, allowing children to learn from diverse thinking strategies. Finally, teachers utilise music and counting songs with associated movements to capitalise on the mnemonic benefits of rhythm, creating multisensory learning experiences.

5.3 Conclusion

This study examined the strategies employed by teachers in the Berekum Municipality for using play to teach pre-number activities in early childhood centres. The findings reveal a rich tapestry of play-based pedagogical approaches that effectively transform abstract numerical concepts into concrete, engaging learning experiences. Teachers in the study demonstrated remarkable creativity in implementing five key play-based strategies: physical movement activities, manipulatives and concrete objects, storytelling and role play, group activities and peer learning, and music and songs. These approaches align with contemporary early childhood education research, which emphasises the importance of active, multisensory learning experiences for young children's mathematical development.

The study highlights how physical movement, through activities like hopping to numbered mats and number races, enables children to embody numerical concepts while channelling their natural energy. Similarly, manipulatives such as blocks, beads, and natural objects make abstract number concepts tangible, developing foundational skills in counting, grouping, and one-to-one correspondence. Storytelling and role play contextualize numbers within meaningful scenarios, while group activities foster mathematical dialogue and expose children to diverse thinking strategies. The integration of music and counting songs capitalises on rhythm's mnemonic benefits, creating multisensory learning experiences.

Despite these innovative practices, the study revealed significant challenges. Many teachers lack specialised training in play-based numeracy instruction, with professional development opportunities being infrequent and often disconnected from classroom realities. Resource constraints and inadequate space further hinder optimal implementation. Nevertheless, teachers demonstrate remarkable resourcefulness, adapting traditional games, using locally available materials, and creating informal learning networks.

These findings highlight the need for targeted professional development that bridges theory and practice, particularly in pre-number applications. Educational institutions should provide more structured, ongoing support for teachers, including increased access to appropriate resources and training opportunities that reflect local classroom contexts. The study confirms that play-based approaches not only enhance children's mathematical understanding but also promote holistic development, fostering social-emotional growth, language skills, and physical coordination. By creating low-pressure environments where children learn through exploration and discovery, teachers can make pre-number instruction more engaging, inclusive, and effective, laying a strong foundation for future mathematical learning.

5.4 Recommendations

In light of the findings and conclusions of the study, the following four recommendations are proposed, each aligned with one of the study's objectives and directed to the Education Directorate of the Berekum Municipality for implementation and policy action:

The Education Directorate of the Berekum Municipality should organise regular school-based workshops and demonstration lessons on the effective use of play-based

strategies in teaching pre-number concepts. These sessions should focus on practical techniques such as kinesthetic games, storytelling, manipulatives, and music-based activities to help teachers translate abstract numeracy ideas into concrete learning experiences.

The Education Directorate of the Berekum Municipality should create open forums or dialogue platforms where early childhood educators can share their perspectives, challenges, and best practices related to play-based instruction. These platforms will help the directorate understand classroom realities and design context-appropriate support systems to promote play in teaching foundational mathematics.

The Education Directorate of the Berekum Municipality should collaborate with teacher training institutions and the Ghana Education Service to design targeted in-service training programmes that focus on integrating play into early numeracy teaching. These programmes should prioritise hands-on practice, contextual relevance, and continuous professional support for all early childhood teachers in the municipality.

The Education Directorate of the Berekum Municipality should work with schools to develop resource banks of culturally relevant teaching and play materials made from locally available items. They should also provide guidance and supervision on classroom organisation, creation of learning centres, and use of outdoor environments to ensure teachers can implement play-based strategies effectively and consistently.

5.5 Suggestions for Further Studies

A further study should conduct a longitudinal study tracking children from early childhood centres in Berekum Municipality through their primary education. Also, studies should focus on cultural adaptation and the effectiveness of indigenous play methods for pre-number concept development.

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APPENDICES

APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF EARLY CHILDHOOD EDUCATION
INTERVIEW GUIDE FOR TEACHERS

Semi-Structured Interview Guide for Early Childhood Teachers

Dear Sir/Madam,

This interview guide is meant to collect data for a study being conducted by Cynthia Herdrita Amfo, a student from the above-mentioned University in connection with a

MASTER OF PHILOSOPHY (Early Childhood) thesis titled "**Teachers' use of play in teaching pre-number activities in early childhood centres in the Berekum Municipality, Ghana".**

The information you provide will help the researcher, the management of Early Childhood Education, and other stakeholders in education to better understand the extent to which teachers use play in teaching pre-number activities in early childhood centres to provide data for improving the situation. You are assured that the information you provide will be given the utmost confidentiality, in addition to non-disclosure of your identity should the data be published. Taking part in this study is, however, voluntary. Thank you.

SECTION A: DEMOGRAPHICS

Sex: Male [ ] Female [ ]

Age-group: 20-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ]

Qualification: Diploma [ ] Degree [ ] Masters [ ]

Years of Experience: Less than 5 years [ ] 5-10 years [ ] 10 years or more [ ]

SECTION B

OBJECTIVE ONE: How do teachers use play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

1. How do you integrate play into your teaching of pre-number concepts, and what specific activities have you found most effective in helping children grasp numeracy skills?
2. Can you describe how you organise your classroom to support play-based learning? How do you balance structured activities with child-led exploration?
3. In what ways do you incorporate local or cultural resources (e.g., traditional games, everyday materials) into numeracy activities? How does this impact children's engagement and learning?
4. How do you facilitate learning during play sessions? Could you share an example of how you guide children's thinking without disrupting their play?
5. How do you adapt play-based activities to meet the diverse needs of learners, such as children with varying abilities, language barriers, or learning styles?
6. Can you share a challenge you've faced in implementing play-based numeracy instruction and how you addressed it?

OBJECTIVE TWO: What are the views of teachers on the use of play in teaching pre-number activities at the early childhood centres in the Berekum Municipality?

1. Can you describe a specific play-based activity you have used to teach counting or sorting, and how it helped children grasp the concept better than traditional instruction?"
2. Could you share an example where a game or playful activity significantly increased participation, especially among reluctant or struggling learners?"

3. "Beyond numeracy skills, how have you observed play contributing to children's social, emotional, or physical development? Can you give an example where a math-related play activity also strengthened other skills?"
4. What barriers have you encountered, and how have you adapted to still provide meaningful play experiences for your students?"
5. "How do you incorporate local or culturally familiar materials (e.g., traditional games, everyday objects) into numeracy play? Can you share an example where this approach helped children connect learning to their real-life experiences?"
6. "Have you noticed specific improvements in children's numeracy skills after using play-based methods? Could you describe a situation where a child's understanding of numbers visibly improved due to a playful activity?"

OBJECTIVE THREE: What is the training level of teachers in use of play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

1. Can you describe how your initial training prepared (or failed to prepare) you to teach pre-number concepts through play? What key elements were missing?"
2. What opportunities for professional development have you had since becoming a teacher? How accessible or relevant were they to your classroom needs?"
3. Can you share how you've independently developed your play-based teaching skills? What resources or strategies have been most helpful?"
4. Can you give an example of a play-based concept you learned in theory but struggled to implement in the classroom? How did you overcome this gap?"
5. How does your school facilitate knowledge-sharing among teachers about play-based methods? Could you describe a time when peer advice significantly improved your approach?"

6. "Based on your experiences, what changes would you recommend to teacher training programs or professional development workshops to better prepare educators for play-based numeracy instruction?"

OBJECTIVE FOUR: What strategies are available to teachers for using play in teaching pre-number activities at early childhood centres in the Berekum Municipality?

1. Could you describe how these kinesthetic approaches help children understand number concepts differently than more sedentary methods? What improvements have you observed in children's number recognition through these activities?"
2. Can you share a specific example of how using manipulatives helped a child (or group) grasp a challenging numeracy concept? How do you select which materials to use for different number concepts?"
3. How do you design these narrative experiences to effectively incorporate mathematical concepts? Could you describe a particularly successful role-play scenario that reinforced number skills?"
4. How do you structure peer learning activities to ensure all children remain engaged with the numeracy content? What challenges have you faced with group-based number games, and how have you addressed them?"
5. How do you adapt or create number songs to match your students' developmental levels? What specific benefits have you noticed from combining music with numeracy instruction compared to other methods?"
6. Could you describe how you combine multiple strategies in a single lesson? What considerations guide your decisions about which strategies to combine?