EXPLORING THE PRACTICE OF SUPPORTING EARLY CHILDHOOD STUDENTS' NUMERACY SKILLS THROUGH COLLABORATIVE LEARNING IN WORKING GROUP ACTIVITIES

A Thesis

Submitted to the Master's Study Program of Education at the Faculty of Education in partial fulfillment of the requirements for the degree of

Master of Arts (M.A.)

by:

Nafisah

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UNIVERSITAS ISLAM INTERNASIONAL INDONESIA

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ABSTRACT

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Collaborative learning has been increasingly recognized as an optimal pedagogical strategy to support early numeracy development. This study explores the application of collaborative learning in early numeracy education at the kindergarten level in Indonesia an area that remains relatively under-researched. Using a qualitative approach, data were collected through classroom observations, analysis of student work and teacher interviews. This research shows that there are three key elements to successful collaborative numeracy learning which are: students' interdependence, peer support (scaffolding), and mathematical dialogue. These features reflect how active engagement and purposeful interaction within student group work can foster the successful accomplishment of numeracy tasks. Conversely, minimal collaboration in groups tends to result suboptimal numeracy outcomes, as seen in numbered LEGO sequence the result of student work was failed to follow number order. There are enablers and challenges have also distinguished in implementing optimal collaborative numeracy learning it is as the key enablers which included effective group dynamics and the use of concrete media, which supported visual and manipulative understanding of mathematical concepts. On the other hand, challenges involved instructional constraints, difficulties in group formation, and the complexity of monitoring and assessing student engagement and learning progress. These outcomes reveal important findings of effective dynamics for early childhood numeracy teaching in collaborative learning dynamics and the importance of specific collaborative numeracy instruction, teacher's roles and instructional design in maintaining systematic teaching to optimize collaborative learning and mathematical development for early learners in kindergarten settings.

Keywords: *Collaborative Learning, Numeracy Skills, Early Childhood Education, Kindergarten, Early Childhood Student.*

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ABBREVIATION DIRECTORY

ACARA	: *Australian Curriculum, Assessment and Reporting Authority*
PISA	: *Programme for International Student Assessment*
KEMENDIKBUD	: *Kementerian Pendidikan dan Kebudayaan*

CHAPTER I

INTRODUCTION

In the beginning of the introduction explains the conceptual and empirical foundations underpinning this research, emphasizing the significance of numeracy learning in early childhood education within the Indonesian context and the potential of collaborative learning as an effective pedagogical strategy for early childhood students.

1.1. Research Background

Numeracy learning at early childhood level is one of the main focuses in Indonesian curriculum. By definition, numeracy refers to a central concept of early perception, processing, and reasoning about numbers and understand how numerical can be used in everyday activities. In an effort to improve the quality of children's understanding in mathematics, Indonesian Government through the Merdeka curriculum emphasizes the key priority of numeracy learning at the basic level by placing numeracy as the main component that must be studied begin in early childhood (Wardhani et al., 2021). Early numeracy learning aims to develop number and mathematics skills in kindergarten as early as possible (Morsanyi et al., 2024). Mathematics ability that can shaped from the numeracy mastery in children stage of academic development, impacted numeracy skills as a crucial factor in determining children academic success in their future study (Pham et al., 2025).

As numeracy skills are widely acknowledged to play a pivotal role in shaping children's long-term learning trajectories, Seitz and Weinert (2022) highlights the role of early numeracy skills in preschool children as a predictor of mathematical competence such as the ability to count and compare quantities, significantly predict mathematics achievement in the early years of school. Evidence consistently shows that strong early numeracy skills are highly correlated with success across a wide range of academic areas, highlighting the broad influence of mathematical understanding (Clements et al., 2024). Furthermore, the development of mathematical reasoning skills extends beyond theoretical applications and is effectively transferred to problem-solving ability in a variety of real-world contexts and aspects of life (Fawcett & Garton, 2005).

In children's cognitive development, numeracy skills are fundamental skills that play a crucial role in problem-solving, both inside and outside of school. For instance, a literature study by Guhl (2019) has stated that early numeracy skills have a significant impact on students' academic abilities at the elementary school level, as stated in the research those mathematical skills included how to operate numerical operations, which

help to foster logical thinking and problem-solving skills, such as time management, understanding the concept of money, and interpreting data. Those skills also linked to solving complex life problems in the 21st century (Geiger et al., 2015).

The development of numeracy in Indonesia is one of the main concerns in the field of education, considering that numeracy skills are one of the important aspects in preparing the younger generation to face challenges in the era of globalization and the industrial revolution 4.0 (Azmi et al., 2024). In the context of early childhood education in Indonesia, the development of numeracy skills remains a critical concern, as reflected in national assessments. For example, the *Asesmen Nasional* Arsani and Mahayukti (2023) revealed that a significant proportion of students struggle with applying numeracy concepts in real-life contexts, indicating a gap not only in procedural understanding but also in reasoning and as problem-solving abilities. Numeracy is not only limited to basic mathematics or counting skills, but also includes skills in understanding, analyzing and solving problems related to numbers, data, and information (Gashaj et al., 2023). Therefore, numeracy development in Indonesia is closely linked to efforts to improve the quality of education oriented toward providing 21st-century skills (Kawuryan et al., 2021).

Several strategies have proven effective in supporting early childhood numeracy development, due to the complicated nature of mathematical learning (Onoshakpokaiye, 2023). Among them, play-based learning is very popular and most widely used in early childhood education settings. It takes advantage of children's natural curiosity and engagement in a playful way and consistently proves to have positive results in gaining basic mathematical concepts through exploration and discovery (Gianan, 2025). Similarly, manipulative-based learning, where children directly engage with objects to represent mathematical ideas, has been discovered to facilitate understanding and improve children's engagement (Laski et al., 2015). Furthermore, technology-based learning, through digital tools and interactive media such as game-based software and augmented reality, offers interactive and customized experiences that can significantly contribute to numeracy skills and engagement (Liu et al., 2024). While the above strategies have proven academically appropriate to children's cognitive development, children's developmental stages aim not only at cognitive development but also at social development (Acharya et al., 2024).

Collaborative learning is a highly recommended educational strategy for contemporary classrooms, shifting the pedagogical focus toward interactive and socially-based educational experiences (Dovigo, 2016). In the Indonesian context, collaborative learning is not only a pedagogical method, but also a core social attitude in accordance with the national vision of developing the Pancasila Student Profile, which emphasizes

teamwork, mutual respect, and civic responsibility as important competencies that must be cultivated from an early age (Kemendikbudristek, 2021). This emphasis is progressively integrated into education policies and curriculum frameworks, which promote social learning and peer interaction as crucial components of quality learning in this 21st century (OECD, 2006). Research evidence consistently supporting collaborative approaches, demonstrating their efficacy in fostering increased student engagement, enhancing motivation, and leading to deeper conceptual understanding across a range of subjects, including mathematics (Douglas & Rittle-Johnson, 2024). Furthermore, there is clear recognition that developing 21st-century skills requires the ability to collaborate effectively with others, communicate complex ideas, and articulate mathematical thinking clearly, all of which are directly developed through collaborative learning environments (Hmelo-Silver et al., 2013).

Although collaborative learning has been widely promoted as a highly effective pedagogical strategy across various levels of education, its comprehensive implementation in early childhood numeracy remains very limited (Oktaviani, 2021). Numerous educators and researchers have analyzed the feasibility and practicality of implementing effective collaborative learning approaches with young learners, citing developmental considerations and potential challenges in managing group dynamics (O'Donnell & Hmelo-Silver, 2013). This creates a significant gap between theoretical advocacy for collaborative learning in early childhood education and its actual practical implementation in Indonesian Early Childhood Education settings Furthermore, the lack of specific guidance and clear, robust evidence regarding collaborative numeracy learning specifically designed for early childhood contexts hinders its wider adoption, leaving educators lacking the resources and clear frameworks to effectively integrate the approach into their daily teaching practices.

Most studies on the use of collaborative strategies to enhance mathematics skills have been conducted at the elementary and secondary levels. For example, Rahman and N.A.A.A (2022) emphasized the effectiveness of collaborative learning in improving mathematical understanding in elementary classrooms. Similarly, Horn (2012) observed notable improvements in attitudes and mathematical achievement among secondary students who engaged in collaborative learning. On the other hand, Sarama and Clements (2013), in their foundational work on early math learning, point out the dominance of individualistic approaches over social ones in early numeracy research. Another study found that research in early childhood education has heavily favored literacy over numeracy, highlighting the limited exploration of social and collaborative pedagogies in

early mathematics learning. This trend is often based on the assumption that kindergarten students lack the capacity for sustained, goal-oriented collaboration.

Perceived hindrances to the implementation of collaborative learning in early childhood numeracy are often attributed to developmental characteristics of early childhood, namely the phenomenon of egocentrism. According to Piaget's classic developmental theory, children in the preoperational stage, typically 2 to 7 years of age, exhibit difficulty taking the perspectives of others (Byrnes, 2020). It is this egocentric nature that leads to the assumption that early learners cannot effectively engage in collaborative learning activities because they attend more closely to their individual perspectives and cannot understand or integrate the contributions of others (Tudge & Rogoff, 2014). This long-standing developmental observation has been instrumental in promoting skepticism about the feasibility and effectiveness of collaborative learning in early childhood numeracy, inadvertently limiting its exploration and implementation in instructional practice (Fawcett & Garton, 2005).

Studies have demonstrated that guided interactions with peers can help children build collective mathematical knowledge through discussion, shared reasoning, and collective investigation (Rogoff, 1994; Clements & Sarama, 2013). Underestimating the collaborative potential of early childhood thus not only debilitates pedagogical innovation but also misses valuable possibilities to develop numeracy via socially mediated learning. Successful early childhood education needs to discern such developmental hurdles as possibilities and create learning environments that deliberately cultivate collaborative competencies in tandem with mathematical insight.

An experimental study by Fuchs et al. (2001) at the elementary and secondary levels showed that research on collaborative learning in mathematics generally focuses on two aspects: improving students' learning outcomes and implementing collaboration in solving mathematical problems. Several studies in early childhood education also support that strategies such as peer-assisted learning and social interaction are effective in building mathematical understanding (Clements, 2022; Hasan & Abdullah, 2023). However, there is little research exploring the key features of collaborative learning in supporting numeracy in early childhood. Therefore, this study aims to identify the key features of collaborative learning that contribute to numeracy learning in early childhood.

There are a number of studies that emphasize various activities in learning play an important role in supporting students' numeracy development. Research shows that experiences in the home environment, such as playing board games, playing cards, shopping, and cooking, have a significant contribution in helping children develop early

mathematics skills (Badzis, 2003). Before entering formal education, children have experienced early development in understanding mathematical concepts through everyday interactions. Furthermore, children's math skills develop through more structured mathematical processes at school (Louw & Claassens, 2024). Various learning activities that are systematically designed in the school environment play a role in strengthening the understanding of numeracy concepts and improving children's logical thinking skills.

Study by Miller (2018) and Benavides-Varela et al. (2016) showed that game-based collaborative activities have a significant contribution to children's numeracy development. In this activity, children work together in groups to understand mathematical concepts and solve problems interactively and enjoyably. In addition, another study revealed that the assisted performance approach applied by teachers in collaborative learning can improve interaction between students, allow sharing of ideas, and enrich their learning experiences. However, several previous studies have not deeply explored the mechanisms and processes underlying the effectiveness of collaborative learning in supporting numeracy development. Therefore, this study will further explore the mechanisms of collaborative processes in supporting numeracy learning in early childhood.

Several studies indicate that several factors act as enablers like resources and training, but hindered by limited skills, resources, and group dynamics in the implementation of collaborative learning (Ha Le et al., 2017; Kiviluoto et al., 2022). First, well-structured collaborative strategies designed by teachers can help students gain a deeper understanding of mathematics (Acharya, 2023). In this sense, the teacher's ability plays a crucial role in activating students' numeracy learning. To maximize its benefits, teachers need to create an equitable learning environment and select challenging tasks that encourage active participation and interaction among students (Horn, 2012; Iraola et al., 2024).

Second, the main problem lies in the teacher's ability to implement numeracy learning that includes limited mathematical knowledge and language skills, inadequate teaching time, and underestimation of learners' abilities (Gqoli et al., 2022). In addition, teachers struggle to create engaging learning environments and incorporate play into instruction. Effective collaborative learning for teachers requires structural, motivational, and sustainable features, addressing power differences and cultural issues (Liu et al., 2024).

However, the methods of teaching numeracy to kindergarten students are commonly conducted in an individual activity by doing exercises such as counting or solving problems with the least possible interaction with their classmates (Ilany & Ben-Yehuda, 2021). In this manner, the teaching technique allows students to practice and improve their numeracy

abilities, although it does not encourage the teaching of collaboration and communication skills that are indispensable in education and the future skills in working together (Dovigo, 2016). In addition, this way of teaching might not provide the students with the diverse and shared learning, collaboration, and the challenging experience that teamwork can bring, especially for students who have to manage more difficult mathematical problems.

Another significant challenge is to actually implement effective group-based activities in early childhood classrooms. Numerous prerequisites prevent the early childhood education environment from the proper use of collaborative teaching methods which in turn foster a child's numeracy development due to reasons such as inadequate teacher training, lack of resources, time constraints among others (Salminen et al., 2021). Besides, managing early learners in a group setting can have its intricacies, like it needs a balance between the children's different learning and ensuring that every child participates actively in the numeracy-oriented activities (Geiger, 2016). These challenges prevent the full potential of group-based collaboration learning in numeracy education (Dovigo, 2016).

This study intends to investigate how collaborative learning practices in supporting early childhood numeracy, focusing on teacher strategies and challenges, group dynamics, and how children perceived in collaborative numeracy learning processes. This research is expected to provide an empirical contribution to the development of numeracy learning in the form of group models that are more contextual, participatory, and appropriate to the developmental needs of early childhood. To address the identified gaps in the literature and advance understanding of collaborative learning in early childhood numeracy, this study seeks to investigate the following key questions.

1.2. Research Questions

The research background that has been presented is formed into three research questions of this study, which aims to support teaching and learning numeracy activities of early childhood students by using collaborative learning through group work activities.

1. What are the key features of collaborative learning in group work activities that could support the development of students' numeracy skills?
2. How does collaborative learning in group work activities support students' numeracy learning?
3. What are the enablers and challenges that early childhood educators face in orchestrating collaborative learning in group activities to support students' Numeracy learning?

1.3. Research Objectives

The research objectives created following the research questions above are:

1. To identify and explore the key features of collaborative learning that could support the development of students' numeracy skills.
2. To examine how collaborative learning supports students' numeracy learning.
3. To investigate the enablers and challenges early childhood educators face when orchestrating collaborative learning to support students' numeracy learning.

1.4. Significance of the Study

This study has both theoretical and practical significance for early childhood education in Indonesia. Theoretically, this research contributes to the growing body of research on collaborative learning by examining how this approach functions in early childhood class settings, where developmental characteristics such as egocentrism can influence early learners' ability to engage in collaborative problem-solving. By situating collaborative learning within the specific context of numeracy, this study offers a deeper understanding of how collaborative mechanisms support mathematical thinking at an early age. These insights can enrich theoretical discussions in developmental psychology and pedagogy.

Practically, this research provides evidence-based guidance for early childhood educators who wish to implement collaborative numeracy learning aligned with the national curriculum. By examining practical challenges faced by educators such as classroom management, uneven participation among children, and limited teacher training, this study offers insights into strategies for improving classroom practices and the design of group-based collaborative learning in numeracy instruction. These findings also have implications for teacher education and professional development programs, particularly in equipping teachers with the skills to foster meaningful collaboration in numeracy learning. In addition, this research supports education policymakers by highlighting areas requiring targeted support and curriculum refinement and enriching learning strategies that educators can use to strengthen early numeracy outcomes in kindergarten classrooms, specifically in Indonesia.

CHAPTER II

THEORETICAL FOUNDATION

This chapter discusses comprehensively about the conceptual basis underlying this research. This chapter aims to provide an understanding of the key concepts relevant to the research topic, as well as to identify the root causes underlying the need for research on supporting numeracy skills in early childhood students through collaborative learning activities in the classroom. As part of this discussion, a review of relevant literature to the topic will also be reviewed, which will help identify the gaps from the previous research.

2.1. Literature Review

Literature review in this study is important to see the root of the previous study and to enrich the information about the theories that support the objectives of this study about collaborative learning practices in kindergarten to support early childhood students' numeracy skills.

2.1.1. Numeracy Skills in Early Childhood Education

Cognitive development is conceptualized as a progressive and cumulative process where children gradually acquire the ability to comprehend, think, solve problems, retain information, and make decisions through continuous interaction with their surroundings and based on their experiences (Goswami, 2002). This process is greatly influenced by the child's age, environment, social interactions, and stimulation (Raghubar & Barnes, 2017). Numeracy skill is included as one of the fundamental components in children's cognitive development, which includes the ability to understand, use, and apply mathematical concepts in everyday life, and play an important role in children academic experiences (Clements & Sarama, 2013). As early childhood education becomes increasingly crucial stage of human development, understanding numeracy skills becomes more in-depth and urgent to be considered in the basic education curriculum (Bikić et al., 2024). As the lasting effects of early childhood education on academic achievement become more widely acknowledged, emphasizing numeracy is crucial for designing curricula that cater to the developmental requirements early learners (Clements & Sarama, 2013)

Seitz & Weinert (2022) argue that the foundation of numeracy developed earlier than is commonly believed, even the beginning of numeracy knowledge can appear in infancy. According to the research existed infants approximately six months old are able to distinguish between small quantities. They point out that early numerical understanding

can be strengthened through verbal interaction between children and more knowledge others such as parents.

The development of numeracy abilities in education cannot be separated from the development of mathematics itself. As early as ancient times, mathematics has been employed as a tool for other practical activities, such as trade, agriculture, and navigation (Bennison, 2016). In ancient Greece, mathematicians and philosophers such as Pythagoras and Euclid had already begun to build the foundation of mathematics that had relevance to human life (Decock, 2008). However, the notion of numeracy as a basic skill in children's education only began to develop systematically in the 20th century (Geiger et al., 2015).

In the field of early childhood mathematical education, Douglas H. Clements and Julie Sarama are quite eminent researchers whose extensive study provides a holistic understanding of numeracy development. Rather than a single definitive definition, their work is centered on numeracy as a fundamental capacity grounded in the realization of number magnitudes and relationships among them, which begins developing relatively early in a child's life (Clements & Sarama, 2023).

Central to their theoretical and empirical framework is the concept of learning trajectories, which delineates the typical developmental paths children follow in acquiring mathematical concepts, outlining specific goals, the progression of children's thinking, and corresponding instructional activities (Clements & Sarama, 2013). This perspective broadens the scope of early numeracy beyond mere counting to encompass a rich array of interconnected mathematical competencies. These include the crucial skills of subitizing (the instant recognition of small quantities, both perceptually and conceptually), robust spatial reasoning (interpreting and manipulating objects and their relationships in space), foundational geometric understanding, early measurement concepts, and nascent arithmetic and algebraic thinking (Clements & Sarama, 2023).

Clements and Sarama consistently highlight that while children possess innate mathematical abilities, their full numeracy development is significantly shaped by their experiences and opportunities to "mathematize" their world that is, to reflect on, represent, and formalize quantitative situations using mathematical tools and language. As a result, their research underscores the critical role of intentional teaching, the strategic use of concrete materials, and engaging, play-based activities in fostering a deep and comprehensive understanding of numeracy in early learners (Clements & Sarama, 2022).

At first, formal education was essentially a matter of learning to read and write. But during the 1950s to 1970s, with educational theory and cognitive psychology emerging, more emphasis was placed on the use of mathematics in child development (Piaget, 1964).

Jean Piaget, a developmental psychologist, suggested that children go through a series of sequential cognitive stages, including the sensorimotor, pre-operational, concrete operational, and finally formal operational stages (Oogarah-Pratap et al., 2020). In the chapter on concrete operations (between 7 and 11 years of age), children begin to develop the ability to think logically concerning things and ideas, including mathematically. This means that numeracy skills are developing alongside children's mental growth. In later decades, maths teaching grew to be more structured, and countries started developing curricula that focused on core maths at a young age, in the majority of countries, including the United States and the European countries, the importance of numeracy abilities has been increasingly highlighted, with an extension of the evidence showing that strong numeracy skills acquisition early in childhood as a result of substantial potential of math abilities in later life (Bennison, 2016).

Numeracy skills can be divided into two general categories: (1) basic numeracy skills, including understanding numbers and simple arithmetic, and (2) advanced numeracy skills, which tend to be closer to understanding more complex mathematical concepts such as geometry, statistics, and algebra (Chan & Scalise, 2022). Research-based evidence by Niza et al. (2023) revealed that numeracy skills can improve the decision-making skills of children in social and economic life. A longitudinal analysis of 85 students on numeracy skills during early years by Džumhur et al., (2022) revealed that such skills could predict overall test achievement during school life such as calculations in writing, sequences, and comparisons. This is in agreement with the correlation test conducted by Gashaj et al., (2023) among preschoolers. The findings of the study revealed that early numeracy abilities correlate with later mathematics achievement.

Teachers' intervention activities among children have been implemented to improve student numeracy. For example, meta-analysis by Charitaki et al., (2021) explored the effectiveness of early numeracy intervention among 3080 low-achieving children. The study analysis found that the intervention program had a moderate effect. Additionally, short-term intervention activities (1-9 sessions) also produced greater effects by emphasizing explicit instruction, corrective feedback, CRA (Concrete-Representational-Abstract), concrete props, visual representations, and one-to-one instruction.

Powell and Fuchs' (2012) study offers a thorough examination of early numeracy abilities in pupils with learning difficulties in mathematics. This research indicates that pupils with learning difficulties in mathematics tend to have impairments in early numeracy abilities, including number sense, numeracy skills, and numerical representation. This study highlights the fact that challenges with these early numeracy abilities could serve as

a good predictor of more complex mathematics difficulties in the later years of school. Early numerical abilities intervention is, therefore, crucial to prevent mathematics issues from becoming long term. Overall, this study provides insight into the importance of timely diagnosis and adequate treatment of students facing learning challenges in mathematics. Ultimately, a focus on early numerical abilities will help reduce the gap between students with and without learning difficulties and therefore increase their chances of success in mathematics in the future.

Actually, early numeracy skills can become crucial in determining the attitudes of children towards mathematics later on. Children who are exposed to enjoyable and encouraging mathematics learning at an early age develop more favorable attitudes towards mathematics when older (Cheng et al., 2024). Conversely, neglecting to provide proper numeracy teaching at an early age will result in children becoming insecure or alienated when it comes to studying math classes in school, which would in turn stifle the development of their academic abilities. Numeracy skills are all that much important at an early age because it is at this time that the child's brain has the ability to learn new things at a very high speed.

2.1.2. Collaborative Learning in Early Childhood Education

Collaborative learning is a well-known and established teaching model that utilizes the sociality of learning and allows children to learn collectively by interacting and collaborating through discussion, and collective problem-solving activity (Laal & Laal, 2012. In the early years, the approach allows children to work in a way that conforms to their developmental predisposition to engage socially and to explore, particularly in learning environments that foster peer-to-peer interaction and collaborative activity. Collaborative learning does not first depend on a teacher-directed instruction-first strategy; children are active participants in the development of meaning especially in fields such as early numeracy in which students must engage with abstract concepts underpinned by various representations and shared exploration.

Under a social constructivist lens, collaborative learning in mathematics provides valuable opportunities for young children to be in a space where the focus is on mathematical dialogue, hearing and describing varied methods, and elaborating ideas through the negotiation and reasoning processes with their peers. Dialogue is invaluable not only to reinforce conceptual understanding, but also for metacognitive processes including self-regulation, and reflection that foster the behaviors needed for life-long mathematical thinking (Webb et al., 2014). For example, while children attend to collaborative learning opportunities to calculate, measure, or spatially reason, they both

learn from peer mediation, and are challenged to carry out the articulation and rationale articulation of their thinking processes which are vital to developing greater understanding. In addition, cooperative learning encourages social-emotional learning competencies including turn-taking, listening, empathy, and conflict resolution which are key components of classroom participation and more broad developmental trajectories (Clements & Sarama, 2014).These competencies are often built within group-based numeracy activities and provide an opportunity for children to cement their cognitive and interactional skills simultaneously. Cooperative or collaborative learning must not be thought of as an add-on strategy, but as an essential pedagogical vehicle for supporting the development of early childhood numeracy within developmentally and socially appropriate means.

Collaborative learning is an educational method to teaching and learning that involves groups of students working together to solve a problem, accomplish a task, or create a product (Laal & Laal, 2012). Dovigo (2016) stated that collaborative learning is not the same as traditional classroom instruction. Within the context of the collaborative learning setting, the learners are subjected to social and emotional challenges as they listen to a variety of opinions and are forced to communicate and defend their own ideas regarding those perspectives (De Paula et al., 2024). According to the study by Peńeda (2023), the characteristics of collaborative learning is that students are able to engage in conversation with their classmates, present and defend their ideas, discuss a variety of opinions, examine various conceptual frameworks, and are actively engaged in the learning process when they are in a collaborative learning environment.

Collaborative learning in early childhood education involves a variety of interactive features that support children's cognitive and social development. Through planned play, children actively construct shared knowledge by coordinating actions and resolving social conflicts, which in turn strengthens their ability to self-regulate and interact with others (van Schaik, Leseman, & de Haan, 2017). The learners will not be able to rely exclusively on the framework provided by an expert or a text because they will begin to develop their own distinctive conceptual frameworks this way. Collaboration between peers in solving problems not only creates effective group dynamics but also contributes to individual development (Karakoç & Pekdoğan, 2024). Structured approaches such as the "buddy system," where children are paired to play, talk, and do activities together, strengthen social relationships and friendships (Siller & Ahmad, 2024). In this collaborative process, the role of teachers is more than just a teacher; they participate as learning partners who accompany and guide children's explorations (Loes, 2022).

Through the process of collaborative learning, students work together in groups to accomplish the shared objective of each idea (Le et al., 2018). Early childhood students nowadays are very familiar with technology and information, they have the potential to produce creative ideas and broad insights. This interaction is crucial for developing social skills and understanding diverse perspectives. Collaborative learning encourages students to work together towards a common goal, allowing them to exchange ideas and solve problems collectively, there are so many prominent research on collaborative learning in early mathematics, such as the studies by Dovigo (2016) and Fuchs et al. (2014), has been conducted in Western or specific Asian (e.g., China) educational systems. The findings may not be directly transferable to the unique cultural and pedagogical context of Indonesian kindergarten classrooms. This study addresses this limitation by using a qualitative approach to explore the specific dynamics within this under-researched setting. Many quantitative studies, focus on measuring the *outcomes* of collaborative learning interventions (e.g., test scores) rather than the *process* of collaboration itself. There is a scarcity of in-depth qualitative studies that examine *how* children interact, the nature of their mathematical dialogue, and the specific strategies they use to scaffold one another. Our study's qualitative methodology is specifically designed to fill this gap by providing a rich, descriptive account of these processes.

While Piaget's theory is widely cited, there is a lack of empirical research that specifically explores how teachers can mitigate egocentric limitations to facilitate effective collaboration in the preoperational stage. Our study directly investigates this by examining how structured, teacher-facilitated activities can enable collaboration even among children who are still in the egocentric phase of development. This approach is in line with the skills needed for success in the 21st century, which are often referred to as the 4Cs: creative thinking, critical thinking, communication, Innovation and collaboration (Rizaldi & Fatimah, 2024).

However, although the importance of these skills has been recognized, they have not been fully implemented in educational practice, especially in early childhood education. Teachers often only focus on teaching at lower cognitive levels, such as understanding (C1) and application (C3) (Rizaldi & Fatimah, 2024), resulting in a gap in the development of higher-order thinking skills. These ideas can be directed through collaborative learning, where students work together to solve problems. In this process, students not only learn to appreciate each other's perspectives, but also receive appropriate guidance from the teacher (Rizaldi & Fatimah, 2024). The students must develop these skills from an early age, due to their characteristics, they need to be able to interact collaboratively. However, early

childhood education often involves limited peer interaction, which is now increasingly influenced by technology advancement (Irham et al., 2022).

Therefore, collaborative learning plays an important role in teaching children to respect each other and interact with their peers, which in turn supports the development of social and cognitive skills. According to Van der Westhuize(2023), students who participated in a collaborative learning strategy demonstrated improved social skills, such as conflict resolution and communication, which are critical for effective learning and overall development. Salminen et al., (2021) claim that collaborative learning strategies can improve students' attitudes toward mathematics, leading to increased motivation and engagement (Peńeda, 2023).

Various studies have identified several main characteristics that have been used in collaborative learning to develop initial numeracy. This case study of Wood and Frid (2005) reports on the implementation of an inquiry style of numeracy in a multilevel early childhood center (ages 4-6) with a focus on teacher role and children's interaction. Unlike the traditional view of numeracy being simply the acquisition of arithmetic facts, this study uses a broad definition in which numeracy is the application of mathematics meaningfully and in context in day-to-day life, and with children involved in mathematical inquiry. The present case study provides rich insight into how collaborative pedagogy can be employed in early childhood mathematics environments. It emphasizes the employment of dialogue, scaffolding, and context exploration in supporting children in memorizing their numeracy facts, rather than repeating Math facts by rote.

The study is witnessed with an alteration in the role of the teacher from teacher only to learning facilitator, as a "mediating agent" and "co-thinker" with children. The study also demonstrated that carefully designed learning environments and language-rich discourse are critical in developing numeracy. Through the provision of deliberate mathematical instruments and contexts, children can be encouraged to organize and structure their minds to achieve profound understanding of numeracy. In Sufa et al.'s (2020) study clarifies cooperative skill stimulation methods. From the above study, two ways are suggested which include encouragement to undertake cooperative activities in solving math problems, activities selected including motor and sensory interaction with peers. This is consistent with Macmillan (2001) who posited that an open context and collaborative learning system has the ability to improve the engagement and awareness of children regarding numeracy. However, the collaborative learning process of specific tasks with the ability to develop students' numeracy learning still needs to be elaborated. Hence, this research will discuss in detail how collaborative learning in practice enhances early childhood students'

numeracy development. There have been various studies that have determined some major points of collaborative learning that help enhance early numeracy development.

These include dialogic interaction, peer scaffolding, joint problem-solving, and teacher mediation (Muhonen et al., 2016; Murphy et al., 2025; Nieminen et al., 2022). For example, Muhonen et al. (2016) emphasize the importance of inquiry settings facilitating children's engagement in mathematical dialogue and reasoning in context, while Sufa et al. (2020) highlight the importance of sensorimotor tasks facilitating joint problem-solving and peer communication. Murphy et al. (2025), on the other hand, is interested in the open-endedness of collaborative practices through which children are able to explore numeracy concepts in terms of open and meaningful discussion. Although all three studies confirm the value of interaction and teacher support, they differ in emphasis. Muhonen et al. (2016) highlight teacher-facilitator intervention within organized investigations; Murphy et al. (2025) emphasize the social and spatial dimensions of problem-solving; and Nieminen et al., 2022 suggests that collaborative learning is effective as a general principle, but its application has to be context-specific, in relation to children's ages, classroom settings, and cultures.

For the present study, these findings offer a useful foundation but also point to a gap: there is limited qualitative research that examines how collaboration unfolds in real-time among young children in Indonesia how they negotiate meaning, resolve disagreement, or rely on peer scaffolding in numeracy tasks. This research aims to address these limitations by exploring the processual and contextual nuances of collaborative learning in early numeracy, offering insights that are both theoretically grounded and practically relevant for educators in local settings. Table 2.1 below is the overview of the studies, in order to see the key findings and the limitation of the reviewed studies.

Table 2.1. *Detailed Findings of the Reviewed Studies*

Study	Key Focus/Methodology	Key Finding	Strengths Limitations
Muhonen et al. (2016)	Case study of an inquiry-based numeracy program for ages 4–6.	Emphasizes a shift in the teacher's role to a "mediating agent" and "co-thinker." Highlights the importance of dialogue and contextual exploration for deep	**Stregth :** Provides a detailed understanding of classroom dynamics in inquiry-based learning. Demonstrates the transformation of the teacher's role from instructor to facilitator.

		numeracy understanding.	Emphasizes the importance of dialogue, collaboration, and contextual exploration in numeracy. **Limitation:** There is no quantitative data to statistically measure effectiveness. The results are more descriptive and exploratory in nature, so generalization is limited.
Murphy et al. (2025)	Study on strategies to stimulate collaborative skills in children.	Recommends encouraging collaborative activities and utilizing motor and sensory interactions between peers to solve mathematical problems.	**Strength:** Provides a flexible, learner-autonomy-focused framework. **Limitation:** The study is more theoretical, lacking an in-depth empirical exploration of the process in a real classroom setting.
Nieminen et al. (2022)	Framework for collaborative learning in numeracy.	Argues that open-ended tasks and a teacher-as-mediator role increase children's interest and understanding of numeracy.	**Strength:** Provides a flexible, learner-autonomy-focused framework. **Limitation:** The study is more theoretical, lacking an in-depth empirical exploration of the process in a real classroom setting.

2.1.3. Collaborative Learning and Early Childhood Numeracy Development

Collaborative learning has gained traction as a potent pedagogy in early numeral education and in the development of early numeracy competence. Based on a sociocultural

theory, specifically on Vygotsky's Zone of Proximal Development (ZPD), collaborative learning sees children learning best through social interaction and guided participation with others who can include peers and adults (Vygotsky, 1978; Rogoff, 1994). Here then, the learning of numeracy is not one in which children are solely engaged in an individual activity, but it is one in which children can co-construct their learning while simultaneously exploring, reasoning, and negotiating mathematical ideas with each other.

Research shows that group learning situations have the potential to foster mathematical conversation, promote various strategies of solving a problem, and promote metacognitive thinking, all of which are necessary in the impacts of early childhood numeracy. Within groups or in pairs while sorting objects, measuring amounts of items, or comparing numbers - children will work through mathematics and learn conversational norms such as expressing their own ideas, listening to others, and modifying their ideas through discussion (Webb et al., 2014). These social processes can potentially advance conceptual understanding greater than individual or procedural acts. This would mean specific aspects of collaboration i.e. peer talk, problem solving together, and direct guidance from teachers were central to early childhood numeracy development in a particular classroom context.

Moreover, collaborative learning also serves some developmental needs of young children. Children aged 4–6 years are at a critical stage for developing social-emotional competencies such as cooperation, empathy, and respecting other's perspective, which can be nurtured alongside mathematical thinking in well-designed group activities (Vintere, 2018). Although children at this age are still egocentric (Piaget, 1964), carefully designed collaborative activities within adult scaffolding can help them increasingly attain more reciprocal and empathetic interaction (Vintere, 2018). These findings offer crucial insights into the manner in which developmentally appropriate collaborative frameworks can operate as enabling factors in learning numeracy. Based on the work of

In addition, group numeracy activities can reduce mathematics anxiety, which is often a product of perceived individual performance pressure and fear of mistakes. Collective learning settings, on the other hand, normalize effort, celebrate diverse thinking, and build a positive peer culture (Schwarz et al., 2021). For example, in this research this environment fosters risk-taking and provokes a positive emotional climate for mathematics learning, especially crucial in the first years when attitudes towards learning are still highly receptive (KarademiR & Akman 2020). This specifies emotional and affective facilitators of shared numeracy learning.

The general benefits of collaborative learning are also confirmed by evidence in primary education. A quasi-experimental study was conducted in Lahore Pakistan where they found that sixth-grade students who did collaborative mathematics instruction actually outperformed their peers engaged in traditional instruction, regardless of achievement level. They also had more positive attitudes about the subject of mathematics, including reductions in anxiety and increases in confidence. Even though this study was conducted with older children, it supports the potential for collaborative learning to influence cognitive and emotional numeracy outcomes, suggests a need to investigate the functioning of mechanisms similar to early childhood classrooms.

Finally, collaborative learning approaches to early childhood mathematics instruction benefit children by serving to develop a key competency in mathematics at the same time as it develops social and emotional learning that serves holistic learning. For all these reasons, collaboration is not an ancillary strategy, but a core approach in developmentally appropriate numeracy pedagogy. In spite of this, there is a knowledge gap concerning the specific classroom mechanisms, teacher roles, and contextual constraints that shape collaborative numeracy learning in early childhood gaps.

2.2. Theoretical Framework

This theoretical framework provides the conceptual foundation to understand how collaborative learning can be used in early childhood development of numeracy in the Indonesian educational system. This framework integrates three constructively enriching theoretical perspectives: social constructivist learning theory, collaborative learning theory, and early childhood development theory. These theories collectively explain how young children acquire numeracy through collaborative task work and using social interaction as the media to extend their understanding.

2.2.1. Mathematical Learning Theories in Early Childhood Education

Understanding how young children learn mathematics is a question of learning about some theories that explain the development of mathematical ideas and thinking. Number development theory is one of the prominent perspectives, which proposes a hierarchical progression in children's learning about number ideas from the simple to complex, and from concrete experience to abstract understanding. Early mathematical cognition begins with innate number sense and is developed through experiences with concrete representations such as counting blocks of physical objects, fingers, or using blocks (Clements & Sarama, 2020). As children grow older, they gradually move towards more abstract thought, for instance, symbolic number recognition, mental calculation, and understanding of place

value. This sequence also involves the use of multiple representation systems like visual models, verbal explanations, written symbols, and real-world contexts which promote understanding and develop flexible mathematical thinking (Linder & Stegelin, 2011). The theory emphasizes that without a grasp of the previous stages like one-to-one correspondence, cardinality, and part-whole relationships, children can fail to comprehend later concepts like operations or number properties.

Developmental theorists have helped us understand the intellectual capacities of children, particularly in mathematics. In early childhood education, Piaget's constructivism has been a leading theory with regard to understanding how children build their own knowledge by interacting with the environment. Nugraha and Nuriadin (2025) confirmed that young children "build" their own knowledge through interactions with the environment. Further, the involvement of Vygotsky's social learning theory is also central to the investigation of how children learn mathematics (Kozulin, 2015). Further, according to Sufa et al. (2020) there are two early numeracy skills that are the competing theoretical foundations for later math development such as (1) counting, where babies are born with an innate ability for counting, and (2) comparison of quantities, where number sense develops through comparisons of quantities Extending the developmental theories of cognitive development in young children. To this, the problem-solving theory emphasizes mathematical thought processes underlying students' ability to access and solve mathematics problems.

More than procedural fluency, this theory values students' competence to interpret problems, devise strategies, and implement them adaptively. Young students begin developing strategy choice competencies, typically through trial and error, modeling, or guided exploration. Over time, they learn to choose successful strategies, monitor their progress, and change their approach if necessary. One of the main elements of this theory is metacognitive awareness the ability to think about one's own thinking, describe solutions, and recognize errors which fosters deeper conceptual insight and long-term mathematical resilience (Nieminen et al., 2022). During the early years, problem-solving capacity can be developed through open questions, investigative tasks, and group discussions that encourage reasoning and justification. These theories together provide us with essential understanding of children's achievement of mathematical knowledge: number development theory focuses on the structured unfolding of number concepts, and problem-solving theory focuses on the active, reflective processes whereby learners engage with mathematics in meaningful ways. Numeracy is one of the most important aspects of children's numeracy

development, that is, the ability to recognize and understand numbers or sizes through various representations and interactions (Raghubar & Barnes, 2017).

Some of the key concepts in early math education that kids must understand at the earliest stages of numeracy development include the concepts of the principle of non-symbolic manipulation, and symbolic representation are very critical in building a more complex understanding of numbers and basic mathematical operations (Clements & Sarama, 2013). An understanding of is one of the key foundations in children's numeracy development.

This principle demands that each item in the set being counted has to be paired with a different number, and each number has to be paired with a specific object. Research by Clements et al. (2023) revealed that the understanding of one-to-one correspondence is a very important early stage in the development of children's mathematics. Children who understand this concept can begin to count objects in a coherent and accurate way, which also supports a more advanced concept of numbers and mathematics (Newburger & Vaughan, 2006). As an example, when a child is counting a set of toys, they must be able to understand that each toy must have a different number, and that each number represents a specific object (Perso, 2011). This skill is the foundation for children's execution of arithmetic operations such as addition and subtraction. Additionally, the cardinality principle as the size of the further numeracy development is described as an understanding that the number of elements in the set does not change under the circumstances when the elements are rearranged.

To this point, the child who has grasped the principle of cardinality will be able to realize that even when he or she rearranges the items he or she is counting, the items he or she is counting are still the same numbers. The principle of cardinality was featured in a study by Pixner et al. (2018), and was determined to be an important step in the development of children's numerical learning, in which children learn not only to count objects, but also to understand the relationship between numbers and quantities represented in the count. For example, when counting five apples, when a child understands the five apples are in a different order or are in a different group of apples, the child should know that this is still five. This principle informs children that numbers are more than just a sequence of symbols but also represent a real quantity (Clements & Sarama, 2013).

Besides these concepts, one-to-one correspondence and the principle of cardinality, quantity manipulation can consist of non-symbolic manipulation meaning managing and comparing quantities without writing symbols (Björklund & Alkhede, 2017). Some of the fundamental activities in early numeracy development are direct interaction with quantities

in the form of observation and manipulation of physical objects (blocks, balls) by children. According to research by Aunio and Räsänen (2016) shows that children who engage in these numeracy activities, such as grouping objects or arranging objects in order, can strengthen their understanding of basic mathematical concepts, such as more, less, or the same. These also prove to form a good starting point towards being able to grasp the abstract concepts later on when they start learning the use of numbers in the form of symbols. The activities also allow children to acquire the observational skills and problem deducing capabilities they will require when confronted with a more complicated mathematical scenario. By grounding the research in developmental milestones and core mathematical concepts, the study aims to assess how learning environments and instructional strategies support or hinder the progression of early numeracy, ultimately informing more effective and developmentally appropriate teaching practices in early childhood education.

The development of early childhood numeracy skills serves as an essential foundation which builds the basis for mathematical understanding in later years (Gashaj et al., 2023). The development process happens mainly between infancy and preschool years when children explore numbers together with basic mathematical concepts through multiple activities (Clements & Sarama, 2013). Early childhood numeracy skills represent basic competencies which help students comprehend numerical operations and elementary mathematical principles and number relationships. The fundamental numerical abilities children develop from infancy through preschool serve as essential building blocks for their academic success in mathematics. Children from lower socioeconomic backgrounds tend to have weaker numerical knowledge because their daily environments provide fewer chances to interact with numbers. The initial stage of numeracy development begins when children identify basic numerical patterns and shapes (Chan & Scalise, 2022). The development of numerical understanding in children starts with the ability to distinguish basic quantities before developing into organized numerical comprehension (Clements & Sarama, 2013).

The infant stage (age 0-1) shows basic numeracy skill beginnings because children start to identify number sequences and basic shapes according to Nugraha and Nuriadin (2025) children demonstrate the ability to distinguish between limited quantities (two or three objects) and establish basic connections between counting words and their finger count together with other physical items (Besser et al., 2025). This initial understanding is important because it lays the foundation for the further development of numeracy skills that will emerge in subsequent stages. At the beginning of toddlerhood (ages 1 to 3 years),

children establish practical numeracy abilities. The children use numerical expressions to communicate their needs like requesting "two apples" or "three toys." During this period, children start to recognize object size differences between big and small while they perform grouping and classification tasks. Basic activities help children create essential cognitive abilities which later support their numerical and logical thinking capabilities (Clements & Sarama, 2016).

As children reach preschool age (3 to 5 years), their numeracy skills develop rapidly, with an emphasis on understanding spatial concepts and basic arithmetic skills. At this stage, they begin to master basic concepts such as simple counting and division (Aubrey & Godfrey, 2003). In addition, children begin to learn through everyday experiences, such as setting the dinner table or participating in games involving money and division, which allow them to understand basic mathematical relationships (Clements & Sarama, 2013), These experiences not only teach children numbers, but also enhance their ability to solve practical problems and develop more abstract mathematical skills (Aubrey & Godfrey, 2003).

Clements and Sarama (2013) identified four central themes influencing research of young children's numeracy development. As describe by Aubrey and Godfrey (2003) include: "(1) concepts act as tools,with both positive and negative implications for children's reasoning; (2) children's early concepts are not necessarily concrete or perceptually based even preschool children are capable of reasoning about non-obvious, subtle, and abstract concepts; (3) children's conceptual understanding varies across domains, individuals and tasks and (4) children's concepts reflect their emerging 'theories' about the world; to the extent that children's theories are inaccurate, their conceptions are also biased". In terms of actual activities with mathematical concepts, research has indicated that children have the capability to deal with numbers before they enter formal schooling (Clements & Sarama, 2016), and further, children learn foundational mathematical knowledge throughout infancy and the preschool years (Clements & Sarama, 2024). Between the ages of two and five years, children learn the system of number words in order to eventually connect the written numerals (i.e., graphic shapes) to verbal counting. Additionally, children develop the ability to "see" perceptual patterns (i.e., groups of manipulatives) before developing the ability to conceptualize imagined patterns. Very young children are also aware of the differences in small groups of items when individual items are either added or taken away.

Number sense and counting measured in preschool or kindergarten predict later elementary school math achievement test scores children who have difficulty counting tend

to have later difficulties in mathematics (Perso, 2011). One to one correspondence is one of the numeracy component according to the study by Clarke et al. (2000) as a foundational concepts that can be build, such as knowledge of numbers, allow for deeper understanding of more complex mathematical problems and flexible problem-solving techniques, conventional mathematical skills include the foundational skills of number such as counting, number facts, and base-ten structure and more advanced skills such as calculations and measurement (Missall et al., 2012).

Mathematical concepts and mathematical conventions are interrelated, but the direction of the relationship between them is the subject of much debate (Clements & Sarama, 2016). For example, children acquire the words of counting almost from the time they begin to speak but before they understand one-to-one correspondence, a conventional mathematics skill. At the same time, conventional units are key for a child's ability to represent quantity, and learning these math conventions might expand children's understanding of measurement (Baglici et al., 2010).

In summary, this study uses developmental and constructivist theories to explore how young learners develop early numeracy skills through collaborative, active exploration of numeracy. This study is rooted in the thinking of Piaget and Vygotsky and additional contemporary research on early mathematics development that concerns individual cognitive development and collaborative learning experiences. By focusing on the foundational number components of counting, quantity comparison and one-to-one correspondence in relation to each other, it provides a more holistic perspective on how young learners are involved in collaborative developmental ways to construct mathematical knowledge.

2.2.2. Collaborative Learning Approach

The history of collaborative learning began in the 1960s and 1970s, when cooperative learning also began, in which cooperation between students in the accomplishment of tasks was the main emphasis (Wherland, 2012). With notions such as those created by Lev Vygotsky with the invention of the Zone of Proximal Development (ZPD), and Jean Piaget who was of the view that learning was greatly reliant on social interaction, collaborative learning was increasingly considered a way of completely developing students' cognitive capacities (O'Donnell & Hmelo-Silver, 2013). Collaborative learning in this case not just improves the scholarly knowledge, but also communication and social skills (Mooney, 2013).

Collaborative learning is a practice where students engage in learning and working in small groups to solve issues, complete tasks, or achieve objectives. In contrast,

collaborative learning involves instructional use of small groups to help learners make effective team functioning strategies for enhancing learning outcomes (O'Donnell & Hmelo-Silver, 2013) Such strategies are not aimed at forcing homogeneity of thought and understanding, but at the process of co-exploring, finding out, and comprehending ideas through collective and collaborative means (). Thus, group work is a vehicle for uncovering differences and shared conceptualizations. This study applies this principle in tracking practices of early children to engage in numeracy work particularly in counting, sorting tasks in small groups. Thus, this theoretical framework enables the study to assess not just whether tasks are completed, but also how group process and interaction are able to support development of numeracy skills. Collaborative learning is commonly referred to as a pedagogical approach that promotes learning and socialization of students from kindergarten to the university level and even higher according to Laal and Laal, (2012) and is used very extensively throughout this volume and includes cooperative learning, peer learning and peer collaboration.

Since collaborative learning encourages socio-cognitive conflict when students are presented with contrasting opinions while operating in groups, it encourages them to challenge and reconceptualize their own thinking by embracing the ideas and perspectives of others (Van der Westhuizen, 2023). This process is different from the traditional learning method based on the teacher being the center of knowledge and the learners passive recipients (Babakr et al., 2019). By adopting collaborative learning, the learners become motivated and responsible for their own learning process, which enhances their comprehension of the material being taught.

As revealed through research done by Sufa and Setiawan (2025), cooperative learning has assisted in boosting student engagement in common learning experiences. For example, in a seminar on history, students who are involved in group discussions are more inclined to understand the subject content and examine discussion topics critically. This suggests that student interaction not only adds to their content knowledge, but is also contributing to their higher-order thinking skills. Collaborative pedagogy is a student-centered learning approach, as the research by Acharya et al. (2024) suggests, in place of the traditional teacher-centered approach with a more interactive structure. Through devices such as group work, debate, and collaborative problem-solving, this pedagogy enables active involvement of the students.

Multiple studies suggest that participatory learning is essential to enhance both understanding and recall of knowledge, and improve social skills development. Its advantages, i.e., peer-to-peer learning and active engagement, create an active classroom

atmosphere. Yet, pedagogical challenges exist for implementation ,especially in developing countries like Indonesia, ie, limited resources, teacher-centered culture, and overpopulation. Addressing these barriers requires broader teacher training and pedagogical cost, infrastructure support, and flexible pedagogy. In general, if well implemented, collaborative pedagogy can significantly improve learning quality and prepare students for real issues. Another study that elicits collaborative learning, quoted by Yang (2023), stated that collaborative learning is where the student can create conditions that can easily control the student-student boundaries, where they ought to be, and the teacher's role as a facilitator (Yang, 2023). In regard to this study, the concept is providing an initial insight into the manner in which teacher's role can be sufficient enough to evolve from being a direct trainer to that of facilitator having the ability to initiate a dialogue, cooperation and peer interaction. This shift is fundamental in early learning environments in which children are building their social identities and shaping their academic experience.

As technology and other forms of education have progressed, collaborative learning has been pushed to a very wide range of fields and remains relevant in contemporary education (Hamsah et al., 2024). It is not limited to the traditional classroom but also exists in various online learning environments where students can collaborate despite being located in different places (Beldarrain, 2006). As a learning methodology, collaborative learning is essential in preparing students for a more complex and interconnected world.

Constructivist theory is also depended upon by collaborative learning. Collaborative learning is a major aspect that is linked to constructivist theory. Collaborative learning is a scenario where students collaborate to solve problems or make sense of subjects, sharing their ideas and knowledge throughout the learning experience (Bada & Olusegun, 2015). During numeracy learning, group work gives learners a chance to discuss, problem-solve, and explain their thinking (Dovigo, 2016).

In groups, students learn not only from the teacher, they learn from each other while continually rechecking each other's learning. During collaborative learning, students can bring together their different ideas, they can provoke thinking (each other's), and they can help one other when they are unable to move forward. A joint learning process will give a deeper understanding of the numeracy concepts, chiefly because students will be called upon to verbalize their thinking and participate in mathematics in a shared context (Ramani & Brownell, 2014). This is in accordance with Vygotsky's social constructivist model, where learning is socially conducted within settings that promote higher cognitive development (Wherland, 2012). Studies on collaborative learning indicate that the method has a lot of benefits in both educational and social and interpersonal skills development.

There have been studies indicating that students who apply collaborative learning perform better academically compared to students who learn on their own. For instance, a study by Zisopoulou (2019) revealed that students who applied collaborative learning made great progress in terms of their academic performance. This is due to active learning that empowers students to support the material using discussion and solving of problems together. This is also supported by another research by Sufa et al. (2020), which shows collaborative models of learning can increase students' critical thinking and problem-solving skills as they take part in discussions that force them to critique information, make collective decisions, and offer grounds for arguments.

This interactive process enables students to engage in deeper learning and establish problem solving/rationality skills. Moreover, collaborative learning has been effective in developing students' social skills. According to Bada & Olusegun's (2015) findings, the students who engaged in collaborative learning acquires not only communication and collaboration skills, but also conflict resolution skills. Group interactions are prerequisites for students to learn to communicate effectively, listen to the opinions of others, and work together towards a common goal. It is important for students to develop these interpersonal skills because they will be necessary in an academic setting and increasingly coveted in the workplace. On this note, collaborative learning not only improves students' academic ability, but also prepares them to work effectively in a working environment that involves collaboration (Dovigo, 2016).

However, in order to achieve the effectiveness of collaborative learning, the role of facilitation that the teachers perform in coordinating the group dynamics and keeping all the learners active in the learning process is of utmost importance. In this, the role of the teacher too shifts from that of the chief instructor to that of a facilitator who helps learners grasp concepts and steer group discussions. A study pointed out that the teacher should be able to help learners solve problems in collaboration by posing tough questions as well as encourage deep thinking (Geiger, 2016). Having a proper role, educators are able to create an environment that is conducive to effective collaborative learning, such that students appreciate their input and feel empowered to contribute in group discussions. Collaborative learning theory improves critical thinking immensely through processes that promote active engagement, variance in opinions, and increased understanding among learners (O'Donnell & Hmelo-Silver, 2013).

Learning, according to Macmillan (2001), occurs within a social setting where individuals build their knowledge from the interactions with other individuals. Within the setting of collaboration, learners are actively engaged in discussions and problem-solving,

and they are thus required to articulate their ideas, support their opinions, and critically evaluate others' ideas (Schoor et al., 2015). In these interactions, students not only become responsible for their own learning, but also for the success of the group which intersects meaningfully with what they are learning. In addition, multicultural work groups provide learning contexts for students to engage with multiple perspectives and problem-solving methodologies.

When students engage with the diversity of perspectives in their cooperative groups, they are encouraged to better engage with and incorporate those different ideas. (Lin, 2015) claimed that learning experiences in cooperative groups help students become more critical thinkers because they have to analyze and assess information from other peoples perspectives, and then also demonstrate that they can integrate the information in their thinking and assessment of learning. Peer feedback also plays an important role in the cultivation of critical thinking skills within a collaborative work environment where students work together (Lowyck & Pöysä, 2001). As students provide feedback to their peers, challenge their reasoning, or suggest alternative solutions, they are encouraged to think logically more and deeper (Barrouillet, 2015).

This kind of interaction allows students to refine their thought process as well as form better arguments. According to Zisopoulou (2019), students who learn in groups possess greater abilities to develop analytical thinking than learners who learn in an individual manner, as they contribute to the group decision-making process. Through dialogue on efficient and inefficient techniques within group work, the students are able to evaluate their individual approaches to problem-solving. Huitt and Hummel (2003) explained that reflection on learning enhances the deeper comprehension of concepts and develops higher-order thinking in students. This reflective practice aids in developing metacognitive skills; these skills are at the centre of efficient critical thinking. Therefore, collaborative learning not only enhances conceptual understanding and builds cognitive knowledge, but it also develops in students critical thinking skills that are critical in every aspect of their life and studies.

Dovigo (2016) researched was confirmed collaborative learning promotes cognitive knowledge supporting communication and problem-solving skills for the workplace and society. Therefore, the implementation of collaborative learning methods in schools needs to be improved to produce individuals who can think critically and manage the complexities of the modern world. In cooperative learning contexts, decision-making processes, innovative solution development, and knowledge exchange are naturally presented. Therefore, this study places collaborative learning theory discussed above as the central

concept to know how students best learn when knowledge is interpersonally shared and actively built, thereby aligning education with the cognitive and interpersonal demands of 21st-century learning.

2.2.3. Social Constructivist Learning Theory in Numeracy Learning

Constructivism is a model of pedagogy that focuses on students' active participation in constructing their own knowledge and comprehension through direct experience (Bada & Olusegun, 2015). Constructivism posits that students build new knowledge from past experiences and interaction with the environment by actively engaging, and not by receiving and internalizing information (Kembubi, 2020). This model presumes learning as active interpretation of information rather than mere fact assimilation (Gilligan-Lee et al., 2023). Socio-constructivist teaching, based on Vygotskian theory address the fact that knowledge is constructed through social interaction, collaboration and problem-solving. In mathematics instruction this approach encourages richer concept understanding In mathematics instruction in this context, experiential learning in numeracy instruction matters since it enables students to work directly with mathematical concepts, deal with resources, and solve problems, thus fostering richer understanding through active inquiry (Kembubi, 2020).

One of the most prominent constructivist philosophers was Lev Vygotsky, a prominent Russian psychologist, who contributed highly to educational theory (Lourenço, 2012). Vygotsky's scholarship is key to the learning about children's thinking development, particularly in terms of social interaction and cultural surroundings (Tudge & Rogoff, 2014). He posited that learning is inherently a social activity, and intellectual development emanates as a result of contacts with other people who know more than oneself, for instance, teachers, peers, or relatives (Christy, 2013; Wherland, 2012). For Vygotsky, the Zone of Proximal Development (ZPD) is an important term that refers to the distance between what a child can accomplish independently and what they can accomplish with the assistance of one who is more knowledgeable (Tudge & Rogoff, 2014). Constructivism theory was traditionally developed and holds that learning is a constructive process by which people construct their own knowledge from experience and interaction with the environment.

Information in constructivism is not learned passively but constructed through the process of internalizing information being interpreted by the individual. Cognitive development occurs in four stages that are primarily sensorimotor (0–2 years), pre-operational (2–7 years), concrete operational (7–11 years), and formal operational (11 years and above) as cited by Piaget in a paper by Babakr et al., (2019). During the concrete

operational and the formal operational stages, humans begin to develop logical, abstract, and sequential thinking patterns, which serve as the basis for problem-solving learning (Oogarah-Pratap et al., 2020). Oogarah-Pratap et al., (2020) in one of their studies showed that group discussions, problem-solving together, and individual discovery are very effective in supporting the process of learning by constructivism. Another study explained by Mooney (2013), for example, in a class taking a constructivist approach, the teacher is no longer merely an information provider, but a facilitator of the environment who helps students to develop their own concept through interaction and discovery.

The core principle of constructivism consists of assimilation and accommodation. When people add fresh information to their current knowledge frameworks, they perform assimilation but when information contradicts their current understanding. They need to modify their frameworks through accommodation (Wahyudi et al., 2022). Students acquire fresh knowledge while refining their critical reflective thinking abilities which serve as fundamental elements for collaborative learning through this process.

Practical or hands-on activities in the learning of numeracy is highly correlated with the constructivism theory which stresses on real life experiences in developing numeracy knowledge. Introduced by Jean Piaget, this theory holds that children are active learners actively engaging their environments and building knowledge, by means of experience and reflection (Babakr et al., 2019). One of the main constructivism development theory contributor Vygotsky introduced a social component to the learning process by stating that a great impact on the cognitive development of the child after birth is made by the interaction with other people, in particular, adults or more advanced peers (Bada & Olusegun, 2015). Applied to learning numeracy, this form of pedagogy is particularly useful in arguing that children do not receive information about mathematical concepts passively, but they can develop an idea of what a number is, how shapes are constructed, what measurements entail by discussing these ideas and working with others in building structures out of blocks. Engaging children in numeracy learning by direct exploration and engagement in social interaction helps a child become more grounded and apt in the progression of the ideal development of his/her understanding of mathematics.

In contrast to the constructivism of Piaget, who focuses more on the inner processes within an individual, the theory of social constructivism, proposed by Mooney (2013) emphasizes that the process of learning is social and interactions with the surrounding people have significant influence on cognitive development of a person. According to this perspective, the learning process is carried out not only by individuals in their experience but also in the communication and cooperation process with other people, peers and more

experienced teachers (Van der Westhuizen, 2023). Zone of Proximal Development (ZPD) is one of the primary ideas of the social constructivism theory. The ZPD is the difference between the skills or the knowledge that a student can attain with the assistance of a more competent individual and the capabilities that the student would have otherwise (Blaschke, 2019). Vygotsky stated that students are capable of reaching greater levels of comprehension in their learning when guided properly in what is known as scaffolding than when each student is to learn alone (Vygotsky, 1978).

With regards to collaborative learning, the theory of social constructivism describes why group discussions and joint completion of tasks as well as instructions of the teachers or fellow learners are critical in enhancing student knowledge. When students collaborate in groups, they are able to assist one another, exchange thoughts and confront a line of thought. This will enable them to develop a stronger concept, as compared to when they would learn on their own (Mooney, 2013). It has also been noted in this theory that language and communication are very significant in the learning process. Vygotsky argues that language does not just serve as a communication process but it is also an instrument of thinking that enables the individual to organize and gain insight about new ideas (Hausfather, 1996). The process of collaborative learning based on discussion in the process of verbal interaction allows students to build critical thinking, receive information more effectively, and enhance the level of conceptual knowledge (Wahyudi et al., 2022). That is why, in this study the constructivist and social constructivist theories have been combined to understand not only how students can be actively engaged in the learning of numeracy but how that learning is intensified and supported into greater depth by focusing social interactions and guided participation.

Scaffolding mathematics as practice-based case study, drawn from a three-year school-based participatory research project, focuses on the role of scaffolding in early childhood mathematics collaboration. The research uses Vygotsky's sociocultural theory to examine how teachers and peers provide support during group work. In this study, teachers provided asynchronous scaffolding, such as guidance and reinforcement of learning steps, which then led to productive peer-supported synchronous learning.

This study notes that effective collaboration among young children may not occur naturally, and teachers often feel the need to provide clear and unambiguous instructions, especially to low-achieving children. The study argues that explicit instruction is not always sufficient to address delays in mathematics acquisition, particularly in children from low-income families. By utilizing adaptive strategies to foster collaboration in small group work, teachers can support and guide learning through collaborative problem-solving. In

this study, the use of manipulatives, such as wooden blocks to represent chocolate, plays a crucial mediating role in collaborative dialogue and shared learning within the groups. Manipulatives help bridge abstract mathematical ideas with physical representations, thereby facilitating verbal thinking and reasoning.

While collaborative learning has the potential to authentically engage students in mathematics learning, there is a tension between teacher autonomy and the need to meet predetermined curriculum objectives. This can lead teachers to use a more authoritative approach, which can reduce opportunities for students to interact with each other. Thus, this case study provides practice-based evidence of how productive interactions in small group work can act as a temporary scaffolding that helps children collectively construct mathematical understanding.

CHAPTER III

RESEARCH METHODOLOGY

This chapter demonstrates the research methodology used in the study. It begins with an elaboration of the qualitative approach that was used in this study, which encompasses the exploration of the research approach to be employed. The discussion followed by a detailed explanation of the case study design that is to be used during the research, the contextual framework in which the research will be situated, the identification of research subject, and the scope of the investigation. Ethical considerations are also addressed, particularly in relation to working with children and adherence to institutional and school regulations is emphasized.

The data collection process is then explained in detail, focusing on the systematic observations conducted to see how the practical integration of collaborative numeracy learning in group work activities, and the in-depth teacher interview process. To provide a clear understanding of how these diverse data sources were integrated and sequenced over time, a diagrammatic flow is presented (as proposed below), illustrating the phases of data collection and how findings from one method informed the next, thereby operationalizing triangulation. Finally, the chapter concludes with an explanation of the reflective thematic analysis used to interpret the collected data, ensuring a rigorous and insightful approach to understanding the research phenomenon. This integrated methodological approach aims to provide a rich, multi-faceted understanding of the research problem.

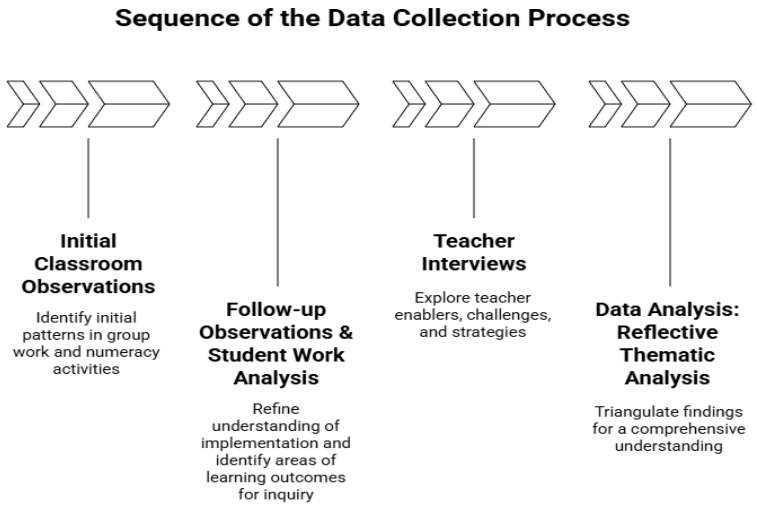

Figure 3.1. *Sequence of the Data Collection Process*

3.1. Research Approach

This sub-chapter explains the research approach that is used in this study. The qualitative approach is the most appropriate approach and was deemed the most suitable, as it offers particular advantages for investigating complex issues. It does not use random sampling since they seek to examine linkages and address problems that are difficult to quantify (Cresswell, 2013a). In addition, qualitative can give thorough vision about individual or groups experience by exploring how the participants' perspectives would give deeper insights into the study (Benaquisto & Given, 2008)

In this study in order to gain deeper investigation of the numeracy learning implementation, it involves collecting narrative information of the study by using the flexibility in data collection such as interviews, observations, and student work analysis. The narrative in this context of study is presenting in a chronological order of the stories and experiences (Yin, 2009), by explaining the experiences of the participants it allows to see the new insight of how they interpret their event through process of the experiment according to the study conducted by (Harrison et al., 2017).

3.2. Research Design

This research is using an exploratory case study design to align with its qualitative research approach. This design allows for an in-depth analysis of one or more cases, particularly within real-life educational settings (Cresswell, 2013b). The utility of case study design has gained considerable traction in the field of education, supported by its capacity for a thorough exploration of phenomena within diverse educational domains (Gillham, 2010)

More precisely, an exploratory case study is utilized to initiate an investigation aimed at understanding how a program or practice is implemented, thereby identifying the phenomena that occur (Swedberg, 2020). The primary of this design is to clarify and define the cases being studied and will provide new insight. This stage is carried out using the interview method to find out the teacher’s explanation related to how the implementation of collaborative learning has been carried out, aiming to dig deeper about the collaborative learning specifically in supporting early childhood students’ numeracy skills. By adopting this qualitative methodology, the researcher is able to describe current events comprehensively, including the intricate "how" and "why" behind social phenomena as they operate within specific classroom activities (Lewis, 2015)

3.3. Research Participant

The subject of this qualitative research consists of early childhood teachers and students. The researcher conducted a classroom observation in two different schools which are School Mars and School Pluto, focusing specifically on Class A and Class B levels. The selection of these two schools was intended to provide wider perspectives on how collaborative learning strategies are implemented across diverse educational context, allowing the researcher to capture variations in practice and outcomes of the data. In addition, the emphasis on A and B classes is due to their critical development stage, where foundational numeracy skills are introduced and where collaborative learning methods are particularly could be effective in fostering early cognitive and social development.

In addition, the participants of this study are teachers with specific criteria: they had minimum experience at least 3 years in teaching early childhood students and hold a bachelor degree majoring in education or in early childhood education. In addition, teachers have practiced substantial experiences in implementing collaborative teaching and learning. Under the teacher's guidance, numeracy learning in both school was frequently facilitated through classroom activities designed following the government learning outcomes outlined in the national curriculum standard and simultaneously being adapted to the contextual needs of individual school curricula.

3.4. Data Collection

This study aims to uncover how collaborative learning in classroom activities support early childhood students' numeracy skills. To address the objectives, this study is using three methods for collecting the data: classroom observation, student work analysis and semi-structured interviews.

First, classroom observations were conducted to identify what the features of collaborative teaching and learning practices are implemented in real-time. This includes the entire interaction between teachers and students, as well as the numeracy activities conducted. The second method involves examining students' work analysis (also with observation) to address how collaborative learning supports numeracy at early childhood. Third, semi-structured interviews were conducted with teachers to further investigate enablers and challenges faced by teachers to implement collaborative learning in early numeracy. Each technique of data collection is explained below.

3.4.1. Observation

Observation was utilised as a significant strategy of collecting the data to answer the first research question. This method was chosen because it allowed the researcher to gain a deeper understanding of participants' experiences within their natural learning environments. As stated by Gay et al., (2014) the utilisation of observation in this study proved to be extremely beneficial due to the fact that it enabled researchers to directly witness phenomena without being directly participating in the activities that took place. It is crucial to observe participants in a natural environment, free from researcher influence, to accurately capture their genuine behaviours and relationships.

The researcher visited the schools to observe and record what occurred without taking part in the activities conducted by the participants. The researcher works as a non-participant observer and does not engage in dialogue or participate in ongoing activities in classroom (Cresswell, 2013a). Instead, they observe from a strategic vantage point within the classroom setting. In this study, the researcher was positioned in a corner of the room, observing and recording the processes that unfolded during collaborative teaching and learning activities in numeracy lessons within kindergarten settings.

Within the scope of this investigation, observations were made regarding activities that include collaboration in the process of acquiring numeracy. Additionally, the researcher participated in the observation of the school and classroom environment, as well as the routines of classroom activities, the teaching performance of teachers, and the activities of students while they were learning. Consequently, these result observations provide a more comprehensive understanding of the dynamics of interactions that take place within the classroom as well as the manner in which learning activities are carried out in a context that is more natural and undistorted (Cohen et al., 2009). A natural social scenario possesses high validity in offering numerous contextual elements and enabling the collection of students action in collaborative numeracy activities (Johnson & Christensen, 2020). Additionally, it affords the possibility of capturing the components of physical, verbal, and nonverbal communication in situations that are occurring in real life.

The observation rubric was designed in ensuring systematic data collection and enhance the accuracy also consistency of observations, the rubric was specifically created to identify key features of collaborative learning in early numeracy instruction. Those characteristics detected included shared problem-solving, verbal exchanges of mathematical reasoning, peer scaffolding, role assignment within the group, and collaborative engagement in numeracy tasks. A structured observation rubric was used by the researcher the aim was able to reduce subjectivity in interpretation and ensure that

critical indicators of collaborative numeracy learning were consistently tracked across different classroom settings (Benaquisto & Given, 2008).

Besides the additional provisions of strengthening the validity and reliability of the observational data. The research incorporated triangulation procedures by collaborating with two PhD students in mathematics education who served as validators and observers. Introducing observational participants qualifies as triangulation procedures, which are common in qualitative studies when higher reliability statistics are desired or when one wishes to minimize observer feedback (Johnson & Christensen, 2020). Inter-rater reliability was calculated to assess the level of agreement between observers it was to ensure the consistency of observations in producing the result. This increased the validity of the identification how collaborative numeracy learning features was not exclusively dependent on a single researcher's perspective (Hollweck, 2015) significantly enhancing the credibility and confirmability of the observational findings.

During these observations as the primary researcher, I was consistently present during all classroom observation activities. I also took detailed notes and completed an observation checklist. However, it's important to emphasize that my observations and checklist result primarily served as a confirmation mechanism for the data collected by the two PhD students who served as independent observers. In actively preventing the researcher bias from influencing the findings, only the data gathered and validated by the two external observers were included in the final results and analysis.

3.4.2. Student Work Analysis

Student work analysis served as another crucial data collection technique in this study, specifically addressing the second research question. In particular, the present analysis is dedicated to the artefacts produced by students in course of collaborative numeracy activities, in essence. As Cohen et al. (2009) highlight, the qualitative analysis of such artefacts allows for a deeper understanding of the underlying processes, interpretation and learning outcomes relevant to the research focus In this regard, student-generated work offered substantive evidence of how learners collaboratively approached numeracy concepts. The qualitative method that is going to be applied to analyze and interpret existing students' documents in a manner that throws some light on the research questions and themes of the study. In that regard, the activities and work of the students provide highly useful data concerning the results of the instructional strategies adopted and the methods followed by the teachers in promoting numeracy acquisition. Furthermore, student work, complemented by teacher notes, serves as direct evidence regarding the outcomes of the shared numeracy learning process.

The analysis of student work enabled the study to identify key components in the content, structure, and progression that characterized the students' output. This form of analysis provides deeper understanding into how students' engagement in group learning situations influences their participations in numeracy activities. In analyzing student work demonstrate how peer interaction, collective problem-solving, and the process of constructing shared knowledge play a crucial role in developing numeracy understanding. This approach aligned with the constructivist perspective on education, which emphasizes active student participation and the importance role of collaboration in the learning process (Tudge & Rogoff, 2014).

Employing thematic analysis of students work samples in identifying shaped pattern from the result, recurring themes, and mismatches between planned and actual classroom activities. This serves as a source of information when considering a more complete exploration of how collaborative learning strategies and environments support students in constructing and demonstrating their understanding of their numeracy skills. This approach is also consistent with a qualitative methodology, where the role of context and meaning are prioritized in data reflection, rather than solely focusing on numerical values (Creswell, 2013).

3.4.3. Semi – Structured Interview

Semi-structured interview is one of the important parts of the data collection, this interview open-up the data validity in confirming the result of the observation and student work analysis (Cohen et al., 2009). There are four homeroom teachers who involved in the interview, the semi-structured interviewed was conducted after the teaching and learning activities finished. semi structured interviews are extensively applied as a qualitative research technique, it permits more open conversation and also exploration of the specific topics to discuss (Cohen et al., 2009). This method offers an advantage over structured and unstructured interviews because the researcher can keep controlling the focus of the conversation within the study while varying questions to probe emergent highlights further or clarifications on responses from participants (Ruslin et al., 2022). Therefore, flexibility is critical in eliciting such detailed experiences and perceptions, enablers and challenges that teachers face implementing collaborative learning between and among children in their numeracy development.

3.4.4. Collaborative Learning Elements and Early Numeracy Outcomes

There are three research instruments were used in this study (see Appendix). The instruments were developed by synthesizing key elements of collaborative learning and

numeracy skills from various journal sources and existing Indonesian curriculum standards for early childhood units. The two age groups into which they were classified are 4-5 years and 5-6 years old. This study derives its collaborative components from established theoretical perspectives on collaborative learning, especially those that underscore the importance of interaction, shared goals, and mutual support among learners. Numeracy skills were chosen by its importance to early childhood education and based on a match with Indonesian national curriculum standards. Below is the component used in the instruments to measure the teaching and learning activities. Table 3.1 presents a detailed mapping of these components and skills, which served as a reference during classroom observations and ensured that data collection remained systematic, consistent, and aligned with the study's research objectives.

Table 3.1. *The Details of the Collaborative Component and Numeracy Skills used in Collecting the Data*

Collaborative Learning Elements	Sharing idea and thoughts (LeJeune, 2003; Le et al., 2018) Listening Attentively (Le et al., 2018) Joint decision making (Le et al., 2018) Solving common tasks (LeJeune, 2003) Giving and receiving feedback (Le et al., 2018) Helping and supporting each other (Le et al., 2018 Group Reflection (Scoular, et al. 2020)
Numeracy Skills Outcomes	Demonstrate concepts of counting using everyday experiences (ACARA, nd). *(Counting)* Recognise the effects of adding to and taking away from a collection of objects (ACARA, nd). *(Counting)* Compare the number (many-few) of objects around them withou one-one correspondence (Standar & Kurikulum, Kemendikbud) ***(Counting)*** Demonstrate an understanding of one-to-one correspondence concrete objects **(One-to-one correspondence)** (Standar & Kurikulum, Kemendikbud, 2023)

	Understand that the last number mentioned indicates the num objects counted (Standar & Kurikulum, Kemendikbud, ***(Cardinality)***
	Connect and order numbers, numerals, and groups of objects using numbers up to two digits ***(Counting)*** Solve everyday addition and share stories. (ACARA, nd). ***(Counting)***
	Compare the number (many-few) of objects around them without using one-one correspondence (Standar & Kurikulum, Kemendikbud, 2023) ***(Counting)***
	Demonstrate an understanding of one-to-one correspondence using concrete objects **(One-to-one correspondence)** (Standar & Kurikulum, Kemendikbud, 2023)
	Understand that the last number mentioned indicates the number of objects counted (Standar & Kurikulum, Kemendikbud, 2023) ***(Cardinality)***

3.5. Data Analysis

There are several methods used in the process of analyzing the data collected from the conducted research in gaining a deeper understanding and getting the new perspective as the novelty of the study. To enhance the credibility and depth of the analysis, this study employed methodological triangulation by integrating and cross-analyzed data from three main sources: classroom observations, student work samples, and teacher interviews.

Each source offered a unique lens to understand collaborative numeracy practices in early childhood classrooms. Observational data provided real-time insight into student interactions and group dynamics; student work documented the outcomes of collaborative tasks; and teacher interviews offered reflective, contextual interpretations of the observed practices. The triangulation process involved comparing and contrasting themes and patterns that emerged across these data sets. For instance, moments of peer collaboration noted during observations were cross-verified with the nature and accuracy of the student work products. Similarly, teachers' explanations in interviews regarding group learning

strategies were compared with observational records to assess alignment or discrepancies. This cross-validation approach helped to reinforce findings that were consistently observed across sources and identify areas where interpretations needed refinement. Below is how the cross validation of the data collected.

Table 3.2. *The details of confirmation and validation of the data analysis process*

Collaborative Numeracy Detail	Observed in Classroom	Evident in Student Work	Discussed in Teacher Interviews
Peer explanation and helping	✓	Partially (shared annotations)	✓ (teachers mentioned pairing strategies)
Joint problem-solving	✓	✓ (co-created solutions)	✓ (teachers emphasized group tasks)
Verbal mathematical reasoning	✓	✗ (not always visible in work)	✓ (discussed as a goal)
Uneven participation or dominance	✓	✓ clearly reflected as low	✓ (teachers reflected on this issue)
Use of manipulatives collaboratively	✓	✓ (evidenced through placement patterns)	✓ (teachers address this as one of the important aspects)

Thematic analysis was used to detect recurring features and structures in the student's work, revealing how collaborative learning processes manifest and contribute to numeracy learning (Benaquisto & Given, 2008). In analyzing qualitative data obtained through semi-structured interviews, a thematic analysis approach was used. Interview data transcripts explained by identifying themes that emerged repeatedly in the conversation, which then summarized to provide a clearer understanding of educators' experiences and perspectives on collaborative numeracy learning, it was also uncover the perceptions, views, and factors that influence numeracy learning through collaborative methods in the context of this study (Ruslin et al., 2022). Then, data labeling (coding) was carried out on the interview transcript and creating themes according to the research question (Cresswell, 2015). Finally, Interpretation (making meaning) of the interview findings by discussing them with relevant theories (Cresswell, 2013b).

To enhance the credibility of the qualitative findings, this study employed a member-checking technique after the interviews. Immediately after the interviews concluded, the researcher reviewed the participants' answers by repeating a tentative summary and

highlighting the main points of the responses. During this stage, the researcher reaffirmed the initial interpretation of the participants' opinions, while also requesting confirmation or corrections if any statements did not align with the original intent. This practice aimed to ensure that the data interpretations accurately represented the participants' perspectives and experiences and minimized the potential for researcher bias. This member-checking process provided space for participants to reaffirm the meaning of their statements and strengthened the validity of the data used in the analysis.

All of these methods complement each other to provide a comprehensive picture of the actual key features of collaborative teaching and learning activities also student's how student may perceive in understanding numeracy concepts as Cresswell (2013a) recommended that qualitative analysis methods such as coding can help uncover themes related to numeracy lesson progress it is to analyze checklist of the documents more easily.

3.6. Ethical Consideration

In conducting research there is an ethical consideration that must be applied from the beginning of the research, along the process of collecting the data and up to the end of the research. It aims to protect the identity and personal information of participants who involved in the research. As a researcher who upholds the confidentiality of the identity of the participant who help in the process of the research, such as teachers and children who also involved, the researcher submitted a request for permission addressed to all parties involved in the research. Therefore, in protecting the privacy of children, the researcher prepared an official letter addressed to the school. The letter was provided to the school institution, as a representative of all participants who will be studied. The content of the letter to ask permission, giving them the information regarding the technical consideration of the study and ensuring the participants are willing to participate in the study within their consent and knowing their rights also plays a role in the process of data collection.

Once consent was obtained, the researcher implemented rigorous data management procedures to ensure that the confidentiality of all participants is protected throughout the study. One of the primary strategies employed was the anonymization of data. This involved the systematic removal or replacement of any identifiable information such as names, specific school identities or other personal details with pseudonyms. This measure is crucial to prevent the identification of participants in any subsequent reports, presentations, or publications derived from this research (Cohen et al., 2009).

CHAPTER IV

RESULT AND DISCUSSION

This chapter illustrates the research findings of the study by bringing up the discussion of the interrelated data from the obtained data of the study that has been conducted. Expressing the analysis of the data from the study is also part of the highlighted data, which explored how collaborative strategy through working group activities in numeracy learning support early childhood students' numeracy skills. The themes that emerged from the structured questions and indicators are used to discuss the findings. The study was done through case study where research started with the observation at four kindergarten classrooms in two schools. The study employed multiple data collection methods carried out in sequential stages to comprehensively capture the dynamics of collaborative numeracy learning in the classroom.

This study began with non-participatory classroom observation to identify collaborative features in numeracy learning between teachers and students which is intended to answer the first research questions ‘’what are the key features of collaborative learning in group work activities that could support the development of students' numeracy skills?’’ The observation was conducted without intervention, using indicators based on instruments of students' numeracy skills outcomes and key dimensions of collaborative learning (see Appendix 1). Furthermore, analysis of student work results was conducted to examine the contribution of collaborative learning to the development of numeracy skills of early childhood students through a systematic review of their assignments and group work which in the objectives to answer the second research questions ‘’How does collaborative learning in group work activities support students' numeracy learning?’’ Finally, semi- structured interviews with teachers were conducted to explore pedagogical practices, as well as supporting factors and barriers in the implementation of collaborative numeracy learning strategies which will answer the third research question’’ What are the enablers and challenges that early childhood educators face in orchestrating collaborative learning in group activities to support students' numeracy learning?’’.

This study was conducted as a field-based investigation involving four teachers as primary participants, besides students from four different classrooms, which served as the units of analysis. The participants consisted of two classes which are Class A level (ages 4–5) and two classes at the Class B level (ages 5–6), allowing for the collection of data that reflects collaborative numeracy learning practices across a diverse range of early childhood developmental stages.

The research employed a qualitative approach using a multi-site case study design, enabling an in-depth exploration of variations in collaborative numeracy practices across multiple classrooms. Throughout the data collection process, a total of 11 collaborative numeracy learning activities were documented in Table 4.1. Most classrooms implemented three distinct collaborative numeracy activities, with the exception of one class that conducted only two such activities. The variety in the number and types of activities provided rich insights into the implementation of collaborative numeracy strategies in each classroom. In the subsequent section, the results of these observations analyzed in detail to address the first research question, which focuses on identifying the forms of collaborative features that emerge during collaborative numeracy learning in the kindergarten classroom settings. These following sub-chapter presents the name of the activities conducted by the four different classes. .

Table 4. 1. *List of students' collaborative numeracy activities*

School	Class	Activities
School Mars	Class A	1. Pyramid construction according to the number order 2. Arranging number puzzle 3. Pasting college materials onto numbers
	Class B	4. Found number cards 5. Identifying missing numbers 6. Counting bottle caps
School Pluto	Class A	7. Arranging LEGO with number blocks 8. Building a store with blocks.
	Class B	9. Sorting numbers (1 to 20) using bottle caps 10. Building structure using wooden blocks 11. Counting the ball

4.1. Research Findings Questions 1: Key Features of Collaborative Learning in Group Work Activities Support Students' Numeracy Skills

Observations on collaborative numeracy learning revealed key features that serve as references in supporting early childhood students' numeracy skills. The features were obtained from thematic analysis of eight collaborative components (see Appendix 1) with varying levels of collaboration. Furthermore, observations were made by observing the group work process, student interactions, and how children completed numeracy tasks

together according to the stages of early age development. Based on the results, not all activities that have been applied meet the criteria of the eight collaborative components.

In addition, the observation results showed that some group activities still showed less optimal involvement in the concept of numeracy and low quality of collaboration between students. This can be seen from the way children interact during activities and how their numerical thinking skills are less actualized in the learning process. Although there are variations in implementation, this study has succeeded in identifying real manifestations of collaborative numeracy learning through observed student behavior and facilitation strategies carried out by teachers. Conceptually, these findings are formulated into three key features of collaborative learning based on group work that potentially support the development of early childhood numeracy skills. As shown in Figure 4.1.

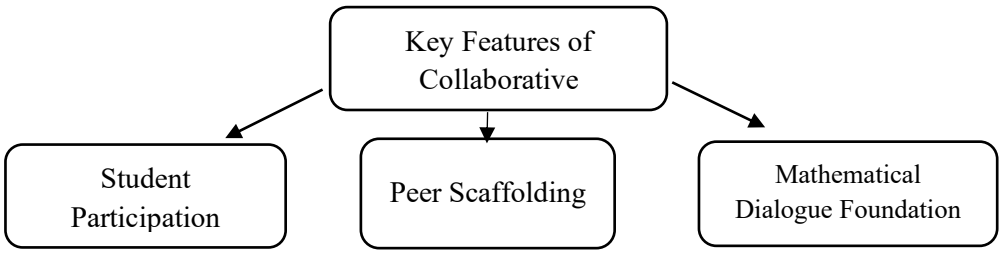

Figure 4. 1. *Key Features of Collaborative Numeracy Learning*

Based on the illustration above, three main findings that emerged from the collaborative numeracy learning practices between students will be described in the following sub-chapters based on the three main key features of collaborative learning that have been identified. Each finding is analyzed in depth with reference to actual implementation in the classroom and is reinforced through observation notes that reflect interactions between students and group dynamics during the activities. This approach allows for a more comprehensive understanding of how each characteristic contributes to the development of early childhood numeracy skills in the context of group-based learning.

Student Participation Through Interdependence

One of the main characteristics that emerged from the analysis of observation results in collaborative numeracy learning at the early childhood level is student participation through interdependence. This theme was formed based on thematic analysis of the observation data collected. This feature consists of three important elements that support each other, namely: active participation, democratic decision-making, and collective involvement. All three reflect the role of students who are not only active individually, but

also socially connected in the process of completing numeracy tasks with interdependence on each other, which is shown in Figure 4.2 below.

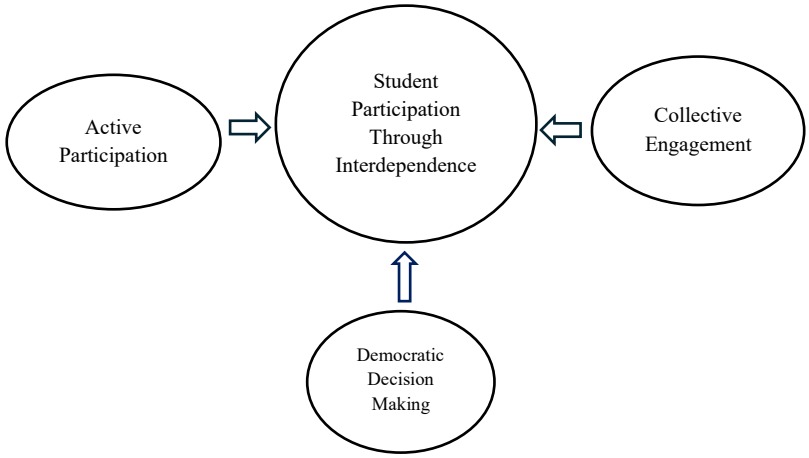

Figure 4.2. *M ap of the Elements of Collaborative Numeracy Feature*

In this subchapter, the researcher will explain the first element, namely active participation, a condition where students actively carry out activities in collaborative numeracy learning. Student activity here is more detailed in seeing how students actively contribute to discussions to complete numeracy tasks, the formation of active students with the emergence of discussions. Active participation that emerged in classroom learning that was observed, there was one activity that was very visible in the active participation element, which occurred at School Mars at class A. As one observer notes showed,

> *''The Number Pyramid activity strongly encourages students to actively participate, discuss, and contribute their ideas and actions within their groups to successfully complete the numeracy task'' - (Observer2)*

The quote from Observer 2 confirms that The Number Pyramid activity encourages active participation of students in the numeracy learning process. This participation is seen through the direct involvement of students in group discussions and concrete actions in completing tasks together. Through this activity, students are not only active individually but also show conducive dependence on each other (interdependence), such as asking each other questions, giving advice, and working in turns. This kind of interaction reflects that active participation built in a collaborative context contributes directly to the formation of mutually reinforcing cooperation in small groups, which is an important foundation in the development of early childhood numeracy.

The element of active participation also appears most prominently in several other activities, one of which is the activity of adding bottle caps based on the additional problem

given by the teacher. In this activity, the teacher divides students into small groups of two, then gives instructions to take bottle caps as many as the number shown in the problem. The children then count the total number and record the results. During the process, students show intense interaction. There is an exchange of information, active discussion, and cooperation in solving numeracy problems. This activity shows cognitive and social engagement simultaneously, where active participation goes hand in hand with interdependence between students, as also noted by Observer 2.

> *'' Pair activity is most engaging, group activity: Pair activity produces the most interaction or discussion between students'' - (Observer 2)*

The occurrence of student activity in discussing with their group mates depends on how active the numeracy task is carried out by the students. This is a determinant of how children can grow meaningful interaction dynamics, to build interdependence with group members. Meanwhile, there are several activities that do not generate active student participation in discussions, for example in the activity of building a shop from blocks, in this activity there is no discussion between students, as emphasized by the observer

> *'' Students were active in working with their numeracy tasks, however the tasks were designed for individual'' (Observer 2)*

The observer notes above show that the activity did not encourage interaction between students. The tasks given were designed to be done individually, even though students were physically placed in groups of three and in the same area. Because there were no directions or instructions that explicitly emphasized cooperation, discussion, or role-sharing, the situation did not produce meaningful interaction. As a result, there was no active participation in the collaborative context, and interdependence between students did not develop.

Collective decision-making is the second element that forms the framework of the student participation feature through interdependence in collaborative numeracy learning. This element emphasizes the importance of student involvement in determining mutually agreed steps to complete numeracy tasks. In the dynamics of collaborative activities, there is a growing dependency between students in determining the process and the final results of the tasks they work on in groups. This situation is evident in the Number Pyramid and Number Puzzle activities in class A, Mars School. In these two activities, students actively discuss and make joint decisions regarding the sequence of numbers and the accuracy of the results. As emphasized by Observer 1,

'' Joint decision-making was done by most students when confirming whether the pyramid was correctly arranged and the number puzzle was accurate''
– (Observer 1)

This condition also occurred in collaborative numeracy activities in Class B School Mars which was emphasized by the same observer with different kind of numeracy activities, as stated,

'' Joint decision-making was mostly observed when students ensured the number of bottle caps was correct'' - (Observer 1)

Observer 1's statement emphasized that no single student dominated the decision, but rather all group members were involved in the confirmation process together. This shows the existence of a mechanism for mutual checking and approving the steps taken, which is a characteristic of interdependence in collaboration.

Moving to the last element that creates a feature, which is collective engagement where children from all groups can actively engage with each other in completing numeracy tasks together, This involvement is not only individuals who are dominated by certain active individuals, this was highlighted by observers who noted that in Class B of Mars School, all students were actively involved in the activities carried out, as in the following statement,

''All activity formats (class, group, and pair) were structured around a collective task. Students were actively engaged and worked together to complete their assigned tasks'' - (Observer 2)

The observation notes above explain that students' ability to complete numeracy tasks collectively is a key indicator to assess the extent to which collaborative learning creates conditions for productive interdependence. Observation data show that when students are involved in solving problems together, their participation increases, interactions become more meaningful, and numeracy learning outcomes are achieved through a dialogic and collaborative process. This finding confirms that giving students similar tasks alone is not enough to build collaboration. When teachers do not encourage cooperation and the task structure does not require interaction between students, there is no

reason for them to depend on each other. The absence of this dependency emerges individual participation, not the collective one.

Based on the results that have been presented, it can be concluded that interdependence between students thrives when numeracy activities are designed as collective tasks not only in terms of form, but also from the demands of the completion process. When students are required to reach a joint solution, they involve each other in discussions, divide tasks, correct mistakes, and agree on results. In a context like this, Student Participation Through Interdependence is not just a pedagogical strategy but becomes a living learning principle in classroom practice.

On the other hand, when students work on the same task in parallel without interaction or cooperation, participation still occurs but is not socially connected. This shows that interdependence does not arise only because of physical togetherness, but because of the real need to work together in solving problems. Therefore, collective involvement in completing numeracy tasks is one of the most real forms of collaborative learning based on meaningful participation.

Peer Scaffolding

One of the main features of collaborative numeracy learning identified in this study is peer scaffolding, which is the result of the integration of several collaborative indicators. This feature reflects how students actively support each other in the learning process through social interaction. Peer scaffolding in this context is formed from three main roots, namely peer-to-peer responsiveness, peer feedback, and peer assistance in problem solving. The focus of this analysis is on the first element, namely peer-to-peer responsiveness, which refers to students' ability to listen, respond, and build ideas based on the contributions of their peers. As illustrated in Figure 4.3 below, these elements function collectively to represent how young learners not only participate actively in their own numeracy tasks but also contribute to the progress of their peers.

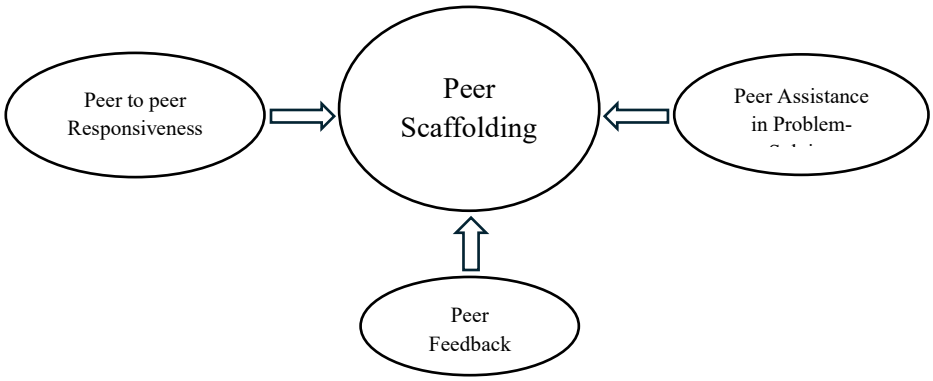

Figure 4. 3. *Map of the Elements of Collaborative Numeracy Feature*

Observational data showed that peer-to-peer responsiveness emerged consistently in various collaborative numeracy activities in both schools studied. In Class A School Mars, this engagement was strongly reflected in pyramid building and puzzle-assembling activities. One observer viewed,

> *''In the pyramid construction and puzzle activities, students paid attention to and responded well to their peers' opinions to complete the tasks correctly. -''(Observer 1)*

This kind of responsiveness shows active listening and willingness to consider friends' views, which are important prerequisites in creating interactions that support shared cognitive development. A similar phenomenon was also recorded in School Mars Class B, where students were actively involved in counting activities using bottle caps. In this activity, observers express,

> *''In the bottle cap counting activity, students responded to each other's ideas'' (Observer 1)*

> *''This was most evident during the pair activity, where a good discussion was established. In the group activities, students also listened to evaluate other students' answers.'' (Observer 2)*

The presence of peer-to-peer responsiveness is most prominently seen during pair activities, where meaningful discussions are built between students. In this context, children do not only share answers, but actively listen, respond, and build ideas based on peer input. This interaction shows that children are not only working side by side, but also actively building two-way communication that is relevant to the context of the task. Interestingly, the findings from the observations also showed that peer-to-peer responsiveness not only emerged in activities explicitly designed for collaboration but also occurred spontaneously in individual learning contexts. At the School Mars and Pluto, observers explained,

> *"Students themselves building their interaction and discuss with their classmates and giving their friends corrections,"(Observer 1)*

> *''Even with individual activity setups, most students took the initiative to actively discuss with their nearby classmates,''- (Observer 1)*

It shows that children naturally develop forms of reciprocal interaction without direct guidance from the teacher. Thus, responsiveness in the peer-to-peer context is not only social, but also cognitive, because children actively process and respond to information provided by their peers. In both pair and group activities, this element shows that collaboration does not only occur at the surface level but becomes the foundation of deeper and more meaningful numeracy learning.

Peer feedback is the second element that builds peer scaffolding into a collaborative key feature. Based on the results of observations in two schools, namely School Mars Class B and School Pluto Class B, it can be seen that peer feedback is an important element in forming peer scaffolding as one of the main features in collaborative numeracy learning. In School Mars Class B, peer feedback occurs explicitly, especially in pair activities, where students not only submit their answers, but also discuss and evaluate their friends' answers directly. This shows from observer notes,

> *''Students had the opportunity to evaluate other students' answers in both group and pair activities. This was particularly effective in the pair activity, where direct discussion was established'' (Observer 2)*

Meanwhile, in School Pluto Class B, peer feedback is manifested in the form of spontaneous conversations between students when they are doing the number sorting activity. In this context, students correct each other and help their friends find the correct numbers. This kind of interaction indicates that students are not only working side by side but are also active in providing input and strengthening their peers' understanding through joint correction and clarification. At the end of the activity, students even show a more complex form of collaboration by supporting each other and counting the balls together.

> *''The sorting number activities, there were seen the conversation among peers to correct each other and help their friends find the number, and the last activities they support and count together for the total ball that they have moved''(Observer 2)*

These findings support that peer feedback not only strengthens children's mathematical thinking skills but also strengthens social relations and a sense of shared responsibility in groups, which are essential in the collaborative numeracy learning process. This shows that peer feedback is not just about giving opinions, but also involves strategic

support and direct correction, which contributes to the achievement of both group and individual tasks.

Without the practice of giving and receiving feedback between peers, collaboration loses its reflective and dialogic dimension. More than just working together, collaborative numeracy learning requires situations where students can express ideas, receive feedback or correction, and also improve understanding through a shared process. Such interactions not only strengthen numeracy achievement, but also develop communication skills, critical thinking, and empathy, all 21st-century competencies that are important for early childhood.

However, these practices do not emerge automatically. They require the design of activities that are open to discussion, and the role of teachers as facilitators who encourage a culture of positive feedback. When these conditions are met, peer scaffolding can become a core feature that bridges numeracy learning and children's collaborative character building. In the context of collaborative numeracy learning in early childhood, assistance between students especially when facing difficulties in completing tasks is one important manifestation of peer scaffolding. This process occurs when students show initiative to support their friends' understanding through clarification, correction, or direct support during the activity

This observation emphasizes that the activity structure that allows two-way interaction directly contributes to the emergence of peer assistance. Collaborative activities not only encourage mechanical cooperation but also facilitate learning processes that occur in the zone of proximal development where more advanced students assist other students to understand numerical concepts more. Interestingly, peer assistance was also observed in the context of individual activities, indicating that peer scaffolding is not limited to explicit collaborative designs. As two observers stated

> *"Even with individual activity setups, most students took the initiative to actively help their nearby classmates."(Observer 1)*
> *"Most of the students took initiative to help their friends to correct the wrong answer of the number order."(Observer 2)*

This case suggests that students' social interactions can extend beyond the structural boundaries of activities. When students are accustomed to an environment that supports collaboration and dialogue, they will independently identify their peers' difficulties and offer assistance as part of the collaborative learning process. This demonstrates social

independence and cognitive empathy, two important aspects of effective collaborative learning. However, not all classes show an even pattern of support. In Class A school Pluto and Class B school Pluto, only a few students showed initiative in helping friends who were having difficulties.

> *"Few students helped each other during the numeracy learning activities."(Observer 1)*
> *"Students only check their friends' work in arranging Lego numbers, not correcting their friends' work."(Observer 2)*

This indicates that without intervention or structure that encourages interaction, students tend to remain in individual workspaces. The assistance that occurs is passive and does not result in deeper shared understanding. This condition strengthens the argument that peer scaffolding requires not only the physical presence of peers, but also the facilitation of a learning environment that promotes equal involvement and opportunities for mutual support. To conclude, the observational findings indicate that collaborative assistance between students in numeracy learning is not only a social practice that supports task completion, but also an integral part of knowledge construction through interaction. Peer scaffolding in the form of support for friends who are having difficulty is an important indicator that numeracy learning is taking place in a true collaborative framework where understanding is developed socially, and learning success is not only assessed individually, but as a collective achievement.

Mathematical Dialogue as Foundation for Understanding

Mathematical dialogue is one of the main features of collaborative numeracy learning that is able to encourage students' conceptual understanding in numeracy. In this dialogue, students not only provide answers, but also explain reasons, compare strategies, ask questions, and respond to ideas from group members. This process provides a space for children to explore mathematical ideas socially and deepen their understanding of numeracy concepts. In addition, this kind of interaction allows for co-construction of knowledge, where understanding develops through social negotiation of meaning. Mathematical dialogue is divided into two elements of collaborative learning, which are mathematical expression and mathematical reflection process illustrated in Figure 4.4 below.

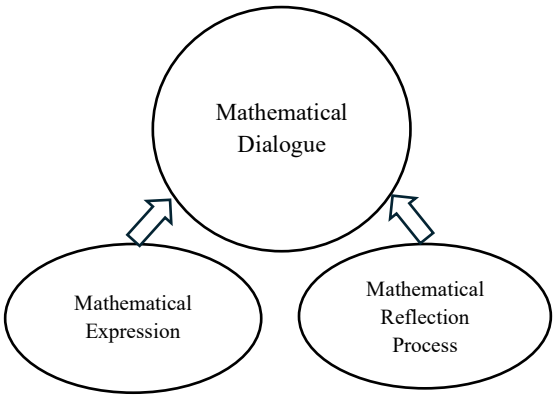

Figure 4.4. *Map of the Elements of Collaborative Numeracy Feature*

In mathematical expression children are able to express their opinion, sharing their ideas, and giving their strategy in an actual example that occurred in school exlplained by one observer notes in Class A School Mars,

> *''In the pyramid construction and puzzle activities, students planned strategies for ordering and checked each other's work.'' (Observer2)*

The results of observations show that the level of student involvement in mathematical dialogue varies between schools and is highly dependent on the design of the activity and students' habits in discussing. In Class A School Mars, mathematical interaction was quite strong, especially in the pyramid construction and number puzzle activities. Observers noted:

> *''In the bottle cap counting activity, students were able to express their opinions and work together with their partners''(Observer 1)*

Findings from Class B School Pluto show interesting dynamics in the mathematical expression element in collaborative numeracy learning. Although students are seen actively providing assistance to their closest friends in finding the numbers they are looking for, there is no exchange of ideas or in-depth verbal explanations.

> *''Students have been seen helping their closest friend to find the number they search, however they are not explaining or giving any opinions. '' (Observer 2)*

This phenomenon indicates that while a sense of social support is emerging among peers, the interaction remains at a surface level and lacks substantive mathematical dialogue. The students' collaboration does not yet demonstrate the kind of verbal reasoning, justification, or reflection that supports deeper cognitive development. In the context of

Vygotsky's sociocultural theory, this suggests a missed opportunity for peer-mediated learning within the Zone of Proximal Development (ZPD). The absence of explanation or elaboration implies that scaffolding either by more capable peers or through teacher modelling has not been sufficiently established.

This low-level scaffolding may result the absence of peer explanation. This was reflected in classroom routines that emphasize task completion over exploratory discussion, a lack of explicit instructional modelling on how to verbalize mathematical thinking during group work. It requires more structured mediation by the teacher to build the open-ended questions to enhance the children argument. As it also seen in School Pluto Class A according to the observer notes:

> *"Mostly students only focus on their own tasks; there was only interaction with the teacher not their peers."(Observer 2)*

The collaborative behavior supports participation but not yet cognitive engagement. From a constructivist perspective, this kind of interaction hinders the co-construction of meaning and limits the opportunity for students to internalize mathematical concepts through social interaction. Therefore, more structured mediation from the teacher such as prompting students to explain their reasoning or ask each other reflective questions may be necessary to elevate collaborative learning into a more cognitively productive experience. In the context of mathematical dialogue, the mathematical reflection process is an important element that allows students to evaluate their thinking processes and strategies collectively, not just the final results of a numeracy task. This reflection reflects deeper cognitive engagement and supports the development of conceptual understanding through joint discussion Findings from Class A School Mars show that

> *'' Group reflection occurred during the pyramid construction activity to ensure the arrangement was correct. '' (Observer 2)*

Where students jointly review the building arrangement to ensure its correctness. This indicates that reflection is not only focused on the final answer, but also on the collaborative strategy building process, which is a characteristic of effective mathematical dialogue.

In contrast, in Class B School Mars, '

'' Group reflection occurred only slightly, mostly during the bottle cap counting activity. It did not occur in the other two activities."(Observer 2)

In fact, according to Observer 2, although students can evaluate the results of their work especially when assessing friends' answers, reflection on the problem-solving process or strategies used is still less visible. This shows that the strategic evaluation aspect has not become a natural part of group interaction and still requires further facilitation from the teacher in order to develop. Another finding from School Pluto shows that mathematical dialogue based on mathematical reflection does not develop optimally, mainly due to limitations in the design of activities that tend to be individual. Although in practice some students still help each other spontaneously, only a few students discuss their work with their friends around them. This indicates that reflection on the process and results of the work is not part of their social interaction.

The main factor that influences this is the nature of the activity that does not encourage explicit collaboration. When tasks are designed to be completed individually, students' opportunities to share strategies, evaluate errors, or compare approaches with peers are very limited. As a result, mathematical dialogue which should emerge from the exchange of ideas and evaluation of the thinking process together does not form.

This situation shows that mathematical reflection does not automatically emerge even though students are in the same classroom or informally help each other. An instructional approach is needed that consciously designs moments of collective reflection, for example, through post-task discussions, presentation of strategies between groups, or reflective question and answer sessions. Without this, reflection will remain internal and individual, not as part of a meaningful collaborative dialogue in numeracy development.

4.2. Research Finding Questions 2: Collaborative Learning in Group Work Support Students Numeracy Skills

As explained in this study, 11 numeracy learning activities (see in Table 4.1) were implemented in the context of group work in four Early Childhood Education classes, consisting of two classes A (aged 4–5 years) and two classes B (aged 5–6 years). All of these activities were analyzed using a thematic approach to examine the relationship between the quality of collaborative interactions in groups and the development of children's numeracy skills.

The discussion in this sub-chapter focuses on how the quality of collaborative learning reflected through student participation, reciprocal interactions, and joint decision-

making contributes to children's success or failure in completing numeracy tasks. Referring to the second research question, namely "How does collaborative learning in group work activities support students' numeracy learning?", in-depth analysis of student work is directed at two main categories based on field findings: (1) activities with high levels of collaboration and strong numeracy outcomes, and (2) activities with less levels of collaboration and low numeracy achievements.

The first category represents the optimal form of collaborative learning, where students are not only actively involved in the group work process, but also demonstrate a conceptual understanding of the numeracy material provided. Meanwhile, the second category shows limitations in the aspect of group interaction, which has a direct impact on the cognitive process and the final results of numeracy learning. Through the discussion of these two categories of activities, this sub-chapter aims to examine in more depth the strategic role of collaborative learning in supporting the development of early childhood numeracy skills, while identifying factors that strengthen or hinder its effectiveness in the context of early childhood classes.

There are two activities from each category with a total of four collaborative numeracy learning activities. In the strong category, two appropriate activities are *Constructing Pyramids* and *Counting, Adding Bottle Caps.* In the less collaborative category, one activity is *Arranging Lego According to Number Sequence.* The following subchapter is an explanation of why the collaborative numeracy activities are included in the strong and low categories.

Strong Collaborative Learning Support Specific Numeracy Outcomes

1. Understand and order numbers (Counting)

One of the activities that demonstrates strong integration between collaborative processes and the development of basic numeracy skills in children aged 4–5 years (grade A) at School Mars is the Constructing Pyramid activity. This activity is intentionally designed to create learning based on group cooperation, while fostering an initial understanding of the concept of numbers and number sequences through concrete and fun experiences. In implementing this activity, the teacher divides the children into two small groups, each consisting of three students. Each child is given a numbered plastic bottle, which will later be used to construct a pyramid shape of numbers according to the example picture provided. This kind of group organization model not only encourages the active participation of all members, but also creates positive dependency, where each child has a complementary role in completing the task collectively.

The activity takes place with a rotating mechanism, where each child runs three meters to the arrangement point to place their bottle based on the number listed. This process requires them to pay attention to the position of the numbers that have been placed previously, as well as coordinate the position of their bottles so that the pyramid arrangement forms the correct number sequence. Although this activity is simple and playful, children show high cognitive engagement in arranging numbers from 1 to 6, and help each other to ensure that the structure they build matches the reference image. After all the bottles are placed, students jointly recheck the sequence of numbers that have been arranged. This verification process involves discussions among group members, such as comparing the position of numbers, correcting incorrect positions, or ensuring that no numbers are missed. The interactions that occur here are not only social but also reflect early numerical thinking processes that are built collaboratively. For example, a child points to a number and says, "This is 4 above 3, right?" then his friend answers, "Yes, but 5 should be here," indicating that they are negotiating and verifying the sequence of numbers together.

Overall, this activity shows the achievement of two important numeracy indicators in early childhood education. First, children demonstrate an understanding of the principle of one-to-one correspondence through the act of matching each numbered bottle to a certain position in the pyramid structure. This illustrates the child's ability to associate a concrete object with a specific number correctly, as regulated in the PAUD Standards and Curriculum (Ministry of Education and Culture, 2023). Second, they also understand the number symbols from 1 to 6 and are able to sequence them logically, which is in accordance with the counting indicators according to ACARA (n.d). Although still in the early stages of numeracy development, children show that they are able to recognize, differentiate, and arrange numbers with minimal guidance from the teacher, as well as through active interaction with their group members. Thus, Constructing Pyramid is an example of an effective activity in integrating numeracy and collaborative learning in class A. This activity shows that even at a younger age, children can be meaningfully involved in the mathematics learning process as long as they are given the support of an appropriate social environment, relevant concrete media, and a task structure that encourages collective involvement. The activity described in Figure 4.5 below,

Figure 4.5. *Collaborative Numeracy Activity: Constructing Pyramid*

2. Solve everyday addition and share stories (Counting)

Another example of collaborative learning activities that demonstrate high quality in terms of both collaboration and numeracy achievement can be seen in the activity "Counting Bottle Cap" carried out in class B (ages 5–6 years) at School Mars. This activity is designed in a structured manner to involve meaningful social interactions while encouraging the development of numeracy concepts through concrete experiences. In its implementation, the teacher first forms pairs of students, which allows for two-way interaction and more intensive communication between individuals, and then the teacher distributes ten bottle caps to each pair, which are used as manipulative aids to calculate and verify quantities in a concrete way.

The use of real objects directly develops students' understanding of one-to-one correspondence, namely the ability to match each object with one number, which is the foundation of numeracy skills. The teacher then adds a number of bottle caps to the pair without mentioning the exact number and asks students to discuss the total number again (see figure 4.6). This process not only encourages children to use basic addition strategies, but also strengthens mathematical communication skills, such as making guesses, comparing answers, and verifying together. This interaction leads to the application of the concept of addition in everyday contexts in a meaningful and concrete way. This stage directly supports the numeracy indicators set by ACARA, namely "Solve everyday

addition and share stories". Children not only perform additional operations but also share explanations or narratives about how they get the results.

The next step involves the transition from concrete exploration to symbolic representation. The teacher gives simple additional problems in written form, and students are asked to solve the problems with the help of the bottle caps they have. Finally, students are asked to write the answers to the problems on the worksheet provided. This stage shows the integration of concrete experiences with symbolic abilities and early numerical literacy, while strengthening number writing skills and understanding basic mathematical operations. This entire process shows the main characteristics of effective collaborative numeracy learning: positive interdependence, mathematical dialogue between students, the use of double scaffolding (teacher and peers), and critical exploration through open discussion. This activity not only encourages active social engagement, but also directly supports the development of numeracy skills at the class B level (5-6) years old.

Figure 4.6. *Collaborative Numeracy Activity: "Counting Bottle Cup"*

Less Collaborative Hindered Numeracy Outcomes

Understand and order numbers (Counting)

One of the activities analysed in the category of less collaborative numeracy activities is the activity of Arranging LEGO According to Number Sequence, which is carried out in class A (ages 4–5 years) at School Pluto. Although this activity potentially contains numeracy elements that are relevant to early childhood development especially in terms of recognizing number symbols and sequencing numbers the results of observations

show that its implementation has not fully supported the achievement of learning objectives in terms of both collaborative and numeracy achievement.

In this activity, the teacher provides LEGO blocks numbered from 1 to 10, with each number represented by one block. Children are asked to arrange the blocks in the correct number sequence. However, based on the results of observations and analysis of student work (student work analysis), it was found that the activity was carried out individually, without direction or encouragement from the teacher to work in groups or discuss with peers. One of the observer's notes emphasized that

> *"Students' collaborative tasks have not been well designed. Likewise, although there are many numeracy elements that can be explored through the activities, the results/outcomes have not been optimal due to several student errors during the lesson for example, some students were not yet able to sequence numbers correctly." (Observer 1)*

This finding shows that although the activities were designed in a classroom context, their implementation did not provide space for collaboration between students. Children worked separately without helping or discussing with each other in completing the tasks. As a result, the collaborative potential that should be a strength in the group-based learning approach was not utilized optimally. In addition, the targeted numeracy skill achievements namely understanding of the number sequence and number recognition were also not achieved optimally. Several children seemed to have difficulty in sequencing numbers correctly, and there was no intervention from peers or facilitation from teachers to help the process. This strengthens the conclusion that not only was the collaboration aspect low, but also the expected numeracy learning outcomes were not achieved as a whole. Thus, the activity of arranging numbered LEGOs in class A at school Pluto is a clear example of the importance of learning design that not only inserts numeracy material, but also emphasizes structured social interaction and cooperation. Without effective collaborative design, the potential for numeracy in an activity can be hampered, and even fail to provide optimal learning outcomes for early childhood students. This Figure 4.7 shown the activity of ordering Lego,

Figure 4.7. *Collaborative Numeracy Activity Arranging LEGO with numbered blocks*

Then, Figure 4.8 below illustrates the result of the student work, the number order is not correct following the sequence number.

Figure 4.8. *Student Work Result*

Based on the analysis of the four main activities in group-based numeracy learning, it can be concluded that the quality of collaborative interaction has potentially influence on the success of early childhood numeracy skills achievement. Two activities namely constructing pyramid and counting and adding bottle caps show the characteristics of strong collaborative numeracy activities, where interaction between students takes place actively, joint decision-making occurs, and the use of concrete media plays a role in building meaningful numerical understanding. These activities not only support the achievement of

numeracy indicators such as one-to-one correspondence and counting, but also facilitate social skills such as cooperation, discussion, and mutual support between group members.

In contrast, the other two activities Arranging LEGO According to Number Sequence is categorized as less collaborative numeracy activities. This activity shows minimal social interaction between students, the dominance of individual approaches, and the absence of a clear group work structure. Although this activity has the potential to develop numeracy understanding, such as recognizing numbers and number sequences, learning outcomes are not optimal due to the lack of collaborative support in the process. The lack of peer involvement and the lack of teacher facilitation in encouraging collaboration caused some students to have difficulty in completing numerical tasks effectively. Thus, this finding confirms that numeracy learning in early childhood will be more effective if designed in a strong collaborative context. Activities that place children as subjects who interact with each other, help each other, and build shared understanding will have a greater chance of producing optimal numerical achievements. Strategically designed collaboration is an important foundation for meaningful learning and children's cognitive development in the context of early childhood education.

The gap between teachers' understanding and the practice

An interesting finding from this study is the gap between the interview results and the observations. Based on the interviews, the teachers demonstrated a similar understanding of the meaning of collaborative learning in the context of numeracy learning. They also admitted to having implemented this strategy in class several times. However, observations revealed that most classroom activities did not encourage children to work in groups. Collaboration in practice was more visible in technical aspects, such as when teachers placed activity resources in one location so that children had to retrieve them from the same place.

An example occurred in School B, where teachers divided children into groups and provided three different types of activities. Although the materials used were sourced from the same source, for example, LEGO from a single container, the tasks given did not encourage collaboration among group members. Children were asked to construct LEGO structures individually, even though they had collected the LEGO pieces together. For example, they arranged a number sequence using LEGO, but the final result remained an individual project.

This phenomenon indicates a disconnect between teachers' understanding of collaborative learning and its implementation in the field. Two teachers even expressed concern in interviews that if children worked together on a single assignment, they would encounter challenges that would be difficult for them to overcome. This indicates that perceptual barriers and concerns about group dynamics contribute to the low level of implementation of collaborative strategies in numeracy learning.

4.3. Research Finding Questions 3: The enablers and Challenges of teachers in Orchestrating Collaborative Numeracy Learning

The findings addressing research questions 3 in this study, the data was obtained by conducting the final sequence of the data collection process, the interview underscored how teachers face all the challenges and also the enablers factors in practicing the implementation of collaborative learning through working group activities in numeracy learning. interviews conducted by researchers specifically answer the third research question: ‘’What are the enablers and challenges that early childhood educators face in orchestrating collaborative learning in group activities to support students’ numeracy learning?’’ Figure 4.9 below is the visualization of how the theme emerged.

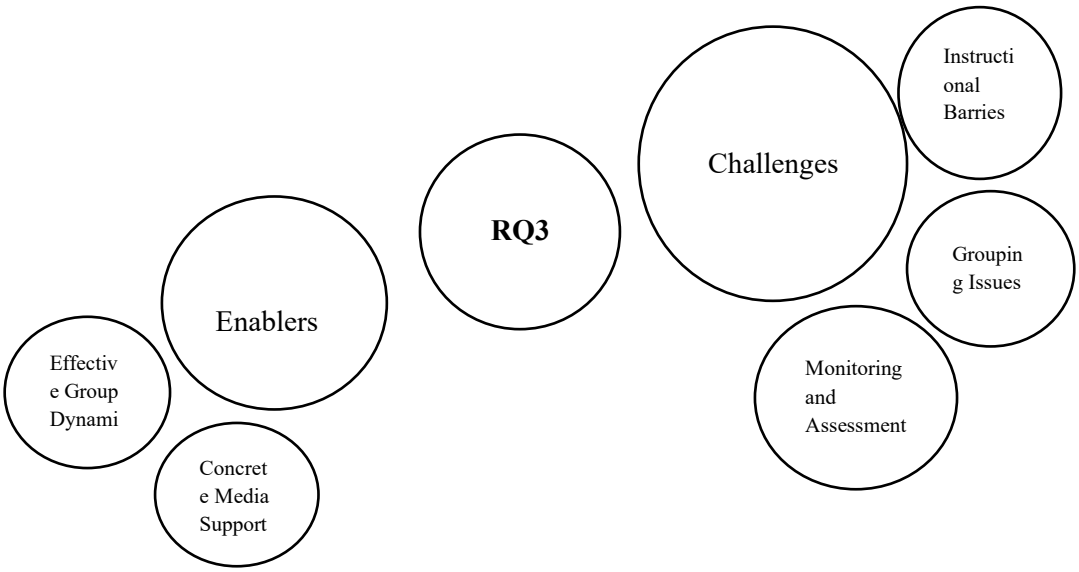

Figure 4. 9. *Map of the Enablers and Challenges of Collaborative Numeracy Feature*

Effective Group Dynamics in Collaborative Early Numeracy Learning

Effective group dynamics in collaborative numeracy learning in early childhood education settings is one of the findings that are characterized by several characteristic factors, namely small group size, heterogeneous division of children (girls and boys), division of roles based on ability, providing a choice of activities, and the development of cooperative values between children. Effective Small Groups based on the results of observations and interviews show that it is the most conducive to effective learning, the number of group members in collaborative learning is two to three children. This was conveyed by Teacher Lala and Teacher Fani in the interview that

> *"In my view, smaller groups tend to be more conducive. Therefore, there should not be too many children in one group. Two or three members per group is sufficient. Having multiple small groups makes the situation more manageable and safer." (Teacher Lala)*

Teachers reported that small groups were easier to manage and allowed children to be actively involved without too many distractions. Furthermore, the strategy of dividing roles in groups based on children's abilities is also considered to strengthen collaborative dynamics. Children with higher abilities can act as group leaders and provide guidance to their friends. This allows for an effective peer mentoring process. One teacher emphasized:

> *"Perhaps, in collaboration within a group, we can divide the children according to their abilities, from higher to lower levels. We can appoint the child with higher ability as the group leader... The leader's role is to provide guidance and feedback during the activity." (Teacher Fani)*

Teacher also believed to have the group composition that worked well on collaborative numeracy learning is to unite children in one group based on the mix gender and also the children who have more understanding with the one who still exploring those are as stated by teachers

Group dynamics also contribute to children's social-emotional development, especially in reducing egocentric behavior. Through repeated experiences of working together, children begin to understand the importance of helping each other and sharing responsibilities. As expressed by one teacher:

"It is very important to instill the value of teamwork in children from an early age... They start to realize that everyone in the group needs to support each other. For example, during play or building activities, they begin to notice when a friend hasn't finished yet and encourage one another: 'Come on, let's finish this together!'" (Teacher Ela)

The combination of these quotes reinforces the understanding that effective group dynamics in collaborative numeracy learning include small group structures, mixing gender, various understanding of numeracy, and encouragement of shared values from an early age. In the implementation of collaborative numeracy learning in early childhood, interviews with teachers revealed that effective group composition is highly dependent on heterogeneous grouping strategies and structured work systems. Teachers stated that children showed high enthusiasm for group activities, often asking, "Miss, when are we going to work in groups again?" This indicates that collaboration is a fun and meaningful learning experience for them. One of the main approaches in forming effective group dynamics is through balanced grouping based on ability levels (heterogeneous grouping). The teacher explained:

‘’Based on the previous activity, the group division was initially done by separating girls and boys. Among the girls, there are high-achieving students like Ayka and Syibila, who are also good at mathematics. For the boys, Syafiq, Rafiq, and Nabil also have strong abilities. Therefore, the division between girls and boys was fair, considering both high and low abilities. There are six boys and six girls in the class, so the division was balance.’’(Teacher Fina)

This strategy allows for a peer learning process, where students with higher understanding accompany their group mates who are still developing their numeracy skills. This is also supported by the statement:

"Each group should include children who are advanced, those who are still learning, and those who need more support. This way, the less capable students can learn from their peers who understand the material better." (Teacher Fani)

‘’Regarding effective group composition, I believe it is important to mix students based on their skill levels. Each group should include children who are advanced, those who are still learning, and those who need more support. This way, the less

capable students can learn from their peers who understand the material better. As for gender, I find that mixed-gender groups are not an issue'' (Teacher Yanti)

In addition to composition, the structure of the activity is also an important factor. The teacher applies a structured turn-taking system between groups, where children are divided into three groups that work sequentially.

"We design the activity by dividing the children into three groups... Once the first group finishes, they can move on to the next group."(Teacher Lala)

This mechanism provides an opportunity for all groups to experience an equal learning process, while allowing teachers to provide more specific attention to each group in turn. Flexibility in implementation is also evident from the mixed approach between child initiative and teacher intervention in forming groups. This shows that the role of the teacher as a facilitator remains crucial in ensuring equality and dynamics that support collaboration. With balanced groups in terms of ability and gender, children can complement each other in the numeracy learning process. Another perspective of interviews with teachers, there are three main skills that consistently emerge, namely peer-to-peer communication, the ability to work in groups with different roles, and flexibility towards differences in work styles and characters. First, communication skills are the main foundation in group work. Teachers explicitly state that:

"Peer communication plays a crucial role in group work. Communication skills are essential for effective collaboration within a group. Without clear communication, children may struggle to express their ideas or understand those of their peers." (Teacher Yanti)

Communication skills help children express ideas, listen to friends' opinions, and avoid misunderstandings in completing numeracy tasks together. Second, interviews show the importance of the teacher's role in providing children with an initial understanding and structure of group work, so that they are able to carry out collaboration well.

"To support effective collaboration, the teacher first provides understanding and knowledge to the children... The children discuss together with their friends, taking roles such as identifying numbers and ensuring the correct order." (Teacher Yanti)

Through early instruction and assignment of roles such as missing number finder or number sequence keeper, children learn how to work as a complementary unit. Third, collaborative

experiences also show how children with different personalities learn to adjust and work together. In a group collage activity, the teacher noted that:

> *"Some demonstrated cooperative behavior, while others tended to work independently... This highlighted the distinct personalities and working styles of each child."(Teacher Fani)*

This fact shows the importance of building tolerance and adaptability as part of a healthy collaborative dynamic. Finally, the teacher also emphasized the importance of appointing group leaders from students who excel academically to accompany friends who need more guidance:

> *"The teacher can select these capable children to be the group leaders. This way, children who struggle can be supported and complemented by those who are more capable." (Teacher Fani)*

Therefore, it has been found that the skills required of the students involved in the collaborative learning of numeracy require the use of skills to communicate, an appreciation of positions in a group framework and the ability to adapt to associates of disparate nature or abilities. This is supported by the fact that teachers have a role in ensuring the development of favorable initial conditions. It can be stated that favorable group dynamics in collaborative numeracy learning in early childhood are developed on the basis of a multi supporting conditions. To begin with, the diverse and balanced combination of groups allows such a process of complementarity in which more able children may assist group mates with greater needs. It opens rooms to refer to each other. Second, the primary key of the sustainability of cooperation in groups is the active interpersonal communication.

The children should learn how to express themselves, listen and comprehend what others think so that teamwork can operate efficiently. Thirdly, a specifically organized structure of activity and role assignment help have a structured orientation in the performance of group tasks, thus, every child has quite definite tasks and roles. Fourth, the use of teacher support as a facilitator cannot be ignored when planning, guiding, and observing group dynamics in a manner that they are highly conducive and well-balanced. Finally, a learning situation which invites the students to take an active role and work with others at an early age contributes as well to the development of the positive social attitudes, namely the empathetic attitude, the attitude of responsibility and the attitude of cooperation.

All these are intertwined in the process of developing a purposeful and functional collaborative numeracy learning environment among children.

Concrete Media Support Collaborative Numeracy Learning Practices

Concrete media or teaching aids emerged as one of the most frequently mentioned elements in the interview results. In particular, teachers consistently referred to the importance of using concrete objects such as blocks, bottle caps, number cards, and everyday objects as the main tools for giving numeracy tasks to students. These concrete media not only function as instructional aids, but also as a means for children to carry out direct exploration, problem solving that can be direct objects, and when carrying out learning in this group. As a mathematical concept, teachers emphasize the importance of preparing teaching aids from the start so that collaborative activities can take place effectively and according to children's needs. As explained by one teacher:

> *"In teaching collaborative numeracy, teaching aids must be thoroughly prepared. The preparation of these aids should be done well in advance… so the children can fully understand the material."(Fani)*

In addition, concrete aids are very helpful for children to understand abstract concepts such as numbers and number sequences, especially since children are still at the stage of fine motor development. The teacher added:

> *"Many children still face challenges with fine motor skills, so concrete learning tools allow them to engage physically, which in turn supports faster understanding."(Teacher Lulu)*

Second, strategic activity planning is an important component so that collaborative activities run in a focused and meaningful way. Teachers not only prepare activity steps, but also consider how these activities support cooperation between children and the achievement of numeracy learning goals. With good planning, teachers can ensure that each child understands their role in the group and the material being studied. Third, the design of collaborative activities also depends heavily on the interests and abilities of children (child-centered planning). Teachers adjust the type of task to the child's interest in a particular topic so that they are more involved. ‘’In my opinion, the use of teaching aids greatly supports the learning process. Teaching aids help children better understand concepts, especially when learning numbers. Many children still face challenges with fine

motor skills, so concrete learning tools allow them to engage physically, which in turn supports faster understanding''

> *"Children's likes and interests are indeed the most commonly observed factors... We also consider whether the children are capable of doing the activities we plan to design."(Teacher Yanti)*

Teachers also show flexibility and creativity by seeking inspiration from various sources, including social media, to design activities that are fun and appropriate to the child's context. Thus, designing collaborative tasks in numeracy learning in early childhood is supported by three main pillars: appropriate concrete media, careful instructional planning, and an approach oriented to children's interests and developmental readiness. The three of them support each other in creating an active, fun and meaningful learning experience.

Educator Challenges in Orchestrating Early Numeracy Skills through Collaborative Settings

The findings that answer the third research question in this study were obtained through the final process of data collection, namely in-depth interviews with teachers. These interviews were specifically designed to explore how early childhood educators face various challenges as well as supporting factors (enablers) in implementing collaborative learning through group activities in the context of numeracy learning. The question answered through this method is " What are the enablers and challenges that early childhood educators face in orchestrating collaborative learning in group activities to support students' numeracy learning?" From the results of the thematic analysis of the interview data, five main themes were found, which were divided into two categories, namely enablers and challenges.

Instructional and Developmental Barriers in Designing Collaborative Numeracy Task

Designing collaboration-based numeracy activities for early childhood is not an easy task. Teachers face various challenges, both instructional and child development. One of the main challenges expressed by teachers is the suitability of the activity to the child's readiness. Not all types of numeracy activities can be done collaboratively. Teachers must first estimate whether children are able to understand and follow the steps of the activity. As explained by one teacher:

“The difficulty lies in selecting activities that can be effectively collaborative, as not all activities are suitable for collaboration, We worry that if the children do not understand the activity, the planned activity might not meet our expectations.”(Teacher Lala)

‘’Finding suitable collaborative activities for mathematics learning. Additionally, there is a challenge in selecting appropriate activities for collaboration because, so far, children mostly work individually, at best in pairs. Collaborative activities in mathematics are still rare, except for gross motor activities such as group ball sheet exercises.’’ (Teacher Fina)

Limitations in children's understanding of the structure of activities are also significant obstacles. In some cases, children experience confusion in understanding collaborative workflows consisting of several steps. Lack of clarity in instructions or children's unpreparedness in understanding social roles in groups makes activities less effective. “In the first activity, the children appeared confused, whereas ideally, those without cards should form the groups.”. This suggests that understanding of sequencing and multi-step processing is still in the early stages of early childhood cognitive development. Preoperational children still think egocentrically and concretely, so they need visual and manipulative aids to understand procedural concepts. Furthermore, instructional barriers are also reflected in children's low attention to teacher directions, which impacts their involvement in activities. Teachers reported that some children preferred to play or joke around during instruction, so only focused children were able to fully understand the purpose of the activity. This reinforces the importance of using sensorimotor and multimodal engaging learning approaches to maintain children's attention.

“The teacher’s instructions were often being ignored because many children were joking around.” (Teacher Fina)

In terms of resources, teachers face challenges in accessing appropriate media and teaching materials. Although concrete aids such as blocks, bottle caps, or popsicle sticks are relatively easy to find and effective for early numeracy learning, teachers stated that efforts to create innovative collaborative activities are often hampered by the limited availability of unique and non-monotonous materials. This condition emphasizes the importance of institutional support in providing contextual, varied, and child-friendly learning media.

"This becomes an obstacle when trying to find new ideas without using frequently used tools."(Teacher Yanti)

The limitations of early childhood cognitive and motor development are the main factors in determining the effectiveness of collaborative numeracy activities. Many children are not ready to understand abstract concepts such as numbers or addition without manipulative media. Thus, the use of concrete tools is not only a methodological choice, but an important pedagogical need so that numeracy learning can take place meaningfully and applicable.

"In my opinion, teaching aids play a significant role in supporting children's learning. They provide more concrete understanding, Many children are not yet cognitively ready to grasp abstract concepts. However, when they can touch, move, or manipulate physical objects, they tend to learn more quickly." (Teacher Ela)

Considering the various challenges above, it can be concluded that the success of designing collaborative numeracy tasks for early childhood is highly dependent on the teacher's ability to integrate aspects of child development, explicit instructional strategies, and the use of appropriate concrete media. Therefore, teachers do not only act as facilitators, but also as learning designers who are responsive to the needs and characteristics of child development. Furthermore, Teachers in both schools highlighted developmental barriers, especially in designing tasks appropriate for early learners' cognitive stages. Yet, the extent and framing of these challenges differed. At School Mars, the focus was on maintaining attention and reducing distractions during instructions, suggesting a need for stronger classroom management structures. In contrast, at School Pluto, the difficulty was more about aligning task complexity with students' readiness for group collaboration, as collaborative mathematical tasks were described as relatively new and unfamiliar.

Grouping Issues: Selectivity and Balance

Grouping children in collaborative numeracy activities is not free from challenges that are closely related to the characteristics of early childhood social development. Interview results show that one of the main obstacles is the tendency of children to be selective in choosing group friends. Teachers revealed that many children want to be in groups with their close friends, so group selection often does not reflect a balance of abilities:

"Some children chose a particular color because their friends had already picked that color... They want to be in groups with friends they prefer."

This tendency is influenced by the egocentric nature of early childhood, which is naturally still centered on oneself and the closest social circle. As a result, the imbalance of group composition becomes a challenge in itself, especially when children with high abilities gather in one group:

"If too many high-achieving students are in one group, it can cause imbalance among the groups."

To overcome this, the role of teachers is crucial. Teachers need to intervene directly in the formation of groups, so that children can learn to interact with different friends. Teachers even try creative strategies such as a color system in choosing groups:

"Children can't always choose their own group members... I step in and help divide the groups so they can learn to interact with others."(Teacher Yanti)

Furthermore, this group challenge also has a positive dimension in terms of social-emotional development. Through group work, children are trained to grow empathy, learn to wait, and care for each other:

"Even in learning activities, some children choose to wait for their friends before finishing their tasks. This is all part of teaching empathy and collaboration from an early age."

Creative strategies such as the use of color systems or random division with certain considerations are alternative solutions to avoid resistance from children who want to be with their close friends. However, teachers are still required to observe and evaluate the dynamics of the groups formed in order to continue to support the numeracy learning process optimally. Thus, the challenges in forming this group are not only related to learning techniques, but also to the process of forming children's social character. Efforts to balance children's social preferences and learning objectives are both challenges and opportunities for teachers to design inclusive and socially meaningful learning experiences

Monitoring and Assessment Challenges in Group Collaboration

In the context of collaborative numeracy learning in early childhood education, monitoring and assessment of student engagement present significant instructional challenges. Although observation is one of the primary tools used by teachers to assess both individual and group participation, data from the field reveal that time constraints and

classroom management demands hinder teachers' ability to observe collaborative processes effectively. As one teacher from School Mars explained,

> *"The challenge was that I wasn't able to stay focused throughout the process, so I only paid attention to the final result. For example, during the pyramid-building activity, I only observed who won at the end. However, in the college activity, we could observe the process more closely beforehand." (Teacher Lala)*

This statement reflects the disconnect between the learning process and the assessment process, teachers have difficulty consistently monitoring the collaborative dynamics that occur within the group. In practice, teachers assess more based on the final product, such as who completes the task correctly or the fastest, compared to assessing the contribution of the collaborative process that occurs during numeracy learning activities. Pedagogically, process-based assessment is an important approach in assessing collaboration, especially in early childhood who are developing in social and emotional aspects.

Limitations in observation time have the potential to cause assessment bias where students who are verbally active or dominant in completing tasks are more easily seen to contribute than other students who may contribute non-verbally or in supporting roles. That is the conditions when teachers have difficulty in handling many aspects simultaneously teaching, monitoring, documenting, and evaluating accurately. This is exacerbated in group learning that involves several social dynamics at once. In addition, the observation process in kindergarten is greatly influenced by the sensitivity of teachers in capturing interactions that are not always explicit. When teachers cannot consistently monitor all groups evenly, the validity of the assessment given becomes limited. As a result, some students who are active in cooperation but are less visible explicitly can be overlooked in the assessment. As explained by one teacher:

> *"I only observed who won at the end."(Teacher Lala)*

While such assessments are more convenient, they fail to capture the richness of collaborative learning processes and the individual contributions within them. Therefore, to accurately assess group collaboration in numeracy learning, teachers need structured observation tools, adequate time allocation, and support systems that enable them to document both visible and subtle forms of participation equitably.

Assessment challenges were prominent in both schools, but manifested differently. At School Mars, limited teacher attention to group processes led to assessments focused only on final outcomes (e.g., "I only observed who won at the end," Teacher Lala). In contrast, School Pluto's teachers were more attuned to subtle behaviors and process-

oriented evaluation but struggled with maintaining consistency across multiple groups. These differences point to variations in teacher training, observation tools, or institutional support. These are the thorough explanation in seeing the differences between school Mars and School Pluto, in all the identified aspects.

Table 4.2 outlines the distinct approaches and challenges observed in collaborative learning practices between School Mars and School Pluto. While both schools employed small groups and heterogeneous grouping strategies, School Mars emphasized structured role assignments and classroom management, whereas School Pluto adopted a more flexible, child-centered approach that encouraged emergent peer support. Similarly, in instructional planning, Mars relied heavily on teacher-prepared roles and structured sequencing, while Pluto integrated children's interests and allowed for spontaneous collaboration. Differences were also evident in assessment practices, with Mars focusing on final products due to observation constraints, and Pluto placing greater though still unstructured emphasis on monitoring collaborative processes. These contrasts reflect variations in pedagogical priorities and underscore the influence of institutional culture on how collaborative numeracy learning is facilitated.

Table 4. 2. *Differences in Collaborative Learning Practices Between School Mars and School Pluto*

Aspect	School Mars	School Pluto
Group Structure & Dynamics	Small groups (2–3) prioritized for manageability and safety - More emphasis on structured role assignment, e.g., group leaders based on ability	Also used small groups - Emphasis on social-emotional learning and natural teamwork development
Heterogeneous Grouping	Clear strategy to mix abilities and gender-Assigned leaders guide peers	Focus on mixing abilities too - Less formalized role designation, more emergent peer support
Teacher's Role	Facilitator and manager of structured group activity - Prioritizes classroom control during tasks	Facilitator with flexible grouping approaches - More focus on child initiative
Instructional Planning	Structured sequencing of activities with rotating groups - Emphasis on teacher-prepared roles	Strong integration of children's interests into planning - Adaptable to spontaneous collaboration
Concrete Media Use	Heavy reliance on physical manipulatives like blocks, bottle caps - Teachers stressed need for early preparation	Also emphasized teaching aids for concept clarity - Sought ideas from social media/contextual inspiration
Developmental Challenges	Difficulty sustaining children's attention during instructions - Distraction and joking common	Main challenge is matching activity complexity with developmental readiness

Group Formation Challenges	Children wanted to be with closest friends, causing imbalance - Teachers used color-coded systems to intervene	Similar issues with preference-based grouping - More open-ended strategies to encourage interaction
Assessment Challenges	Focused more on final products due to limited observation time - Difficulty monitoring multiple groups	More attention to collaborative processes, but still lacked structured assessment tools
Children's Response to Collaboration	Children enthusiastic and often ask for more group work - Stronger response to structured guidance	Children show growing empathy and responsibility through repeated collaboration
Enabling Teacher Practices	Pre-planned role distribution - Turn-taking mechanisms between groups	Flexibility in forming groups - Role modeling empathy and teamwork

Both School Mars and School Pluto emphasized the importance of small group sizes and heterogeneous group composition. However, School Mars showed stronger implementation of structured role assignments within groups, particularly in appointing student leaders to guide peers with emerging numeracy skills. In contrast, School Pluto placed more emphasis on encouraging organic cooperation through repeated experiences and emotional support, as reflected in Teacher Ela's comments on instilling teamwork values. For instance, while Teacher Fani at School Mars explicitly described assigning leadership roles based on mathematical ability, Teacher Yanti from School Pluto preferred more fluid, child-initiated interaction styles without strict role delineation.

The comparison also suggests that institutional and contextual factors (e.g., class size, resources, teacher-to-student ratio) play a role in shaping how collaborative numeracy learning is orchestrated. For instance, School Mars teachers reported more logistical difficulties in supervising simultaneous group activities, whereas School Pluto teachers described greater flexibility in adjusting to students' interests due to smaller class sizes. In summary, while both schools demonstrated a commitment to implementing collaborative numeracy practices, key differences in teacher strategies, group structuring, and assessment methods were evident. These differences underline the importance of adapting collaborative learning approaches to fit the unique needs of each classroom context. Future interventions and professional development efforts should consider these contextual nuances to ensure more effective orchestration of collaborative numeracy learning in diverse early childhood settings

4.4. Discussion

Findings of this study underscore features of collaborative numeracy learning structures in early childhood that can shape meaningful learning interactions, especially through features such as student participation through interdependence, peer scaffolding,

and mathematical dialogue as a foundation for numeracy understanding. This is in line with the research of Webb (2009) which emphasizes that when children work together, interact and depend on each other, they find it easier to understand the concept of learning mathematics. A study by Murphy et al., (2025) revealed that peer cooperative behavior (scaffolding) supports increased numeracy learning. Additionally, (Attard et al., 2015) also explained that mathematical dialogue between children is a collective medium for children in learning mathematics.

First, the findings show that one of the main features that appears strong in collaborative numeracy activities is student participation through reciprocal dependence. In activities such as building number pyramids and counting bottle caps, students demonstrate joint effort and interdependence in completing tasks, where individual success is highly dependent on group contributions. This is consistent with Johnson and Johnson's (2020) positive interdependence theory, which states that effective collaboration occurs when students depend on each other to achieve a common goal. Clements (2022) also showed that in a dyadic work structure, preschool students who helped each other during numeracy games showed significant improvements in numeracy outcomes, confirming the importance of collaboration in supporting academic outcomes. Another important feature that emerged was peer scaffolding, which was formed through three components: peer-to-peer responsiveness, peer feedback, and peer assistance in problem solving.

The observation results from School Mars indicate a highly effective and robust form of peer interaction, where children actively responded to friends' ideas, engaged in discussions, and provided corrections when needed. This strong frequency of discussion and mutual assistance among students aligns directly with the concept of peer scaffolding and its role in fostering cognitive development. As noted by Rogoff (1994) and Clements and Sarama (2013), peer scaffolding within heterogeneous groups is a powerful mechanism for creating a Zone of Proximal Development (ZPD). In such environments, children effectively learn from "slightly more competent peers" within a genuinely cooperative and supportive atmosphere. However, a more nuanced application of Vygotskian theory reflected that effective scaffolding is not only about peer assistance but also requires structured mediation by a More Knowledgeable Other (MKO), which may include adults or teachers who can intentionally guide learning. The quality of tasks presented and the context in which they occur are also crucial in determining whether interactions genuinely extend children's learning within their ZPD. Additionally, the nature and success of peer scaffolding may vary across different classroom cultures, group compositions, and individual developmental levels. Therefore, teachers play a pivotal role not just in allowing

space for collaboration but also in designing learning environments that deliberately support productive scaffolding ensuring that interactions go beyond surface-level help and foster deeper conceptual understanding.

The findings also show that mathematical dialogue serves as an important foundation for understanding numerical concepts in depth. In activities such as pyramid construction, puzzle, and counting bottle cap, students use language to negotiate ideas, explain the reasons behind their strategies, and evaluate the arguments of their peers. A study as evidenced by errors such as some students' inability to sequence numbers correctly during this process, where students not only convey ideas but also reflect and refine their understanding through verbal interaction. Studies by Murphy et al. (2025) also supported that manipulative -based discussions promote mathematical engagement and strengthen students' numeracy reasoning in small groups.

Furthermore, the results of the study indicate that strong collaboration supports good numeracy learning and low collaboration also hinders students' numeracy achievement. Many studies have shown that structured, meaningful and well-facilitated collaboration strengthens numeracy development in early childhood (Siraj-Blatchford & Manni, 2007; Van Oers, 2013; Berk & Winsler, 2013). Conversely, weak collaboration hinders students' numeracy achievement. First, the findings show that collaboration supports numeracy learning such as the activity of arranging pyramids in groups. During the pyramid construction activity, all students were actively involved in sharing ideas, making decisions together, checking for accuracy, and reflecting on results to complete the task collaboratively in promoting ordering numbers. This is in line with the statement by Macmillan (2001) that good collaboration provides space for children to use mathematical language, discuss and provide support to each other so as to support students' numeracy learning achievement. In this sense, high-quality collaboration also creates positive interdependence and active involvement in numeracy learning.

Meanwhile, the findings also show that weak collaboration also hinders the achievement of learning because there is no exchange of ideas, mutual reflection and collaboration in forming an understanding of numeracy. For example, during the LEGO arranging activity, students were not active and worked together in completing the numeracy task so as evidenced by errors, such as some students' inability to sequence numbers correctly during the activity. This is in line with a study conducted by Appavoo et al. (2019) when collaboration in learning is not well structured, children lose the opportunity to work together, share ideas, and reflect on each other's understanding, which has a negative impact on numeracy achievement.

Based on the interview results, the two main enablers that support collaborative learning in numeracy learning are effective group dynamics and the use of concrete media. Positive group dynamics are seen when students demonstrate mutual trust, listen, and pay attention to each other's contributions. This reflects an important element of social-emotional learning in collaboration (Pellitteri & Smith, 2007). On the other hand, concrete media such as blocks, bottle caps, and number cards allow children to interact with real objects in developing mathematical strategies together. Hinton and Flores (2019) noted that manipulatives act as cognitive mediations that support conceptual understanding while building meaningful social interactions.

Moreover, the results of the study showed that effective group dynamics that support numeracy learning in early childhood are the use of small groups and heterogeneous groups. For example, the teacher stated that in my opinion, smaller groups of two or three members are more conducive and manageable during activities, as having too many children in one group can make supervision challenging and less safe. This is in line with research conducted by Warmansyah et al. (2022) and Clement et al. (2023) which stated that small group sessions have been shown to effectively improve numeracy outcomes with intense and meaningful interactions. In addition, groups with diverse abilities provide opportunities for children to share and support their friends and trigger collaborative mathematical activities and thinking However, while the use of heterogeneous groups is theoretically beneficial, its practical implementation can be challenging. Several observations from this study revealed that young children often prefer working with close friends rather than groups with less familiar peers. This preference may limit the intended benefits of heterogeneous grouping, particularly in fostering interactions among diverse peers and collaborative problem-solving. These findings suggest that while structured group composition is important, teachers should also intentionally foster social interactions and help children build collaborative relationships beyond their immediate circle of friends.

Furthermore, other findings of the use of concrete media when supporting teachers in collaborative numeracy learning. As stated by the teacher, ‘’media and appropriate teaching materials, especially concrete objects, play a crucial role in the learning process by helping children better understand concepts and collaborate more effectively before progressing to abstract ideas’’ that is in line with Siller and Alannis (2022) stated that manipulative media provides a concrete way for children to understand abstract mathematical concepts to be more concrete, accessible and abstract and a tool to support peer understanding. In addition, it states that manipulative media functions as a concrete

media that facilitates collaborative discussions and peer-to-peer scaffolding, providing a way for children to discuss mathematical ideas in real-world contexts.

The findings of this study also show that teachers also face three main challenges. First, instructional and developmental barriers arise when teachers have difficulty designing truly collaborative numeracy tasks because most numeracy activities are still individualistic. van Schaik et al. (2017) showed that learning designs that do not explicitly encourage collaboration tend to result in shallow interactions. Second, the issue of grouping becomes a challenge, especially when children choose to work only with their close friends, which causes a lack of heterogeneity and reduces the potential for peer scaffolding. Johnson and Johnson (2009) emphasized the importance of balanced and intentional group formation to optimize collaborative interactions. Third, monitoring and assessing collaboration becomes an obstacle because small group activities occur simultaneously, making it difficult for teachers to observe the process as a whole. This is in line with the study by O'Connor and Michaels (2019) that collaborative assessment must include not only the final results, but also the quality of the interaction process that occurs between students.

The data shows that the first challenge is the difficulty experienced by teachers when designing numeracy tasks because there is still a lack of references and teacher knowledge about numeracy learning that can be done in groups. This was said by one of the teachers that the challenge lies in selecting numeracy activities that are truly suitable for collaboration, as not all activities fit this collaborative approach. This is in line with study by this aligns with a study by Martín-Blas et al. (2023), which found that over 9% of teachers reported never designing collaborative activities, and many required several weeks to develop a single task, highlighting the need for more accessible guidance and resources.

In this study, another challenge of collaborative learning in numeracy occurred is the issue of grouping in which children focus more on their friends than others. It was stated by the teacher in this study that some children still chose a group based on friendship preferences, reflecting their tendency to be selective about groupmates. In line with the statement by Grueneisen et al. (2024) that children choose to work with friends they like not based on their abilities or cognitive diversity which inhibits the exchange of new ideas. Thus, groups that do not consider diversity reduce opportunities for development and the potential for mutual learning.

The last challenge is monitoring collaboration, which is difficult to do for all students due to the limitations of teacher observation. In this study, the teacher stated that there was a lack of focus on the overall process, as they tended to pay attention only to the final result.

In the context of early childhood numeracy learning, teachers find it difficult to simultaneously monitor every small group interaction and often do not see the hidden dynamics between students. Thus, the teacher was unable to ensure the quality of group interactions in numeracy, which led to challenges such as dominance, miscommunication, and weaknesses in mathematical understanding.

The findings of this study indicate that collaborative numeracy learning at an early age is able to create meaningful learning interactions through active student participation through interdependency, peer assistance, and mathematical dialogue. In addition, several collaborative activities conducted in the classroom supported early childhood numeracy, although some activities hindered numeracy achievement. This study also shows that collaborative learning in numeracy is supported by positive group dynamics and the use of concrete media that encourage social interaction and joint understanding of concepts. However, there are several major challenges faced by teachers, especially in designing truly collaborative numeracy tasks due to the limited references and understanding of numeracy in the context of group work. In addition, the grouping process is also an obstacle when children prefer to work with their close friends, which reduces diversity in the group and limits the potential for exchange of ideas. Another challenge is the difficulty of teachers in monitoring the interactions of all small groups simultaneously, due to limited resources and time, so that the collaborative process that occurs between students is not fully observed or documented properly.

CHAPTER V
CONCLUSION AND RECOMMENDATIONS

This chapter provides the conclusion of the current study, implications of the study, and also recommendations for future research, taking into account the limitations of the present study. The conclusion of the study explained by summarizing the main findings concerning the research objectives. It highlights the theoretical and practical implications of the results, especially how they contribute to current knowledge and educational practice. The chapter also acknowledges the limitations encountered during the research process and discusses how these may have influenced the outcomes and recommendations for future research to address these limitations.

5.1. Conclusion

This present study reveals there are three key features of collaborative learning which are interdependence through students' participation, mathematical dialogue, and peer scaffolding those features holds significant potential in enhancing early childhood numeracy skills. The elements of collaborative learning have been proven to create a classroom atmosphere that supports active student engagement, encourages the exchange of ideas, strengthens peer support, and builds a shared numeracy understanding. However, several challenges persist in practice. One notable challenge is the gap between teachers' conceptual understanding of collaborative learning and its classroom application. While interviews suggest that teachers recognize the value of children working together toward shared goals, classroom observations indicate a tendency to assign tasks individually, often without clear structures that promote true collaboration. This disconnect not only limits opportunities for meaningful interaction but also affects children's ability to engage in collective problem-solving that effect to students learning outcomes as seen the evidence in School Pluto the division and clarity of the work flow in the group is still unclear, the teacher only places children in one group to take numeracy media in the same place, however students have to complete the numeracy tasks individually. Moreover, it is also reflected in how teacher facilitate the learning and the dominance of peer selectivity further constrain the effectiveness of collaborative learning environments. In light of this, the study underscores the importance of teacher capacity-building to translate collaborative principles into classroom practices.

From a developmental perspective, the limited collaboration observed among children also reflects the characteristics of the preoperational stage, as described by Jean Piaget, where egocentric behaviour is still dominant. Nevertheless, the study provides

evidence that, when group work is appropriately structured and supported, clear instruction flow from the teachers in teaching and learning numeracy within group form early learners are capable of moving beyond egocentric behaviour. They can engage in cooperative problem-solving, negotiate meanings, and work toward shared numeracy goals, thereby demonstrating that collaborative learning not only supports cognitive but also social development. This highlights the dual function of collaborative learning in early childhood classrooms: as both a pedagogical approach to numeracy and a developmental tool to foster children's transition from individualistic to socially-aware learners.

5.2. Implications

The findings of this research, addressing collaborative numeracy learning, hold a positive potential implication for early childhood education, especially classroom teachers, particularly in the Indonesian context, by challenging the prevailing assumption that young children are not capable of meaningful collaboration, specifically in numeracy learning. The identification of key collaborative features such as interdependent participation, mathematical dialogue, and peer scaffolding demonstrates that, with the right structures and support, even young learners can engage in rich, interactive mathematical experiences. Educators and curriculum developers should therefore reconsider traditional teacher-centered approaches and begin integrating intentional, well-facilitated collaborative learning strategies into early numeracy instruction. This includes designing tasks that promote shared problem-solving, forming heterogeneous groups to maximize peer learning, and equipping teachers with the skills and tools to observe and guide multiple group interactions effectively. Addressing identified challenges, such as peer selectivity and children's limited awareness of collaboration, requires targeted pedagogical interventions, including explicit social skills instruction and strategies to foster inclusive group dynamics. To support this shift, teacher training should include practical workshops on designing numeracy tasks that encourage shared decision-making, such as grouping and classifying objects, describing quantities in everyday contexts, or constructing number lines collaboratively using concrete props. This teacher training should also provide guidance on forming and managing balanced and heterogeneous groups, so that each child has the opportunity to contribute to and learn from their peers. Furthermore, teachers should be equipped with observation tools such as interaction checklists and group work rubrics to coordinate children's collaboration, mathematical reasoning, and verbal interactions during activities. Lesson plans should also encourage the use of open-ended questions, shared manipulatives (e.g., counting blocks, pattern tiles), and structured turn-taking routines to support the development of children's mathematical thinking and social skills.

These targeted strategies can enhance the implementation of collaborative learning in a more appropriate and developmentally appropriate manner for early childhood.

5.3. Limitations and Recommendations

This study has limitations in terms of the scope of participants and the perspectives used. The main focus of the study was only on how teachers and students perceived and received during the collaborative numeracy learning process, without involving perspectives from the students itself who could actually provide additional insights into specific children's numeracy skills as the one received and doing the tasks. In addition, the sample of this study was limited to two schools from similar institutional backgrounds. Nevertheless, teachers' understandings and approaches to collaborative learning in numeracy showed significant variations, indicating the importance of considering the diversity of pedagogical understandings that could have enriched the analysis of collaborative numeracy strategy.

The findings will achieve greater practical significance across different early childhood education settings and their general applicability will be extended through diverse sample inclusion. Research examining the lasting effects of collaborative learning on children's numeracy skill development must use longitudinal methods. Longitudinal studies could also provide insights into the long-term impact of collaborative learning on numeracy skills development. In addition, richer data collection methods such as video recordings of learning interactions and written reflections from teachers can provide a deeper understanding of the dynamics of interactions between students, the scaffolding strategies used, and how collaboration is formed and developed during the learning process. Thus, further studies can provide a more comprehensive contribution to the development of collaborative-based numeracy teaching practices in early childhood education. Teachers training also needed to enlarge teachers understanding about the pedagogical strategy that can be used to teach early numeracy for early learners in kindergarten settings.

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APPENDICES

APPENDIX 1: OBSERVATION SHEETS

Name of Teacher :
Name of Class :
Theme/Sub Theme :
Date/Time :

NO.	Features of Collaborative Learning	Description	Observed (Checklist)	Notes/Comments
1.	Active participation (Le et al., 2018)	*Siswa berkontribusi dalam diskusi dan kegiatan kelompok dalam menyelesaikan tugas numerasi secara aktif.* Students actively contribute to the discussion and group work activity in completing numeracy tasks.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	
2.	Sharing idea and thoughts (LeJeune, 2003; Le et al., 2018)	*Siswa menyampaikan pendapat, gagasan, atau strategi dalam menyelesaikan tugas numerasi.* Students express their opinions, ideas, and strategies in solving numeracy tasks.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	

3.	Listening Attentively (Le et al., 2018)	*Siswa memperhatikan dan merespons ide dari teman kelompoknya dalam menyelesaikan tugas numerasi.* Student listens to and responds to their group members' ideas when working on numeracy tasks.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	
4.	Joint decision making (Le et al., 2018)	*Siswa membuat keputusan secara demokratis dalam menyelesaikan tugas numerasi, bukan dipimpin oleh satu orang saja.* Students make decisions democratically when completing numeracy tasks, rather than being led by just one person.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	
5	Solving common tasks (LeJeune, 2003)	*Siswa menyelesaikan masalah atau tugas numerasi secara kolektif.* Students completing the problem or numeracy tasks collectively.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	
6	Giving and receiving feedback (Le et al., 2018)	*Siswa saling memberi masukan terhadap ide/pendapat satu sama lain dalam tugas numerasi.*	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%)	

		Students give each other feedback on ideas and opinions during numeracy tasks.	☐ None	
7	Helping and supporting each other (Le et al., 2018)	*Siswa membantu anggota yang mengalami kesulitan secara kolaboratif dalam tugas numerasi.* Students collaboratively help group members who are experiencing difficulties with numeracy tasks.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	
8	Group Reflection (Scoular, et al. 2020)	*Siswa mengevaluasi proses dan hasil kerja mereka bersama dalam menyelesaikan tugas numerasi.* Students evaluate their collective process and result in completing numeracy tasks.	☐ All students ☐ Most students (≥50%) ☐ Few students (<50%) ☐ None	

APPENDIX 2: STUDENT WORK ANALYSIS INSTRUMENT

RQ 2 : How does collaborative learning in group work activities support students' numeracy learning?

Level A (4-5 years)

Name of Teacher :
Theme/Sub Theme :
Date/Time :
Working in Group at least consists of 2-4 children.

No	Name of Group/Students	Description of Task	Student's Activity in Collaborative Group Work	Task's Result of Group/Students	Student Achieved Outcome/Skill	Reasons/Comments
					Please give a checklist of the indicators achieved by students: ☐ Demonstrate concepts of counting using everyday experiences (ACARA, nd). ***(Counting)*** ☐ Recognise the effects of adding to and taking away from a collection of objects (ACARA, nd). ***(Counting)***	

					☐ Compare the number (many-few) of objects around them without using one-one correspondence (Standar & Kurikulum, Kemendikbud, 2023) ***(Counting)*** ☐ Demonstrate an understanding of one-to-one correspondence using concrete objects **(One-to-one correspondence)** (Standar & Kurikulum, Kemendikbud, 2023) ☐ Understand that the last number mentioned indicates the number of objects	

					counted (Standar & Kurikulum, Kemendikbud, 2023) ***(Cardinality)*** *Others (Write below! if any)* □	

APPENDIX 3: STUDENT WORK ANALYSIS INSTRUMENT

Level B (5 -6 years)

Name of Teacher :

Theme/Sub Theme :

Date/Time :

Working in Group at least consists of 2 to 4 children.

No	Name of Group/Students	Description of Task	Student's Activity in Collaborative Group Work	Task's Result of Group/Students	Student Achieved Outcome/Skill	Reasons/Comments
					Please give a checklist of the indicators achieved by students: ☐ Connect and order numbers, numerals, and groups of objects using numbers up to two digits ***(Counting)*** ☐ Solve everyday addition and share stories. (ACARA, nd). ***(Counting)*** ☐ Compare the number (many-few) of objects around them without using one-one correspondence (Standar & Kurikulum,	

					Kemendikbud, 2023) ***(Counting)*** □ Demonstrate an understanding of one-to-one correspondence using concrete objects **(One-to-one correspondence)** (Standar & Kurikulum, Kemendikbud, 2023) □ Understand that the last number mentioned indicates the number of objects counted (Standar & Kurikulum, Kemendikbud, 2023) ***(Cardinality)*** *Others (Write below, if any!)* □	

APPENDIX 4 : INTERVIEW INSTRUMENT SHEETS

Name of Teacher :

Theme/Sub Theme :

Date/Time :

Education Background :

No.	Source and Reference	Theme	Component Analysed	Questions according to the references	Reconstruct Questions
1.	(Le et al. (2018)	General viewpoint of teacher learning through collaboration in small groups		● What do you understand about student collaboration in small groups? What is the definition and goals of collaborative learning in the practice of developing numeracy skills? ● In your view, what is an effective learning group?	Adopted
2	Le et al. (2018)	The enablers that early childhood educators face in orchestrating collaborative learning in group activities to support students' numeracy learning.	Collaborative task construction	What are the elements that you often take into consideration when designing collaborative tasks?	What factors support you in designing collaborative tasks for early childhood students' numeracy learning?
			Group composition	Can you share your experience about what kind of grouping worked well?	Based on your experience, what kind of group composition worked well for numeracy learning among early childhood students?
			The teacher's roles while the	What do you think about the skills	Based on your experience, what skills do students

			groups are working	needed for students to work successfully in a group?	need to successfully collaborate in numeracy learning?
			Assessment of student learning through collaboration in groups	How do you assess the collaborative work of a group?	What helps you in assessing the performance of collaborative groups in numeracy learning?
3	Le et al. (2018)	The challenges that early childhood educators face in orchestrating collaborative learning in group activities to support students' numeracy learning.	Collaborative task construction	What were difficulties you experienced as preparing collaborative tasks?	What were the challenges you experienced in designing collaborative tasks in numeracy learning?
			Group composition	What were difficulties you experienced as grouping students?	What were the challenges you experienced when grouping students in numeracy learning?
			Teacher's roles while groups are working	What were difficulties you experienced as promoting skills needed for students to work successfully in a group?	What were the challenges you experienced in promoting skills needed for students to work in group in numeracy learning?
			Assessment of student learning through collaboration in groups	What were difficulties you experienced as assessing student learning?	What were the challenges you faced when assessing student numeracy learning through collaboration in groups?

APPENDIX 5 : RESEARCH PERMIT

Universitas
Islam Internasional
Indonesia

Kementerian Agama Republik Indonesia
Universitas Islam Internasional Indonesia
Jalan Raya Bogor KM. 33.5
Cisalak, Sukmajaya, Depok, Jawa Barat 1641E
secretariat@uiii.ac.id
www.uiii.ac.id

Nomor : 149/Dek.FIP/UIII/UM.02/4/2025
Lampiran : -
Hal : Permohonan Izin Penelitian

Depok, 25 April 2025

Kepada Yth.
Kepala Sekolah TKIT Mutiara Islam Depok

Assalamu'alaikum Wr. Wb.,

Dengan ini kami menyatakan bahwa mahasiswa di bawah ini:

Nama	: Nafisah
NIM	: 04212310010
Fakultas	: Fakultas Ilmu Pendidikan
Program Studi	: Magister Ilmu Pendidikan

sedang melakukan penelitian untuk tesis dengan rincian sebagai berikut:

Judul	: *Exploring the Practice of Supporting Early Childhood Students' Numeracy Skills through Collaborative Learning in Working Group Activities*
Lokasi Penelitian	: TKIT Mutiara Islam Depok
Waktu Penelitian	: ± 1 bulan

Kami memohon bantuan Ibu/Bapak untuk memberikan izin penelitian kepada mahasiswa tersebut. Data penelitian hanya akan digunakan untuk tujuan akademis dan tidak akan digunakan untuk tujuan lain.

Demikian kami sampaikan, atas perhatian dan kerja sama Ibu/Bapak kami ucapkan terima kasih.

Wassalamu'alaikum Wr. Wb.,

Hormat kami,
Dekan Fakultas Ilmu Pendidikan

Universitas Islam Internasional Indonesia
Faculty of Education

Prof. Nina Nurmila, PhD

APPENDIX 6: RESEARCH CONSENT

1 of 1

Taman Kanak-Kanak Islam Terpadu (TKIT)

NURUL IZZAH

"Membentuk Generasi Rabbani Yang Cerdas, Berkualitas Dan Bertaqwa"

No : **53 /TKIT NI/V/2025**

Lampiran :-

Perihal : **Balasan Permohonan Izin Penelitian**

Kepada Yth. Nafisah

Kementrian Agama Republik Indonesia

Universitas Islam Internasional Indonesia

Di Tempat

Assalamu'alaikum Warahmatullahi Wabarakatuh

Dengan hormat,

Menanggapi Surat Nomor : 150/Dek.FIP/UIII/UM.02/4/2025 Tanggal 25 April 2025 Perihal Permohonan Izin Penelitian, pada mahasiswa sebagai berikut :

Nama Lengkap : Nafisah

NIM : 04212310010

Fakultas : Fakultas Ilmu Pendidikan

Program Studi : Magister Ilmu Pendidikan

Kegiatan Penelitian tersebut untuk disertasi dengan rincian sebagai berikut :

Judul Disertasi : Exploring the Practice of supporting Early Childhood Students' Numeracy Skill through Collaborative Learning in Working Group Activities

Sasaran Penelitian : Kelompok Usia 4-5 Tahun dan kelompok Usia 5-6 tahun TKIT Nurul Izzah

Waktu Penelitian : April – Mei 2025

Bersama ini kami sampaikan bahwa mengizinkan untuk melakukan penelitian yang dimaksud. Dengan surat balasan ini kami buat dengan sebenarnya untuk dipergunakan sebagaimana mestinya.

Depok, 30 Mei 2025

Kepala TKIT Nurul Izzah

Risyani, S.Pd

APPENDIX 7 : OBSERVATION ANALYSIS

Statement	Observer 1	Observer 2	Observer 1	Observer 2	Observer 1	Observer 2	Observer 1	Observer 2				
	TK A (X)	TK A (X)	TK A (Y)	TK A(Y)	TK B (X)	TK B (X)	TK B (Y)	TK B (Y)				
Students actively contribute to the discussion and group work activity in completing numeracy tasks.	All students	All students masuk	Most students (≥50%)	Most students (≥50%)	Most students (≥50%)	Most students (≥50%) masuk	Most students (≥50%)	Most students (≥50%)	Open Code	Axial Coding	Theme	Collaborative Features
	All students were actively	The Number Pyramid activity	A Most students were active in the two	Students active in doing	Most students were active in the three	Pair activity is most engaging for students	Even though most of the	Students were active in working	actively contribute, participate,	1) Interaction Driven by Task Structure	Active Contribution in	☑ 1. Student Participation
Students express their opinions, ideas, or strategies in solving numeracy tasks.	Most	Few	Few students	Few students	Few students	Few students	Few	Few				
	In the pyramid construction and puzzle activities	Need more activity to let the students give an	In both activities, there was little exchange of ideas, as most children	Mostly students only focus on their own tasks there	In the number card and missing number activities	Need more activity to let the students give an opinion	The students only asked in the end of the	Students seen to help closest friend to	Students planned strategies in pyramid and puzzle	Limited Verbal Expression of Strategy Task Design	Expression of Mathematical Thinking	☑ 3. Mathematical Dialogue
Student listens to and responds to their group members' ideas when working on numeracy	Most	Most students (≥50%)	Few students	Few	Few students	Most students	Most students	Most				
	In the pyramid construction		A few students attempted to respond to their	There was some students	In the bottle cap counting activity.	students were a bit unaccustomed	Even with individual activity	Students itself building	attention to and responded	Peer-to-peer interaction during	Responsiveness to Peer	☑ 2. Peer Scaf
Students make decisions democratically when completing numeracy tasks, rather than being led by just one person	Most	Most	None	None	Few students	Few students	Few	Few				
	Joint decision-making was done by most	No dominant student in class, each student has a balance	No joint decisions were made during the activities.	Only the discussion with teacher to each individual	Joint decision-m	No dominant student in class, each student has a balance	There wasn't a dominant student figure in	There were no students who tend to work together	Joint decision-making during pyramid and	Democratic Collaboration in Group Tasks Absence of Dominant	Democratic Decision-Making in	☑ 1. Student Participation Through Interdepende

APPENDIX 8 : STUDENT WORK ANALYSIS

Class	name of the activites	activites	numeracy skills outcome	collaborative Indicator	presentation of participatio	indicated as	observer comments
Class A	1.Constructing a pyramid according to number order	a.The teacher divides	•Demonstrate an understanding of one-to-	1. Active participation (Le et al., 2018)	1 dan 7 : All students 2- 6 : Most students (≥50%)	strong collaborative activities	1. In the pyramid construction activities, students
Class A	2.Arranging number puzzles	a.Groups of students are given the task	•Understand about the symbol of number 1-10 and	1. Active participation (Le et al., 2018) 2.Sharing idea and	2 dan 7 : All students 2- 6 : Most students (≥50%)	tengah2 kolaboratifnya	puzzle activities, students planned strategies for
Class A	3. Pasting collage materials onto numbers.	a. Groups of students are	¨ Understand about the symbol of number 1-10	1. Active participation (Le et al., 2018)	3 dan 7 : All students 2- 6 : Most students (>50%)	weak collaborat	activity, there was little exchange of
Claas B	1. Number cards	are asked to surround a	Understand that the last number mentioned	1. Active participation (Le et al., 2018)	2,3,,4,6 : Few students (<50%)7-8 : Most students	weak collaborative	collaborative tasks were well designed,
Claas B	2. Identifying missing num	Groups of students are the missing	Connect and order numbers, numerals, and groups of objects using	1. Active participation	1.Most studentsMost students (≥50%) 2. Few students (<50%) 3. Most	weak collaborative	.Most students helped each other during numeracy
Claas B	3. Counting bottle caps	paired up the students.	and share stories. (ACARA, nd). (Counting)	1. Active participation (Le et al., 2018)	1.Most studentsMost students (≥50%) 2. Few students (<50%) 3. Most	collaborative numeracy	occurred only slightly, mostly during

APPENDIX 9 : INTERVIEW RESULT EXAMPLE

Questions	Teacher 1 –	Teacher 2 – CLASS	Teacher 3 –	Teacher 4 –	Initial ideal	axial code	themes	Main Theme
What do you understand about student collaboration in small groups? What is the	Miss Lita explained that collaborative activities help children learn to	This means that during collaboration, children work together and help	So, as mentioned earlier, the teaching involved combining several activities, such as	Collaboration among students, in my view, is a concept that	Learning to cooperate and reduce peer selectiveness	Peer support and mutual assistance → (codes 2, 3, 5, 9,	Collaborative learning enhances numeracy development	teachers understanding on collaborative learning
In your view, what is an effective learning group?	"In my opinion, smaller groups tend to be more conducive	Perhaps, in collaboration within a group, we can divide the children	Based on my observations so far, children tend to enjoy activities	In my opinion, it is very important to instill the value	Small group size is more manageable Mixed-	Group size and structure → (1, 2, 3) Role	"Effective Group Dynamics in Early	"Effective Group Dynamics in Early Numeracy Collaboration"
What factors support you in designing collaborative tasks for early childhood students' numeracy	In teaching collaborative numeracy, teaching aids must be thoroughly	Media can be one of the factors that assist in the learning process, especially regarding the	The main consideration usually comes from the children's preferences or interests	In my opinion, the use of teaching aids greatly supports the learning	teaching aids and media to assist learning processTea	Use of teaching aids and concrete materials → (1, 3, 4, 8, 9) Child-centered	"Child-centered task design supported by concrete media and	
Based on your experience, what kind of group composition worked well for numeracy learning	So far, in one session, there are usually various activities—around three or four—but not all of them are	Group division is usually done by the children themselves, but the teacher also intervenes. For	Usually, we design the activity by dividing the children into three groups: group one, two, and three	Regarding effective group composition, I believe it is important to mix students	Anak antusias dengan kerja kelompok, bertanya	Antusiasme dan minat terhadap kolaborasi → (1, 7) Komposisi	"Heterogeneous grouping and structured turn-taking in collaborative numeracy	
Based on your experience, what skills do students need to successfully	Actually, when dividing the groups, the teacher can arrange the	To support effective collaboration, the teacher first provides	Previously, we conducted an activity themed around a traditional market by creating	Peer communication plays a crucial role in group work	Guru memilih siswa berkemampuan tinggi	Peer leadership and role balancing → (1, 2) Teacher	"Collaboration through guided roles, communication, and	
What helps you in assessing the performance of collaborative groups in numeracy learning?	we used a checklist, anecdotal notes, and portfolios as assessment tools. During the collage	The assessment focuses not only on the children's knowledge but also on their ability to help and	First, the assessment focuses on the children's teamwork within the	The first thing I observe to assess whether the child understands	Menggunakan checklist, catatan anekdot, dan	Assessment tools and documentation → (1) Collaboration and social	"Assessment through cooperation, comprehension, and balanced	
								challenges in orcastrating collaborative in working group numeracy learning
What were the challenges you experienced in designing	The difficulty lies in selecting activities that can be effectively	Perhaps the challenge in the first activity was when the children	The challenge and difficulty arise when we want to find resources or	In my opinion, teaching aids play a significant role	Tidak semua aktivitas cocok untuk	Task suitability and children's readiness	"Challenges in task design, instruction, and	Instructional and Developmental Barriers in Designing
What were the challenges you experienced when grouping students in numeracy learning?	To create a conducive environment, I have tried certain methods. For example, in yesterday's	The challenge is that when children collaborate to help each other, sometimes we have to manage their grouping. They	It seems not too difficult to manage the groups, especially group B. Group B has begun to understand the	Children can't always choose their own group members. If they only want to be with	Anak memilih teman yang akrab atau dekat Kecenderungan selektif	Friendship-based grouping and teacher intervention → (1, 2, 4) Group	"Grouping issues: selectivity, balance, and socio-emotional goals."	Grouping Issues: Selectivity, Balance, and Socio-Emotional Goals