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Child-Friendly Education: Fostering Mathematical Communication in Primary School Children

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Abstract

Child-friendly education has a high urgency in developing students' mathematical communication in primary schools. Child-friendly education creates a learning environment of holistic development, communication in social interaction. The research objectives in this article are twofold. First, to describe the learning process of mathematics in child-friendly education in primary schools. Second, to explore the growth and development of mathematics communication in child-friendly education in primary schools. The overall research type is research and development. The research type of this article is qualitative case study. Data collection was by interview, observation and document analysis. The researcher was present as the key instrument. Data validity, triangulation of sources and methods. Data analysis cyclical flow model and constant comparison. Research results; 1) Child-friendly education provides opportunities for fun learning, development and prosperity. The research school provides a) hands-on learning experiences, b) constructive activities, and c) space for growth. Maths learning in child-friendly education goes through three stages. Providing opportunities for learners to utilise physical and non-physical facilities. 2) Mathematics learning in child-friendly education at the research schools fostered all aspects of mathematical communication. Horizontal communication development, average 34.74 to 48.87. Vertical communication development, average 33.78 to 63.83. Oral communication growth, average 33.70 to 52.43. Growth and development of written communication, average 33.70 to 49.61. Growth and development of integrative communication, average 33.83 to 53.35.

Keywords: *Child-Friendly Education, Development, Mathematical Communication, Mathematical Learning, Primary School.*

Introduction

Child-friendly education has a high urgency in fostering learners' mathematical communication in primary schools. Child-friendly education creates a learning environment that supports learners' holistic development, including communication skills that are essential in social interaction. A safe, inclusive and caring environment allows learners to be more confident in expressing ideas, discussing and collaborating with peers and teachers. This is in line with research findings that a conducive learning environment can improve learners' communication skills (Makwarela et al., 2017; Cross et al., 2012). Child-friendly education also supports the development of important social and emotional skills in communication, such as empathy, active listening and expressing oneself effectively (Novitasari et al., 2022; Hakkarainen & Bredikyte, 2019). Therefore, the implementation of child-friendly education is crucial in ensuring the communication development of primary school learners.

Learning mathematics in child-friendly education will be more optimal if it is integrated with mathematical communication. Acculturation of mathematical communication in learning is managed from horizontal, vertical, oral, written, and integrative aspects (Alasuutari et al., 2024; Adegoke, 2013). In addition, mathematical communication is carried out by teachers to create learning effectiveness by establishing social competence in the school, family and community environment (Jarl et al., 2024; Cobanoglu & Sevim, 2019).

The results of preliminary observations, at the research site, the main problem in learning mathematics is related to the limited strategies that integrate mathematical communication in child-friendly education. This is supported by the results of interviews with teachers, the tendency of teachers is still focused on results-oriented, so it does not provide space for students to develop mathematical communication actively and creatively. In addition to this, the results of document analysis, supporting facilities for interactive and child-

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friendly learning, such as teaching aids and digital media are still limited, thus hindering the achievement of holistic learning goals.

The root cause of the problem at the research site was limited understanding and application of pedagogical approaches that support effective and child-friendly communication. Teachers tend to use memorisation and problem-solving strategies, without considering the importance of interactive and collaborative mathematical communication. In addition, there is a lack of ongoing training for teachers in integrating child-friendly education principles into mathematics learning.

Previous research related to mathematics learning and mathematical communication in child-friendly education has been conducted. Research in the United States showed that the implementation of child-friendly education in mathematics learning with adequate resources improved learners' communication skills (Mhaidat et al., 2024; Anthony & Walshaw, 2009). The difference with the author's research is that it examines child-friendly education in schools with limited resources and in normative environments. A study conducted in Finland revealed that a national curriculum designed with child-friendly principles facilitated communication (Wang, 2024; Björklund et al., 2018). The main difference with the authors‘ research is that this study was conducted in a country with a well-established and excellent education system, while the authors’ research focuses on implementation challenges in resource-limited education settings.

Research in Australia, the use of technology in learning mathematics in child-friendly education provides opportunities for learners to develop communication (Disney & Li., 2022). The main difference with the author's research is that the Australian research is in schools with advanced technology, while the author's research explores the development of mathematical communication in child-friendly education with limited technology. Research in Singapore found that child-friendly education helps learners develop communication through problem-based learnin (Kaur, 2014). The difference is that the Singapore study was conducted in a school with strong support, while the authors' study was conducted in a school with limited infrastructure and support.

Research in China revealed that child-friendly education has not been fully implemented but emphasises the importance of a collaborative culture to support idea sharing, communication and mathematical solutions (Meng et al., 2021). This study focuses more on pedagogical changes, while the authors' research focuses on teacher management and appropriate media utilisation. Research in South Africa, child-friendly education is starting to be adopted, the main challenges are limited access to materials and insufficient teacher training (Mukuka et al., 2023). The difference with the author's research is that it emphasises that child-friendly education can be optimised in a school environment with limited resources and technology.

Based on this description, the research objectives in this article are twofold: 1) to describe the learning process of mathematics in child-friendly education in elementary schools. 2) to explore the growth and development of mathematical communication in child-friendly education in primary schools.

Methodology

The whole research is research and development. The type of research in this article is qualitative case study. Qualitative research is research used to master social or human phenomena from the perspective of people involved in the situation. Qualitative research focuses on the meanings, experiences and interpretations given by individuals to specific situations or events (Creswell & Poth, 2021). Case study research design to analyse in depth the implementation of child-friendly education in primary schools (Sutama, 2019). This research examines the application of mathematics learning in child-friendly education in primary schools in developing students' mathematical communication.

The research was conducted at Muhammadiyah 1 Elementary School in Surakarta. The address of the research site is on Jalan Kartini No.1, RT.01/RW.09, Ketelan, District. Banjarsari, Surakarta City, Central Java 57132. The research was conducted from July 2023 to December 2023. The research subjects were the principal, teachers, and students of grade 4 of the research site. The researcher was present as the key instrument.

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Research data consists of primary and secondary data. Primary data is data collected directly from the original source by researchers for specific research purposes (Groves et al., 2021). Secondary data is data that has been collected by others for purposes other than the research being conducted by the researcher (Saldaña, 2021; Johnston, 2017).

Data collection techniques included in-depth interviews, participatory observation, and document analysis. In-depth interviews were used to obtain detailed and in-depth information about the experiences, views, and perceptions of individuals related to the research objectives (Bryman, 2022; Saldaña, 2021). Participatory observation where the researcher is directly involved in the activities being researched. Participatory observation allows the researcher to observe and master the phenomenon by interacting and participating in the daily activities of the research subjects (Hammersley & Atkinson, 2023; Emerson et al., 2022). Document analysis involves the collection, evaluation, and interpretation of relevant documents to master the context, themes, and meaning in the case study. Documents analysed are various types of written materials, records, archives, and administrative documents (Bowen, 2022; Prior, 2022).

The validity of the research data with source and method triangulation. Source triangulation involves comparing data obtained from various sources, to ensure that research findings are consistent and valid (Flick, 2023; Denzin, 2021; Morse & Niehaus, 2021). This method helps researchers to verify data by exploring different perspectives, thus providing a more comprehensive and accurate picture of the phenomenon under study. Method triangulation is used to increase data validity by combining various data collection methods. Method triangulation involves using different methods, to obtain a more complete and valid picture of the case under study (Flick, 2023; O'Leary, 2022; Johnson & Onwuegbuzie, 2021).

Data analysis techniques were conducted using the cyclical flow method and constant transparency. The cyclical flow method is a data analysis technique that involves an iterative process of data collection and analysis. Researchers continuously collect, analyse, and interpret data iteratively (Richert & Schlesinger, 2022; Glaser & Strauss, 2021). The constant comparative analysis technique is an approach in qualitative data analysis, where the data collected is continuously compared with other data to identify similarities, differences, and key themes. Researchers categorise data, look for patterns, and then compare them with new data collected (Prayogi et al., 2022; Charmaz, 2021).

The cyclical data analysis process consists of data collection, data reduction, data presentation, verification, and conclusion drawing. The data analysis activities are illustrated in Figure 1.

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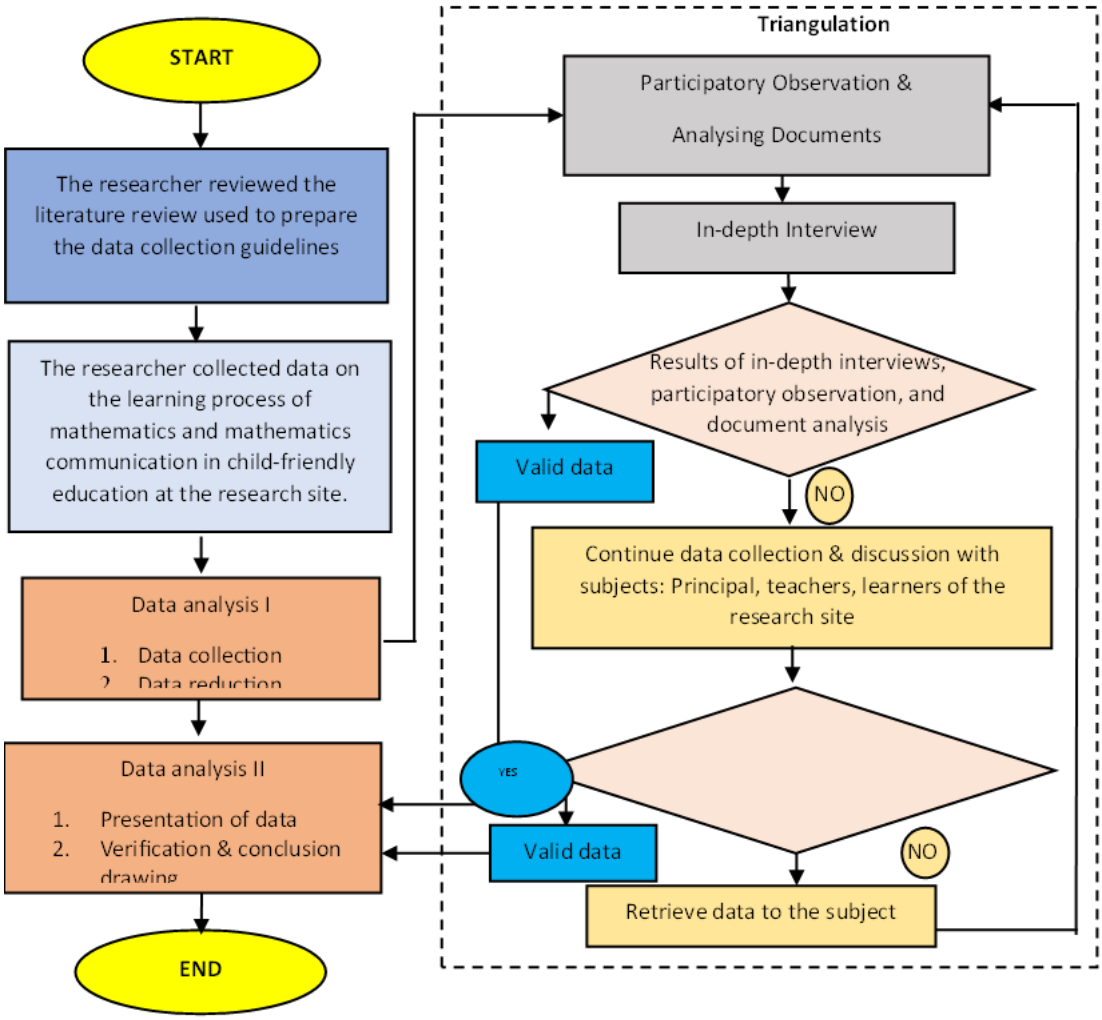

Fig. 1. Cyclical Flow of Data Analysis Techniques

Results

Learning Maths in Child-Friendly Education in Primary Schools

Child-friendly education provides opportunities for fun learning, development and prosperity as a foundation for future educational growth. An interview with the principal of the research school stated that to organise child-friendly education, the school organised in-house training on a) hands-on learning experiences, b) constructive activities, and c) providing space for growth.

This is in line with the grade 4 mathematics teacher of the research school who stated that the school prepares direct learning experiences to improve concept understanding by experimenting, logic and creativity with real objects. The direct learning experience can be illustrated in Figure 2.

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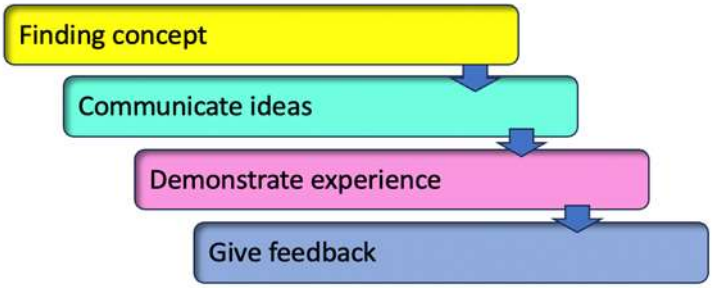

Fig. 2. Hands-On Learning Experience

On another occasion, the teacher stated that the concept of Child Friendly Education is an approach that emphasises respect for each learner, creating a supportive learning environment and building positive communication. This was supported by another teacher at the research school who revealed, "We try to make every learner feel valued in the learning process, especially in maths lessons which are often considered difficult".

Participatory observation results obtained, a) inclusive classroom environment, the classroom is organised in a way that supports communication between learners and between learners and teachers. Teachers move around to give attention to learners who need help. This is supported by the results of interviews with learners who said, "The teacher always comes to my desk if I have difficulties". b) Teachers use various media and props to facilitate understanding of mathematical concepts, such as using building blocks to explain volume. This is supported by the results of interviews with learners who said, "I understand more about volume when the teacher shows me with building blocks". c) Learners are encouraged to work in groups and help each other in solving problems. This is supported by the results of interviews with learners who said, "I really like working in small groups, because all mathematical concepts and problems can be done together".

The results of the document analysis of the curriculum applied in the research schools have been adjusted to the principles of child-friendly education, namely the emphasis on personalised learning approaches and appreciation of the diversity of learners' abilities. This is supported by the results of interviews with principals and mathematics teachers who stated that the curriculum implemented has been adjusted to a personalised learning approach and appreciation of the diversity of learner characteristics.

The results of the document analysis of mathematics lesson plans showed the use of various strategies to meet the needs of different learners. This is supported by the observation of mathematics learning at the research school, where mathematics learning utilises contextual, collaborative and problem-solving strategies. Interviews with mathematics teachers at the research schools indicated that classroom management strategies focused on creating a positive learning environment where learners felt safe to express themselves without fear of making mistakes. The observation results of each activity are presented below.

In the preliminary activities of learning mathematics at the research school, the teacher started the learning by greeting the learners, creating a friendly and pleasant atmosphere. The teacher checked the learners' attendance and ensured that they were ready to learn. The teacher also asked about the learners' health or feelings. The teacher conducts a brief review of the previously learnt material in relation to the material to be learnt. To attract learners' interest, the teacher asks contextual questions related to daily life. Learners analyse the learning objectives, including what they need to master. The teacher provides an overview of the learning process, including individual or group activities, and the assessment process that will be conducted.

In the core activities of learning mathematics at the research schools, teachers conducted various activities designed to help learners master mathematical concepts in depth and develop learners' mathematical communication skills. Teachers begin core activities by presenting new material through direct explanation,

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demonstration, or the use of props and visual media. The presentation of this material is related to everyday life. The teacher encourages learners to actively participate in class discussions. Learners are invited to ask questions, give opinions, and argue about the mathematical concepts being learnt.

In the next core activity, the teacher divides learners into small groups to work together to solve mathematical problems. In these groups, learners are encouraged to discuss, exchange ideas, and help each other master mathematical concepts. The teacher provides various problem-solving exercises, ranging from simple problems to more complex problems. Learners are asked to complete the exercises either individually or in groups, with the teacher providing guidance and feedback throughout the process.

In the closing activities of mathematics learning in the research schools, teachers took several steps to end the learning session effectively. Teachers start the closing activity by summarising the main concepts that have been learned during the learning session. Teachers ask reflective questions to encourage learners to think back about the material that has been learnt. The teacher provides feedback based on learners' participation during the lesson. The teacher provides short assessments such as quizzes or short questions to evaluate learners' understanding. The teacher provides additional exercises related to the material that has been learnt. Before ending the lesson, the teacher conveys expectations and motivation to the learners.

The results of the analysis of assessment documents show that assessment in mathematics learning does not only focus on the end result, but also on the process, including active communication of learners in discussions and group activities. This is supported by the results of interviews with mathematics teachers at the research schools who stated that assessment is carried out before and after learning in affective, cognitive and psychomotor aspects.

Fostering Mathematical Communication in Child-Friendly Education

Mathematical communication is the ability to convey mathematical ideas, arguments, and understanding clearly and logically through various forms, namely horizontal, vertical, oral, written, and integrative. The results of observations, there is a growth of horizontal communication when students are active in collaborative learning groups, open, and problem solving. This is supported by the results of document analysis which shows that there is horizontal communication growth and development, namely before mathematics learning in child-friendly education, the highest score is 38, the lowest score is 31, the average is 34.74, and the standard deviation is 1.81. After mathematics learning in child-friendly education, the highest score was 52, the lowest score was 46, the average was 48.87, and the standard deviation was 1.76.

The results of observations, there was vertical communication growth when presenting the results of the discussions. This is supported by the results of document analysis which shows that there is vertical communication growth, namely before learning mathematics in child-friendly education, the highest score is 38, the lowest score is 30, the average is 33.78, and the standard deviation is 1.88. After mathematics learning in child-friendly education, the highest score was 68, the lowest score was 60, the average was 63.83, and the standard deviation was 1.80.

The results of observations, there was a growth in oral communication when listening and being able to pay attention to the body language of both teachers and other students. This is supported by the results of document analysis which shows that there is growth in oral communication, namely before mathematics learning in child-friendly education, the highest score is 38, the lowest score is 30, the average is 33.70, and the standard deviation is 1.82. After mathematics learning in child-friendly education, the highest score was 57, the lowest score was 50, the average was 52.43, and the standard deviation was 1.74.

The results of observations, there is a growth of written communication when doing group exercises on the student worksheet and independent exercises with questions from the teacher and doing post-tests. This is supported by the results of document analysis which shows that there is growth in written communication, namely before mathematics learning in child-friendly education, the highest score is 37, the lowest score is 29, the average is 33.70, and the standard deviation is 2.07. After mathematics learning

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in child-friendly education, the highest score was 54, the lowest score was 46, the average was 49.61, and the standard deviation was 1.97.

The results of observations, there was a growth of integrative communication during group discussions, presentation of group discussion results, feedback, and reflection. This is supported by the results of document analysis which shows the growth of integrative communication, namely before mathematics learning in child-friendly education, the highest score was 38, the lowest score was 30, the average was 33.83, and the standard deviation was 2.26. After mathematics learning in child-friendly education, the highest score was 59, the lowest score was 50, the average was 53.35, and the standard deviation was 1.99.

The mathematical communication of each aspect both before and after learning mathematics in child-friendly education all grew. The results of this document analysis can be illustrated in table 1.

Table 1. Development of Mathematical Communication.

Notes. Table 1. Displayed on the table 1 *Hs = High Score, Ls = Low Score,* $\bar{x}$ *= Average, Sd = Standart Deviation*

Communication Aspects	Before		After		Description
1. Horizontal Communication	$Hs_{1.1}$ $Ls_{1.1}$ $\bar{x}_{1.1}$ $Sd_{1.1}$	38 31 34,73913 1,81452	$Hs_{1.2}$ $Ls_{1.2}$ $\bar{x}_{1.2}$ $Sd_{1.2}$	52 46 48,86956522 1,760967762	Development
2. Vertical Communication	$Hs_{2.1}$ $Ls_{2.1}$ $\bar{x}_{2.1}$ $Sd_{2.1}$	38 30 33,7826087 1,88188741	$Hs_{2.2}$ $Ls_{2.2}$ $\bar{x}_{2.2}$ $Sd_{2.2}$	68 60 63,82608696 1,799399899	Development
3. Oral Communication 1	$Hs_{3.1}$ $Ls_{3.1}$ $\bar{x}_{3.1}$ $Sd_{3.1}$	38 30 33,69565217 1,820471179	$Hs_{3.3}$ $Ls_{3.3}$ $\bar{x}_{3.3}$ $Sd_{3.3}$	57 50 52,43478261 1,742091083	Development
4. Written Communication	$Hs_{4.1}$ $Ls_{4.1}$ $Sd_{4.1}$	37 29 33,69565217 2,073152619	$Hs_{4.4}$ $Ls_{4.4}$ $\bar{x}_{4.4}$ $Sd_{4.4}$	54 46 49,60869565 1,970216961	Development
5. Integrative Communication	$Hs_{5.1}$ $Ls_{5.1}$ $\bar{x}_{5.1}$ $Sd_{5.1}$	38 30 33,82608696 2,262504817	$Hs_{5.5}$ $Ls_{5.5}$ $\bar{x}_{5.5}$ $Sd_{5.5}$	59 50 53,34782609 1,987914694	Development

Notes. Table 1. *Displayed on the table 1 Hs = High Score, Ls = Low Score,* $\bar{x}$ *= Average,*

Sd = Standart Deviation

Discussion

Learning Maths in Child Friendly Education in Primary School

Child-friendly education provides opportunities for fun, development and prosperity. The implementation of child-friendly education in the research schools began with in-house training. Child-friendly education provides hands-on learning experiences. This is supported by the results of previous research which states that direct learning experiences improve critical thinking, communication, curiosity, and explore students' abilities and personal experiences (Haryadi et al., 2021; Louws et al., 2017; Zohar et al., 2001). This means that child-friendly education in providing hands-on learning experiences ensures that each learner gets the

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opportunity to learn through direct interaction with the environment, materials and peers, according to their own pace and way of learning.

In child-friendly education, the research schools provide space for learners to grow. Growth spaces are used to experiment, explore and reflect on progress and interpret ideas. In this way, skills are acquired to foster curiosity and sharpen creative thinking capacity, so that schools place learners on an ideal developmental path. This is supported by the results of previous research which states that child-friendly education needs to provide physical and psychological spaces that allow learners to engage in the process of exploration and reflection (Sa'diyah & Nurhayati, 2023; Abendroth & Richter, 2021). This means that the growth space is a place to experiment, explore, and reflect on progress and interpret ideas, so that learners can develop communication, critical and creative thinking optimally.

In the preliminary activities of learning mathematics, the teacher begins the learning by saying greetings, creating a friendly and pleasant atmosphere, checking attendance and ensuring participants are ready to learn. The teacher makes apperception and asks contextual questions. Learners analyse the learning objectives and process, and the assessment process. The results of the study are in line with, preliminary activities to prepare students mentally and emotionally as well as to make apperception, motivation, and increase student involvement (Barbosa & Vale, 2021). This means that preliminary activities in learning mathematics, starting with opening greetings, creating a friendly atmosphere, checking learning readiness, apperception, and contextual questions, ensuring understanding of objectives, learning processes, and assessment techniques.

In the core activities of mathematics learning, teachers conduct various activities designed to help learners master mathematical concepts in depth and develop mathematical communication skills. This is in line with the results of previous research which states that activities focused on the exploration and application of mathematical concepts are very effective in developing communication skills (Maulyda et al., 2020). This means that the core activities of learning mathematics should involve a variety of activities designed by the teacher to deepen understanding of mathematical concepts and develop mathematical communication.

The research school teachers started the core activities by presenting the new material through direct explanation, demonstration, or the use of props, or visual media. The presentation of this material is related to daily life. Teachers encourage learners to actively participate in collaborative discussions. Learners are invited to ask questions, give opinions, and argue about the mathematical concepts learned. This is supported by (Saputri & Hasibuan, 2022; Rizqoh, 2021) which emphasises the importance of linking material to everyday life situations, encouraging active participation in discussions, and asking questions and arguing new ideas. This means that the teacher starts the core activities by presenting new material that is related to everyday life, encouraging students to actively participate in discussions, ask questions, give opinions, and argue new ideas.

In the next core activity, the teacher acts as a facilitator in group and independent training. In groups, learners are encouraged to discuss, exchange ideas, help each other master and discover mathematical concepts. Independent exercises for problem solving vary, ranging from simple problems to more complex problems. The results of this study are supported, group discussion activities and independent problem-solving exercises that vary, allowing learners to help each other and explore the material in a more in-depth way (Mentari & Syarifuddin, 2020). This means that as facilitators, teachers play an important role in the training by encouraging discussion, exchange of ideas, and helping each other, as well as completing varied problem-solving exercises.

Closing activities begin with summarising key concepts, asking reflective questions, providing feedback based on learners‘ participation during learning, and providing assessments to evaluate learners’ understanding as well as providing additional exercises to deepen learners' understanding. Before ending the lesson, the teacher conveys expectations and motivation. This is in line with (Askew, 2020), which emphasises that helping learners reflect on the material that has been learned and identify areas for future improvement. This means that closing activities related to summarising key concepts, reflective questions, feedback, assessment, additional practice, as well as conveying hope and motivation.

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Assessment is part of the concluding activities, focusing not only on the end result but also on the process, including learners' active communication in discussions and group activities. Assessment is conducted before and after learning on affective, cognitive and psychomotor aspects. In line with holistic assessment and focusing on the process not just the end result (Luneta, 2020). This means that assessment does not only focus on the final result, but also considers the process and active communication of learners in discussions and group activities, through evaluation involving affective, cognitive and psychomotor aspects.

Developing Communication Skills in Child Friendly Education

Mathematical communication is the ability to convey mathematical ideas, arguments, and understanding clearly and logically through various forms, namely horizontal, vertical, oral, written, and integrative. This is in line with, forms of mathematical communication namely horizontal, vertical, oral, written, and integrative are very important to develop a deep and holistic mathematical understanding (Beauchamp et al., 2024). This means that mathematical communication is a skill to convey mathematical ideas, arguments, and understanding clearly and logically through various forms, namely horizontal, vertical, oral, written, and integrative.

In collaborative, open-ended, problem-solving active learning, the teacher is a facilitator, and the group is organised for problem-solving. The group coordinator is the measure of the group's learning success. The group coordinator's job is to plan and supervise when students solve problems. The group moderator supports the planning and monitoring process. Learners are able or not to solve the problem observed by the group moderator. This is in the development of mathematical communication, is an encouragement, motivation, and structured learning to collaborate with each other in solving problems. Collaborative active learning, open, and problem solving are in line with (AlAli & Al Barakat, 2024; Yuniarti, 2016) which states, that this method includes strategies to foster communication, solve problems, and draw conclusions together. Collaborative, open, and problem-solving active learning can be illustrated in Figure 3.

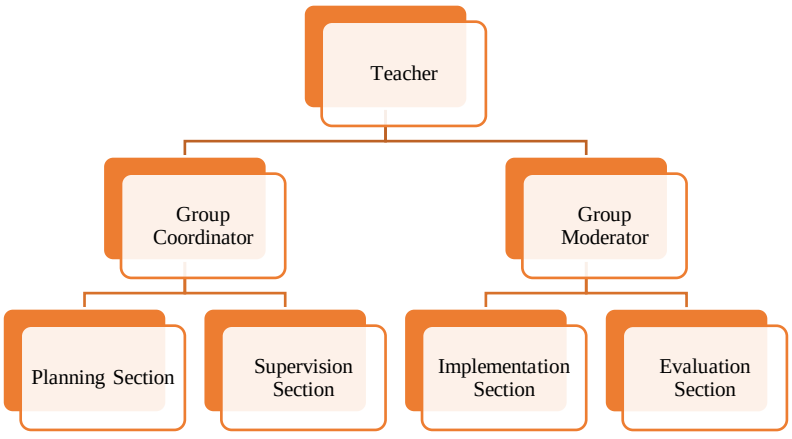

Fig. 3 Collaborative, Open-Ended, Problem-Solving Active Learning

In learning mathematics, there is a growth of horizontal communication when students are active in collaborative, open, and problem-solving learning groups. The growth and development of horizontal communication, namely before learning mathematics, the highest score was 38, the lowest score was 31, the average was 34.74, and the standard deviation was 1.81 and after learning mathematics, the highest score was 52, the lowest score was 46, the average was 48.87, and the standard deviation was 1.76. These results are in line with, horizontal communication is effective in collaborative learning for problem solving and significantly increases the score and consistency of learner performance in a child-friendly learning environment (Slavin, 2020). This means that collaborative learning in child-friendly education significantly fosters horizontal communication, as indicated by the increase in mean score and decrease in standard deviation after mathematics learning.

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In learning mathematics, there is vertical communication growth when presenting the results of the discussion. The growth and development of vertical communication, namely before learning mathematics, the highest score was 38, the lowest score was 30, the average was 33.78, and the standard deviation was 1.88 and after learning mathematics, the highest score was 68, the lowest score was 60, the average was 63.83, and the standard deviation was 1.80. These results are in line with, group presentations can significantly improve conceptual understanding and vertical communication (Uyen et al., 2021). This means that there is a significant growth in vertical communication when presenting the results of the discussion, which is reflected in the increase in the average score from 33.78 before learning to 63.83 after learning.

Vertical communication is the foundation of presentation. This is supported by (Maulida, & Prawira, 2020; Zendah, 2018) which states, the presentation process occurs due to communication and collaboration. Vertical communication tends to occur when learners present the results of their discussions. This forms two-way communication between learners and teachers and is able to resolve conflicts conducively (Ruler, 2018; Isparwoto, 2012). Vertical communication in child-friendly education is the basis for forming learner patterns and concepts (collaborative) (Shahin, 2021; Hollenbeck et al., 2012). Vertical communication is the main pillar in problem solving and critical thinkin (Erdianti & Al-fatih, 2020; Sumaji et al., 2020). On another occasion, it was revealed that presentations with vertical communication were able to create a humane situation (Ross et al., 2023; Ambarsari & Harun, 2019). The following illustrates in Figure 4, the process of vertical communication in collaborative learning.

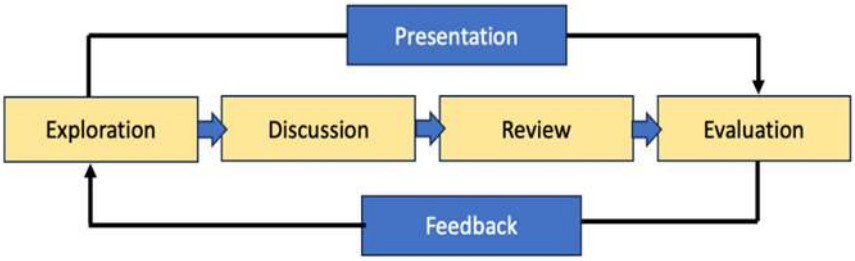

Fig. 4 Vertical Communication in Collaborative Learning

In learning mathematics, there is a growth of oral communication when listening and being able to pay attention to body language. The growth of oral communication, namely before learning mathematics, the highest score was 38, the lowest score was 30, the average was 33.70, and the standard deviation was 1.82 and after learning the highest score was 57, the lowest score was 50, the average was 52.43, and the standard deviation was 1.74. This is in line with the importance of listening skills and paying attention to body language in learning for oral communication (Selter & Walter, 2020). This means that there is a growth of students' oral communication during mathematics learning, reflected in the increase in the average score and the reduction in the standard deviation after learning. Thus, the mathematics learning in child-friendly education developed is effective in the development of oral communication.

Oral communication trains critical thinking skills in narration and discussion. This finding is supported by research which states that oral communication has the advantage of developing critical thinking and collaboration skills (Hernández et al., 2023). This means that learners need to develop the concept of discussion in improving oral communication skills that are fast, precise and effective.

In learning mathematics, there is a growth of written communication when doing group exercises on student worksheets and independent exercises with questions from the teacher as well as post-test results. The growth of written communication, namely before learning mathematics in child-friendly education, the highest score was 37, the lowest score was 29, the average was 33.70, and the standard deviation was 2.07. After mathematics learning in child-friendly education, the highest score was 54, the lowest score was 46, the average was 49.61, and the standard deviation was 1.97. This is in line with, written communication skills can be improved through structured group and independent practice (Farsani et al., 2022). This means

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that the growth of written communication shows the effectiveness of child-friendly education in deepening learners' understanding.

The mathematics learning activities in child-friendly education are not only discussions, presentations, or questions and answers, but there are also times when written communication is required. Written communication requires critical thinking when working on practice questions and post-test questions (Le et al., 2018; Sasaki et al., 2017). Written communication motivates learning and resolves conflicts conducively (Hawali & Cyrielle, 2020; Isparwoto, 2012). Written communication involves emotional and affective to sharpen learners' concept understanding (Siregar, 2019; Castro-Garcia et al., 2016). This means that written communication in learning mathematics in child-friendly education not only requires critical thinking in working on problems, but also plays an important role in motivating learning, resolving conflicts, and sharpening concept understanding by involving emotional and affective aspects.

In mathematics learning, the growth of integrative communication occurred during group discussion, presentation of group discussion results, feedback, and reflection. The growth and development of integrative communication, namely before mathematics learning, the highest score was 38, the lowest score was 30, the average was 33.83, and the standard deviation was 2.26 and after mathematics learning, the highest score was 59, the lowest score was 50, the average was 53.35, and the standard deviation was 1.99. This is supported by the theory (Vygotsky, 2019) which emphasises the importance of social interaction in learning. Furthermore (Beauchamp et al., 2024) highlights the benefits of collaborative learning, and (Slavin, 2020) clarifies the role of communication in improving learning outcomes. This means that mathematics learning at the research site supports the development of integrative communication, which is reflected in higher average scores after group discussion, presentation, feedback and reflection activities.

Conclusion

Child-friendly education provides opportunities for joyful learning, development and well-being. The research school provided a) hands-on learning experiences, b) constructive activities and c) space for growth. Learning mathematics in child-friendly education goes through three stages, namely introduction, core and closing activities. By providing opportunities for learners to use the physical and non-physical facilities that have been prepared for child-friendly education in the research school.

Mathematics learning in child-friendly education at the research schools fostered all aspects of mathematical communication. The growth of horizontal communication is reflected in the increase in the average score of 34.74 before learning to 48.87 after learning. The development of vertical communication is reflected in the increase of the average score of 33.78 before learning to 63.83 after learning. Growth and development of oral communication, reflected by an increase in the average score of 33.70 before learning to 52.43 after learning. Growth and development of written communication, reflected in the increase of average score from 33.70 before learning to 49.61 after learning. Integrative communication development, reflected by an increase in the average score of 33.83 before learning to 53.35 after learning.

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