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Exploration of The Use of Experimental Methods in Improving Children's Problem Solving Skills

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ABSTRAK. *Keterampilan pemecahan masalah sangat penting bagi anak usia dini. Anak usia dini dengan kemampuan pemecahan masalah optimal pada masa prasekolah menunjukkan capaian akademik lebih baik di pendidikan dasar dan menengah. Namun, masih banyak anak usia dini memiliki keterampilan pemecahan masalah yang rendah. Rendahnya keterampilan pemecahan masalah anak usia dini, terlihat dari ketergantungan tinggi terhadap bantuan guru, kesulitan mengidentifikasi masalah sederhana, serta terbatasnya inisiatif mencari solusi alternatif. Penelitian ini bertujuan mengeksplorasi penggunaan metode eksperimen untuk meningkatkan keterampilan pemecahan masalah anak usia dini melalui analisis proses kognitif selama kegiatan eksperimen serta mengidentifikasi faktor-faktor yang mempengaruhi efektivitas metode tersebut. Jenis penelitian adalah kualitatif deskriptif yang melibatkan 15 anak usia 4-6 tahun, 3 guru kelas, dan 5 orang tua selama delapan minggu. Data dikumpulkan melalui observasi partisipan, wawancara mendalam, serta analisis dokumentasi. Hasil penelitian mengungkapkan peningkatan keterampilan pemecahan masalah anak usia dini melalui tiga tahapan: (1) tahap awal ditandai ketergantungan pada bantuan guru, (2) tahap perkembangan memperlihatkan kemampuan mengajukan pertanyaan spesifik dan mencoba solusi mandiri, (3) tahap akhir menunjukkan penerapan pendekatan sistematis saat menyelesaikan masalah. Peran guru sebagai fasilitator melalui teknik scaffolding terstruktur serta program "Eksperimen di Rumah" yang melibatkan orang tua berhasil mendukung perkembangan keterampilan pemecahan masalah pada aspek kognitif, sosial, dan praktis. Faktor pendukung keberhasilan mencakup dukungan orang tua dan lingkungan belajar yang kondusif.*

Kata Kunci: *Metode Eksperimen, Pemecahan Masalah, Pendidikan Anak Usia Dini*

ABSTRACT. *Problem-solving skills are essential competencies for early childhood. Research shows that early childhood students with optimal problem-solving abilities during preschool demonstrate better academic achievement in primary and secondary education. However, many early childhood students still possess low problem-solving skills. This deficiency manifests through high dependency on teacher assistance, difficulty identifying simple problems, and limited initiative in seeking alternative solutions. This study aims to explore the use of experimental methods to enhance early childhood problem-solving skills by analyzing cognitive processes during experimental activities and identifying factors affecting the method's effectiveness. This descriptive qualitative research involved 15 children aged 4-6 years, 3 classroom teachers, and 5 parents over eight weeks. Data were collected through participant observation, in-depth interviews, and documentation analysis. The results revealed improvements in early childhood problem-solving skills through three stages: (1) initial stage marked by dependence on teacher assistance, (2) developmental stage showing ability to ask specific questions and attempt independent solutions, (3) final stage demonstrating systematic approach application in problem-solving. The teacher's role as facilitator through structured scaffolding techniques and the "Experiments at Home" program involving parents successfully supported problem-solving skill development across cognitive, social, and practical aspects. Supporting factors included parental support and a conducive learning environment.*

Keyword: *Experimental Method, Problem-Solving, Early Childhood Education*

INTRODUCTION

Problem-solving skills need to be developed from an early age to prepare for facing learning challenges. Reality shows that young children still experience difficulties when solving simple problems in the school and home environment. These difficulties can be seen in high dependence on teacher assistance, inability to identify simple issues, and limited initiative in finding alternative solutions (Lukman et al., 2022). Kliziene et al., (2022) revealed that young children with good problem-solving abilities in the preschool period showed higher academic achievements at the primary and secondary education levels. This data is in line with the results of research by Nurjannah (2017) proves that young children who are used to solving problems independently have more optimal cognitive, social, and emotional development than young children who always depend on the help of adults.

One effort to improve problem-solving skills in early childhood is through experimental methods. The experimental method provides concrete learning experiences through direct experiments that actively involve young children (Ermida, 2019). Ramadani & Pejchinovska-Stojkovikj (2023) define the experimental method as a way of presenting learning that involves young children carrying out experiments to prove a concept. The characteristics of the experimental method include the active involvement of early childhood, the use of concrete materials, and a guided discovery process (Jainab et al., 2023). Through experimental methods, young children practice observing, asking questions, making predictions, and drawing conclusions based on direct experience (Bintoro et al., 2022).

The effectiveness of experimental methods in improving problem-solving skills has been proven through several studies. A study conducted by Salahova (2023) showed that young children who were involved in simple scientific experiments experienced increased critical thinking and problem-solving abilities compared to the control group. Similar results were found in research by Addini & Widyasari (2022) revealed that the experimental method increased understanding of concepts and science process skills related to problem-solving. Baroya (2018) adds empirical evidence that the application of experimental methods encourages the metacognitive development of early childhood, as seen from the ability to plan, monitor and evaluate the problem-solving process independently.

The experimental method improves young children's problem-solving skills through several integrated aspects. Research results of Piaget (1976) This proves that the experimental method provides concrete experience so that young children can more easily understand real environmental problems Jirout (2020) adds empirical evidence that experimental activities stimulate young children to develop simple hypotheses and test them as part of the problem-solving process. Park (2020) strengthens these findings by revealing that the experimental process encourages young children to collaborate, exchange ideas, and find solutions together, which has an impact on the development of social problem-solving skills. These three aspects prove that the experimental method plays a strategic role in developing problem-solving skills in early childhood.

Even though the experimental method has proven to be effective, several research gaps are still found. Some research gaps regarding experimental methods and problem-solving are still discovered. The majority of studies focused on science learning, while applications in the areas of mathematics, arts, or social-emotional development were limited. Warmansyah et al., (2023) prove that an experimental approach improves the numerical problem-solving abilities of young children, but similar studies in other fields are still rarely carried out. Another gap was identified in

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the dominance of experimental method research in schools with adequate resources. Hamdani. M et al., (2019) revealed that the application of experimental methods faces the challenge of limited infrastructure and teacher training. Although several studies show the effectiveness of experimental methods (Sajid & Rizwan, 2023; Ezeddine et al., 2023), in-depth studies of the problem-solving process during experimental activities are still limited.

The teacher's role in experimental activities is not only limited to technical aspects but includes pedagogical skills that support the learning process. X. Li et al., (2022) study shows that the quality of teacher-early childhood interactions during experiments has a real influence on the achievement of learning outcomes. Harahap et al., (2022) through their research prove that the application of appropriate scaffolding during experimental activities increases the conceptual understanding and problem-solving abilities of young children. Nursarofah (2022) adds empirical evidence that teachers' skills in asking productive questions encourage young children to develop critical thinking and independent problem-solving strategies.. Ermida (2019) strengthens these findings by revealing that continuous professional development programs for teachers in the communication aspect of learning have a positive impact on the quality of educational interactions in the classroom. These empirical data show the urgency of research that examines teachers' pedagogical aspects in depth, especially regarding scaffolding and questioning techniques as essential components of experiment-based learning.

Based on the background and research gaps that have been identified, this research aims to explore in depth the use of experimental methods in improving problem-solving skills in early childhood at Nurul Hidayah Kindergarten Sampang. Specifically, this research aims to analyze the cognitive processes that occur in young children while they are involved in experimental activities, with a special focus on the development of problem-solving skills. Through detailed observations and video analysis, this research will map the problem-solving stages that young children go through during experimental activities, identify the strategies that young children use, and analyze how teacher intervention influences this process. The second aim of this research is to identify contextual factors that influence the effectiveness of experimental methods in developing problem-solving skills at Nurul Hidayah Kindergarten Sampang. These factors include specific socio-economic, cultural, and learning environment aspects.

The novelty of this research lies in the integrative approach which combines analysis of micro-cognitive processes with a macro-ecological perspective on learning at the Nurul Hidayah Sampang Kindergarten. In contrast to previous research which tends to focus on the final results, this study will use detailed observation methods and video analysis to map the problem-solving process that occurs during experimental activities. The use of eye-tracking technology in early childhood education settings, which is still rarely done in Indonesia, will provide new insights into how children process visual information during experiments.

METHOD

This research adopted a descriptive qualitative approach to explore in depth the use of experimental methods in improving problem-solving skills in early childhood at the Nurul Hidayah Kindergarten in Sampang. The research subjects consisted of 15 children aged 4-6 years, 3 class teachers, and 5 parents/guardians of students who were selected using purposive sampling techniques based on involvement in the experimental method program studied (Matthew B, Miles, 1992). Data collection was carried out through participant observation for 8 weeks, semi-

structured interviews with teachers and parents, as well as documentation in the form of early childhood portfolios, teacher learning plans, and video recordings of experimental activities. Data were analyzed using thematic analysis techniques to identify patterns in the use of experimental methods on problem-solving skills in early childhood. The validity of the data was obtained through triangulation of sources and methods, member checking, and thick description.

RESULT AND DISCUSSION

The experimental method at Nurul Hidayah Sampang Kindergarten can improve problem-solving skills in early childhood through systematic stages. The activity of changing the shape of water is a means for young children to gain direct experience from observation and active exploration. When conducting experiments on freezing water into ice, young children begin to develop an understanding of the cause-and-effect relationship of temperature on changes in the shape of objects. Carrying out experiments repeatedly opens up space for young children to hone their logical and systematic thinking skills. The process of observing changes in the form of water that freezes, thaws, and freezes again encourages young children to find consistent patterns of change. The discovery of this pattern strengthens young children's understanding of the concept of reversibility, namely the ability of objects to return to their original form. In-depth observations of early childhood interactions during experimental activities show cognitive development according to Piaget's theory (Maspul et al., 2023). This development is marked by movement from the preoperational thinking stage to concrete operational thinking, reflected in the increasing ability to classify objects and understand cause-effect relationships (Rabindran & Madanagopal, 2020).

Experiments on changing the state of water initially make it difficult for young children to understand the concept of reversibility. However, after several sessions, young children began to recognize that melted ice could be refrozen, indicating a growing understanding of conservation. The research results of Cankaya et al., (2023) revealed that young children who were directly involved with experimental activities displayed a better understanding of abstract concepts compared to young children who only received verbal instructions. These findings prove that direct experience through experiments has a positive impact on the cognitive development of young children. A direct experience-based learning approach has been proven to suit the characteristics of early childhood cognitive development. The results of this study support the findings of Salahova (2023) which proves the effectiveness of experiential science learning for children aged 5-9 years. The experience of manipulating real objects encourages young children to construct scientific knowledge independently based on observed evidence.

Apart from the learning activities above, experimental activities at the Nurul Hidayah Sampang Kindergarten were also seen during bridge construction. The experimental method of bridge construction acts as a means of developing structural problem-solving abilities for young children. Observation results show that young children start activities by arranging blocks without a particular pattern. A series of failures encourages young children to modify the way the blocks are arranged to achieve better stability. The learning process through trial and error trains young children to think creatively and find solutions independently. The discovery of the triangular shape as a sturdy structure by several young children proves that they have achieved an understanding of basic geometry. This achievement occurs naturally through active exploration, not from direct teacher explanation or direction. The research results of Ramadani & Pejchinovska-Stojkovikj

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(2023) strengthen the evidence that experiment-based learning supports the formation of conceptual understanding in young children. Manipulation of real objects provides concrete experiences that make it easier for young children to construct new knowledge. Analysis of the stages of improvement in problem-solving skills revealed a consistent developmental pattern. The initial stage shows the dependence of young children on the teacher's help when facing simple problems such as spilled water or falling blocks. Frustration responses in the form of crying or refusing to continue activities often appear when facing failure. Ezeddine et al., (2023) explained that this reaction is normal because young children are still developing resilience to face challenges.

The next stage of development is marked by real changes in the behavior of young children when facing problems. Early childhood begins to ask specific questions such as "Why did the bridge collapse?" or "How can I prevent the ice from melting quickly?". These questions show the development of the ability to identify problems. Early childhood also begins to try various solutions before asking the teacher for help. Musbah & Barqawi (2021) found that this development was facilitated by the implementation of appropriate scaffolding strategies. The final stage shows the maturity of early childhood problem-solving skills. The systematic approach can be seen in the way young children test the strength of a bridge before adding weight, or check the temperature of the water before trying to freeze it. Experience from previous experiments is used as a reference for solving new problems.Khanam & Awan (2022) state that the ability to transfer knowledge indicates the development of higher-order thinking skills in early childhood.

In this experimental method, the teacher acts as a learning facilitator. Analysis of early childhood teacher-child interactions reveals how teachers facilitate experimentation-based learning. Observation results prove that the effectiveness of the experimental method depends on the quality of the scaffolding provided by the teacher. Teachers who apply effective questioning techniques, such as using open-ended questions and sufficient wait time, are successful in encouraging critical thinking and exploration in young children. These findings strengthen Vygotsky's Zone of Proximal Development (ZPD) concept regarding the role of social interaction and guidance in learning (Akbari, 2022; Irshad et al., 2021). Based on analysis of interaction transcripts, effective teachers do not simply provide information, but facilitate the early childhood discovery process through leading questions and encouraging reflection. Asking open-ended questions such as "What would happen if...?" or "What do you think...?" getting young children to develop simple hypotheses. Providing sufficient time to think encourages young children to explore various possible solutions. This strategy is by the findings of Alarcon et al., (2023) that inquiry-based learning requires patience and positive reinforcement from the teacher.

In line with this, the research identified a transformation in teachers' understanding of their role as learning facilitators. Interview data revealed a shift from traditional models of knowledge transmission towards constructivist approaches. One teacher stated, "I learned to refrain from giving direct answers. Now, I focus more on encouraging young children to find their answers through experimentation and discussion." This paradigm shift is to the findings of Zdanevych et al., (2020) that teachers who adopt the role of facilitator are more effective in encouraging the development of higher-order thinking skills in early childhood. On the other hand, research also reveals teachers' challenges when implementing experimental methods. Limited scientific content knowledge and specific pedagogical skills of inquiry-based learning emerged as barrier. Santana (2023) recommends special training in experiential learning methods

for early childhood teachers to overcome these challenges. Continuous professional development for teachers is a real solution to improving the quality of experiment-based learning.

Based on the results of ongoing observations, the development of cognitive problem-solving skills can be seen in the ability of young children to use simple logic. When conducting experiments on changing the state of water, young children were able to predict that ice would melt more quickly if placed in a hot place. Understanding of cause-and-effect relationships also develops, demonstrated through the ability to explain why certain bridge structures are stronger than others. Addini & Widyasari (2022) state that the experimental method stimulates cognitive development through concrete experiences experienced by young children directly.

In addition to implementing scaffolding in schools, the "Experiments at Home" program strengthens early childhood learning. Parents report an increase in the initiative of young children to carry out simple experiments at home, such as mixing colors or making constructions from improvised materials. Schmid & Garrels (2021) confirm that parental involvement contributes to the success of early childhood education, especially for vulnerable groups. Continuity of learning between school and home creates a complete learning experience for young children. The success of the experimental method cannot be separated from the role of collaboration between teachers, parents, and young children. Creating a learning environment that supports active exploration, both at school and at home, is key to developing problem-solving skills. Direct experience through experimental activities provides a solid foundation for the cognitive development of young children, especially in the aspects of logical reasoning and understanding basic scientific concepts. Social problem-solving skills develop through interaction during group experimental activities. Early childhood children learn to negotiate when sharing experimental equipment, waiting their turn, and respecting friends' ideas. Conflicts that arise are resolved through simple discussions, not aggressive methods such as grabbing or crying. Johnstone et al., (2022) revealed that experience-based learning supports the development of social-emotional skills.

The practical aspect of problem-solving skills can be seen in the way young children overcome technical obstacles. When water is spilled, young children take the initiative to clean up and prevent the next spill by pouring more carefully. When the bridge construction is unstable, young children try various modifications until they find a sturdy structure. T. H. Morris (2020) states that experiential learning helps young children develop practical skills that can be transferred to new situations. Parental support plays a role in the success of the program. Parental involvement in experimental activities at home creates continuity of learning. Providing simple experimental tools and materials allows young children to practice problem-solving skills independently. Lee & Lee (2022) found that consistent learning interactions between school and home improve learning outcomes. A supportive learning environment contributes to the effectiveness of experimental methods. The availability of adequate tools and materials allows every young child to participate actively. Sufficient movement space facilitates free but safe exploration. A learning atmosphere that encourages curiosity makes young children comfortable trying new things. Jirout (2020) emphasized that curiosity is the foundation for the development of scientific thinking in early childhood.

CONCLUSSION

The experimental method has been proven to improve the problem-solving skills of young children at the Nurul Hidayah Kindergarten in Sampang. This improvement can be seen through three stages of development, starting from full dependence on teacher assistance, the ability to ask

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specific questions, to applying a systematic approach when solving problems. Experimental activities on changing the shape of water and bridge construction succeeded in encouraging young children to understand the concept of simple causality and develop solutions to structural problems through a directed trial-and-error process. The success of the experimental method is supported by the teacher's role as a facilitator through structured scaffolding techniques and the "Experiment at Home" program involving parents. The combination of these two strategies results in the development of problem-solving skills in cognitive, social, and practical aspects. Early childhood children demonstrate the ability to use simple logic, negotiate with peers, and overcome technical obstacles during experimental activities. The results of the research show that parental support and a conducive learning environment are supporting factors for the successful application of experimental methods to improve problem-solving skills in early childhood.

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