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Experimental Methods to Enhance Problem - Solving Skills in early Childhood

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Abstract

This study seeks to improve young children's problem-solving abilities with experimental learning methods that emphasize hands-on involvement in the learning process. Using a Classroom Action Research (CAR) approach based on the Kemmis and McTaggart model, the study was carried out over two cycles and involved 10 children in Group A (aged 4–5 years), consisting of six boys and four girls. Data was gathered through direct observation of the children's activities and analyzed using descriptive statistics, presented as average percentages. The findings showed a significant increase in problem-solving abilities, from 0% in the initial observation to 30% in the first and 70% in the second cycles. These results suggest that experimental methods can foster independent exploration, observation, and reasoning among young children. The study concludes that learning approaches grounded in experience and exploration are more suitable for developing problem-solving skills in early childhood settings.

Keywords

Active learning methods, classroom action research, early childhood education, experimental learning, problem solving skills

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Introduction

Problem-solving ability is a critical component of cognitive development in early childhood, as it is closely linked to critical thinking, creativity, and adaptability. However, initial observations in several early childhood education settings, including Kober An-Nur, indicate that the learning approaches employed are passive and dominated mainly by children's worksheets. As a result, children are primarily guided to complete written tasks, with limited opportunities for exploration and active thinking.

This phenomenon shows a disconnect between children's developmental needs and the instructional approaches used in the classroom. According to the *Kurikulum Merdeka* for Early Childhood Education (*PAUD*), learning should be designed around concrete experiences that actively engage children. Instead of passive instruction, children should be encouraged to explore, interact, and participate directly, allowing them to develop problem-solving skills naturally through hands-on experiences.

Sharp et al. (2017) and Sari and Yuliana (2022) have demonstrated that experiment-based learning approaches positively impact children's cognitive skills, including logical and conceptual thinking. However, most of this research has focused on primary or secondary education rather than early childhood. Investigations into the specific effectiveness of experimental methods in Early Childhood Education (PAUD), particularly within non-formal educational settings. This gap shows the need for further exploration into how experimental learning can better support the cognitive development of young children in diverse educational environments.

Hasibuan and Suryana (2022) demonstrated that experimental methods significantly enhance early childhood cognitive development. However, their study did not specifically examine problem-solving skills. Meanwhile, Nirmala and Sabrina (2024) criticized using children's worksheets, arguing that they restrict children's creativity and exploratory opportunities, which are fundamental to developing problem-solving abilities. These perspectives show the need for further research into how experimental learning can be optimized to support problem-solving skills in early childhood education.

Furthermore, Mulyadi et al. (2023) noted that experimental approaches are rarely implemented in rural areas due to limited resources and teacher training. However, this method has effectively encouraged children's independent exploration (Cerino, 2023). Similarly, Rachmawati et al. (2021) emphasized the important role of teachers in creating meaningful learning environments through active methods such as experimentation. These views highlight the importance of equipping educators with the necessary training and resources to implement experimental learning effectively, ensuring that children across various educational settings can benefit from its advantages (Rachmawati et al., 2021).

Recent studies emphasize further the relevance of exploratory approaches in enhancing problem-solving skills. Güley and Keskinkılıç (2024) demonstrated the effectiveness of project-based learning in science education for improving preschool children's problem-solving abilities. Sala-Sebastià et al. (2022) emphasized the critical role of teachers in designing problem-solving activities from an early age. Meanwhile, Elvani et al. (2024) found that problem-based learning significantly impacts the development of problem-solving skills.

However, it has not been widely implemented in Early Childhood Education (*PAUD*). These findings reinforce the need for innovative pedagogical strategies that actively engage children in exploratory and experiential learning (Elvani et al., 2024).

While many studies highlight the benefits of active learning approaches like experimentation, project-based learning, and problem-based learning in strengthening children's cognitive and problem-solving skills, most of this research is focused on primary and secondary education. There is still a gap in understanding how experimental methods shape problem-solving abilities in young children, especially in non-formal education settings like Kober. This makes exploring how hands-on, experiential learning can better support early childhood development more important.

Furthermore, even though the *Kurikulum Merdeka* for Early Childhood Education (*PAUD*) emphasizes concrete experience-based learning, real-world practice, especially in rural areas, still tends to rely on passive approaches like children's worksheets. This method contradicts the fundamental principles of fostering problem-solving skills, limiting children's opportunities for hands-on exploration and independent thinking.

Existing studies, including those by Hasibuan and Suryana (2022), have not explicitly focused on problem-solving skills but on general cognitive development. Additionally, limited resources and insufficient teacher training remain significant barriers to implementing experimental learning approaches in early childhood education settings. These challenges highlight the need for targeted efforts to equip educators with the necessary skills and support to integrate hands-on, exploratory learning into their classrooms. There is an urgent need for research that specifically examines the effectiveness of experimental methods in enhancing problem-solving skills in early childhood, particularly in non-formal educational settings and resource-limited contexts. This gap highlights the lack of empirical studies on the contextual application of experimental learning in developing problem-solving abilities in young children, especially in rural areas with limited facilities.

Therefore, the study aims to improve early childhood problem-solving skills by implementing experimental methods at Kober An-Nur and to evaluate the effectiveness of this approach in fostering active and independent learning experiences. The study assumed that learning environments that provide opportunities for exploration through experimentation will encourage problem-solving development more effectively than conventional worksheet-based methods. Accordingly, the initial hypothesis of this research is that experimental methods significantly enhance early childhood problem-solving skills compared to passive worksheet-based approaches.

Methodology

This study employs a Classroom Action Research (CAR) approach using the spiral model of Kemmis and McTaggart, which consists of four stages: planning, acting, observing, and reflecting. CAR was chosen for its effectiveness in improving classroom teaching through systematic action and collaborative reflection (Machali, 2022; Bleicher, 2014). The research was conducted over two cycles, each comprising three interventions. The study subjects were 10 children in Group A (aged 4–5 years) at Kober An-Nur, including six boys and four girls.

Learning activities were centered around a rainbow soap bubble experiment as a medium for developing problem-solving skills.

Data collection was carried out through observation and interviews. The observation method was guided by an instrument based on indicators of children's cognitive development in problem-solving, as outlined by Poerwati et al. (2022). These indicators include curiosity in exploratory activities and the ability to create, make predictions, and solve problems by matching objects based on shape, color, and size (Poerwati et al., 2022). Interviews were conducted with collaborative teachers to strengthen observational data and assess the effectiveness of the interventions. The researcher also played a role as an instructor in the learning process, assisted by collaborators who provided feedback throughout.

Data analysis was conducted using both quantitative and qualitative methods. The quantitative analysis employed descriptive statistics in the form of percentage-based evaluations to assess children's progress across four developmental categories: Not Yet Developed (BB), Beginning to Develop (MB), Developing as Expected (BSH), and Developing Very Well (BSB). Meanwhile, qualitative analysis followed an interactive data analysis technique, including data reduction, presentation, and conclusion drawing. The success criterion was established as achieving at least 70% of children in the Developing Very Well (BSB) category, indicating that the learning intervention had effectively enhanced their problem-solving skills.

Findings

This study was conducted over two cycles. During the pre-cycle observation, most children were categorized as "Not Yet Developed" (NYD) and "Beginning to Develop" (BD). Specifically, six out of ten children (60%) were classified as NYD, while the remaining four (40%) fell into the BD category. None of the children had reached the "Developing as Expected" (DE) or "Developing Very Well" (DVW) categories, indicating the need for targeted learning interventions to support their problem-solving development.

Table 1. *Pre-cycle observation results*

Criteria	Number of children	Percentage
NYD	6	60%
BD	4	40%
DE	0	0%
DVW	0	0%

Following the first cycle, which applied experimental methods through the colored soap bubble activity, there was noticeable progress. Two children remained in the Not Yet Developed (NYD) category, four were in Beginning to Develop (BD), one reached Developing as Expected (DE), and three achieved Developing Very Well (DVW). These results indicate an initial improvement in problem-solving skills, although some challenges persisted, particularly in maintaining children's focus and participation throughout the learning activities.

Table 2. *Observation results – cycle I*

Criteria	Number of children	Percentage
NYD	2	20%
BD	4	40%
DE	1	10%
DVW	3	30%

Based on these findings, adjustments were made to Cycle II, including modifications to learning materials and delivery methods. As a result, all children showed significant improvement: seven children (70%) reached the "Developing Very Well" (DVW) category, two children (20%) achieved "Developing as Expected" (DE), and only one child (10%) remained in "Beginning to Develop" (BD). No children remained in the "Not Yet Developed" (NYD) category, demonstrating the effectiveness of the experimental learning approach in enhancing problem-solving skills.

Table 3. *Observation results – cycle II*

Criteria	Number of children	Percentage
NYD	0	0%
BD	1	10%
DE	2	20%
DVW	7	70%

The following summary presents the progression of children's problem-solving skills from the pre-cycle observation to Cycle II:

Table 4. *Recapitulation of problem-solving development comparison*

Criteria	Number of children	Percentage
NYD	60%	20%
BD	40%	40%
DE	0%	10%
DVW	0%	30%

Based on the data in Table 4, there was a progressive improvement in early childhood problem-solving skills from the pre-cycle phase to cycle I and continuing into cycle II. During the pre-cycle observation, most children were categorized as Not Yet Developed (NYD) at 60% and Beginning to Develop (BD) at 40%, with none reaching the Developing as Expected (DE) or Developing Very Well (DVW) categories.

After implementing the experimental method in cycle I, there was a significant decrease in the NYD category to 20%, and an increase in the DVW category to 30%. The most notable development occurred in cycle II, where 70% of children reached the DVW category, 20% were in DE, and only 10% remained in BD, with no children remaining in NYD. These

findings demonstrate that the experimental approach had a positive and gradual impact on improving children's problem-solving skills significantly over time.

Discussion

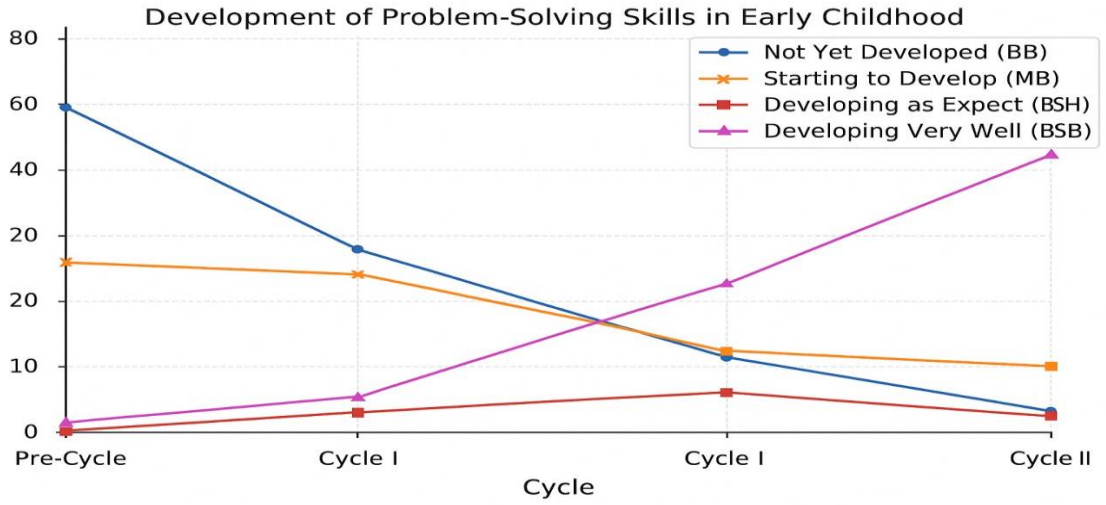
The findings indicate that implementing the experimental method significantly enhances problem-solving skills in early childhood. Learning activities involving children—observing, formulating hypotheses, and drawing conclusions through concrete experiments—align highly with Vygotsky's social constructivist theory and Piaget's emphasis on active exploration. The primary aim of this study was to improve problem-solving abilities in early childhood through the experimental method. The results demonstrate that the application of this method had a significant impact on the development of these skills. This is supported by quantitative data in Table 4, which shows an increase in the Developing Very Well (DVW) category from 0% in the pre-cycle phase to 70% in Cycle II.

Table 5. *Problem-solving skill achievement*

Cycles	NYD	BD	DE	DVW
Pre Cycle	60%	40%	0%	0%
Cycle I	20%	40%	10%	30%
Cycle II	0%	10%	20%	70%

These findings reinforce the argument that the experimental method allows children to engage in active learning, exploration, and independent understanding construction. This approach starkly contrasts with passive methods, such as using children's worksheets, previously the dominant instructional strategy. This contrast is further illustrated in the following figure.

Figure 1. *Development of problem-solving skills in early childhood*



In the first cycle, most children still relied on teacher guidance and had not yet developed the ability to solve problems independently. However, after adjustments to the instructional media and approach in the second cycle, the children demonstrated a higher capacity for formulating

hypotheses, engaging in exploration, and independently drawing conclusions from experiments. Additionally, they could collaborate in groups, share ideas, and exhibit greater curiosity. This improvement indicates that the experimental method effectively fosters critical and creative thinking skills, the foundation for problem-solving abilities. This approach aligns with Piaget's theory of cognitive development, which posits that children aged 4–5 years are in the preoperational stage and require concrete experiences to build understanding. Furthermore, Vygotsky's constructivist theory emphasizes the importance of social interaction and exploratory activities in early childhood learning.

These findings are also consistent with Aunillah (2024) and Soleha et al. (2023), who asserted that experimental methods enhance early childhood scientific literacy, creativity, and critical thinking skills. Addini and Widyasari (2022) emphasized that experimental approaches can foster creativity in young children, a crucial component of problem-solving abilities.

Moreover, Putri (2020) found that the question-and-answer method, when integrated with an experimental approach, can enhance critical thinking skills in early childhood. Through active interaction and exploration, children develop the ability to analyze, evaluate, and make informed decisions, essential components of effective problem-solving (Putri, 2020). Taconis et al. (2001) and Firtak et al. (2012) showed that scientific and experimental approaches are practical in teaching scientific concepts. Meanwhile, Artha and Setiyawati (2023) noted that experimental methods positively impact students' cognitive learning outcomes. Similar findings were reported by Rumihin et al. (2023) in Early Childhood Education (*PAUD*) Ambon and by Maku et al. (2024) in color-mixing activities aimed at enhancing children's scientific understanding (Maku et al., 2024). In addition, Rumihin et al. (2023) found that experimental methods significantly improved scientific skills among children aged 5–6 years at Early Childhood Education (*PAUD*) Rafflessia Arnoldy Kayu Tiga, Ambon. Children engaged in experimental activities showed enhanced comprehension of scientific concepts and improved problem-solving abilities related to the activities.

Overall, these various studies support the present research findings, affirming that the experimental method effectively enhances problem-solving skills in early childhood. This method offers an active, enjoyable, and meaningful learning experience that encourages children to think critically, creatively, and independently in addressing problems. Therefore, implementing the experimental method in early childhood education is highly recommended for the optimal development of problem-solving abilities. Nuryatmawati and Dimyati (2021) also emphasized that through a scientific, experiment-based approach, children can learn to observe, ask questions, and draw conclusions, gradually improving their problem-solving skills. Experiments create a contextual and engaging learning environment, as Schmidt et al. (2018) exemplified in a color-mixing activity that fosters enjoyment and enhances children's ability to predict outcomes and evaluate processes. Similar findings were reported by Nurlaela (2023) and Bullock et al. (2010), who highlighted that direct experience through experimentation strengthens cognitive development and helps children grasp scientific concepts more effectively.

The experimental method has been widely recognized as an effective instructional strategy for enhancing problem-solving skills in early childhood. This approach allows children to learn through observation, prediction, and evaluation of phenomena. Soleha et al. (2024) stated that using experimental methods in science learning enhances problem-solving skills by

encouraging children to think logically, formulate hypotheses, and discover solutions through direct observation. These findings align with Igamberdieva (2023), who reported that an evaporation experiment increased children's active participation and trained them to seek answers to simple scientific questions.

Furthermore, experimentation fosters critical and reflective thinking in children (Nurlaela, 2023). Triwahyuni et al. (2023) found that applying systems thinking through experimentation helps children understand cause-and-effect relationships, foundational to problem-solving skills. Umiyati and Isnaningsih (2024) also demonstrated the effectiveness of experimental media, such as the Busy Jar, in encouraging children to identify and solve problems independently. Thus, the literature indicates that the experimental method supports cognitive development and cultivates critical and creative thinking patterns that enable children to address various problems. Experimental activities are meaningful learning tools encouraging children to think actively, experiment, and make decisions.

Conclusion and Recommendations

This study aimed to enhance problem-solving skills in early childhood by implementing the experimental method. Based on the findings from two action research cycles, it can be concluded that the experimental method effectively promotes the development of problem-solving abilities among children aged 4–5 years. This is evidenced by the increase in the proportion of children categorized as "Very Well Developed," from 0% in the pre-cycle phase to 70% in Cycle II. The experimental method allows children to actively learn through direct experiences involving observation, prediction, experimentation, and conclusion. This strategy has enhanced children's curiosity, collaboration, and logical thinking in solving problems. These findings suggest that early childhood educators should integrate the experimental method into learning activities to optimize children's cognitive development. For future research, it is recommended that the experimental method be tested using a broader range of experimental themes, a larger population, and long-term measurements to assess the sustained impact on children's development.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest.

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