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Implementation of the Experimental Method to Improve Science Skills in Group B Early Childhood Students at Cempaka Putih Early Childhood Education Center (PAUD) in the 2025/2026 Academic Year

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Abstract

Science learning in early childhood education is essential for developing children's cognitive abilities through direct observation, exploration, and experimentation. However, science instruction at Cempaka Putih Early Childhood Education Center (PAUD) remained predominantly teacher-centered, limiting children's participation in scientific activities and resulting in underdeveloped science skills, particularly in recognizing primary and secondary colors. This study aimed to improve the science skills of Group B children through the implementation of the experimental method using color-mixing activities. The study employed Classroom Action Research based on the Arikunto model, involving 12 Group B children during the 2025/2026 academic year. The research was conducted in two cycles, each consisting of planning, action, observation, and reflection stages. Data were collected through observation, interviews, and documentation and analyzed using quantitative descriptive and qualitative techniques. The results showed that the number of children categorized as Very Well Developed (BSB) increased from 1 child (8.3%) in the first meeting of Cycle I to 5 children (41.7%) at the end of Cycle I, 7 children (58.3%) in the first meeting of Cycle II, and 10 children (83.3%) at the end of Cycle II, representing an overall increase of 75.0 percentage points across the intervention. Meanwhile, the Beginning to Develop (MB) category decreased from 6 children (50.0%) to 0 (0%), and the Not Yet Developed (BB) category decreased from 3 children (25.0%) to 0 (0%). These findings demonstrate that the experimental method effectively improved children's science skills through active, hands-on learning experiences.

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1. INTRODUCTION

Science is a systematic process of acquiring knowledge through observation, experimentation, and verification. In early childhood education, science is not merely a collection of facts but also a process that enables children to investigate natural phenomena, develop curiosity, and construct knowledge through direct interaction with their environment. Science learning provides opportunities for children to observe, classify, predict, communicate, and draw conclusions from simple investigations, thereby laying the foundation for scientific literacy and lifelong learning. Yaswinda et al. (2023) emphasize that science process skills contribute significantly to children's

cognitive development because they encourage children to solve problems through exploration and environmental interaction rather than memorizing concepts alone. Likewise, Astuti and Nurhafizah (2023) reported that science learning should provide opportunities for children to actively construct knowledge through meaningful experiences, making science concepts easier to understand and apply in everyday life.

The primary objective of science learning in early childhood education is to foster children's cognitive, affective, and psychomotor development simultaneously. Effective science instruction should encourage children to investigate objects, compare characteristics, classify materials, and communicate the results of their observations. Learning experiences based on exploration enable children to understand scientific concepts more meaningfully because they are directly involved in the learning process. According to Yaswinda et al. (2023), science learning that utilizes the surrounding environment strengthens children's cognitive abilities by providing authentic learning experiences that stimulate curiosity and scientific reasoning. This approach is consistent with the principles of active learning, in which children become the center of the learning process while teachers function as facilitators who provide opportunities for inquiry and exploration. Furthermore, environmental-based science learning helps children relate scientific concepts to real-life situations, thereby improving both conceptual understanding and problem-solving abilities.

One instructional approach that effectively facilitates active science learning is the experimental method. Through experimental activities, children are encouraged to predict outcomes, manipulate materials, observe changes, communicate findings, and evaluate the results of simple investigations. Astuti and Nurhafizah (2023) demonstrated that the experimental method significantly improves science skills among children aged 5–6 years compared with conventional learning because it provides direct learning experiences and promotes active participation throughout the learning process. Their findings also indicate that successful implementation of the experimental method requires careful planning, appropriate learning materials, continuous observation, and systematic evaluation by teachers. Similar evidence was reported by Sekali et al. (2023), who found that experimental learning improves students' engagement and learning outcomes because children are actively involved in constructing knowledge through observation and experimentation rather than passively receiving information. These findings suggest that experimental activities provide meaningful learning experiences that support the development of science process skills, critical thinking, and curiosity from an early age.

Although the benefits of experimental learning have been widely reported, its implementation in early childhood classrooms remains limited. Preliminary observations conducted at Cempaka Putih Early Childhood Education Center (PAUD) in September 2025 showed that science learning was still dominated by teacher explanations, worksheets, and picture-based media, with few opportunities for children to conduct direct investigations. Consequently, many children experienced difficulties recognizing secondary colors and explaining the outcomes of simple scientific activities because learning emphasized memorization rather than exploration. Similar findings have been reported by Pradana et al. (2025), who found that children often struggled to distinguish primary and secondary colors when learning relied on worksheets and verbal instruction instead of practical activities. Likewise, Syahrul et al. (2023) demonstrated that limited opportunities for experimentation hinder the development of science process skills, particularly observing, predicting, and

communicating experimental results. Furthermore, Sari and Hermawan (2023) confirmed that children's science abilities improved significantly after participating in color-mixing experiments, indicating that direct experience is more effective than passive learning for introducing scientific concepts in early childhood.

Despite these findings, previous studies have largely focused on the general effectiveness of the experimental method in improving early childhood science skills, with limited attention to context-specific applications such as color-mixing activities designed to develop primary and secondary color recognition. Moreover, few studies have documented the systematic, cyclical implementation of the experimental method through classroom action research at the PAUD level, particularly within local settings such as Cempaka Putih PAUD, where science instruction has remained predominantly teacher-centered. This gap indicates the need for empirical evidence on how a reflective, cyclical, and context-specific application of the experimental method can address underdeveloped science skills among Group B children. The present study addresses this gap by providing an empirical account of how systematically designed color-mixing experiments, implemented and progressively refined across two classroom action research cycles, can enhance young children's science process skills, thereby offering practical guidance for early childhood educators seeking to design similarly targeted, evidence-based interventions.

2. METHOD

This study employed Classroom Action Research (CAR) using the Arikunto model to improve the science skills of Group B children at Cempaka Putih Early Childhood Education Center (PAUD) during the 2025/2026 academic year. The study involved 12 children and was conducted in two cycles, with each cycle consisting of two learning sessions. Each cycle followed four stages: planning, action, observation, and reflection, which are widely applied in classroom action research to improve learning practices through continuous reflection and refinement (Agustiana et al., 2023). During the planning stage, lesson plans, learning media, observation sheets, and assessment instruments were prepared. The action stage implemented science learning through simple color-mixing experiments, allowing children to observe, predict, classify colors, and communicate the results of their experiments. The use of the experimental method was intended to provide children with direct learning experiences and to facilitate the development of science process skills through active exploration, as recommended in previous classroom action research involving early childhood learners (Rocmah & Sholihah, 2020). Observation was carried out throughout the learning process to assess children's science skills, while reflection was conducted at the end of each cycle to evaluate the outcomes and determine improvements for the subsequent cycle. The overall research procedure is illustrated in Figure 1.

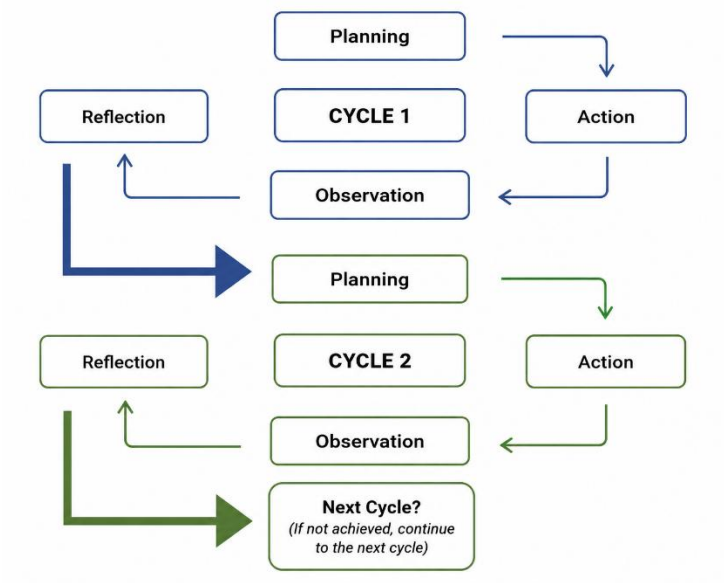

Figure 1. Classroom Action Research (CAR) Procedure

Data were collected through observation, interviews, and documentation. Observation sheets were used to assess children's science skills, including their ability to classify objects based on shape, color, and size, identify primary and secondary colors, and communicate experimental findings. The collected data were analyzed using both quantitative and qualitative approaches. Quantitative analysis calculated the percentage of children achieving each developmental level, whereas qualitative analysis followed the Miles and Huberman framework of data reduction, data display, and conclusion drawing.

The indicators used to assess children's science skills comprised four main aspects: (1) the ability to observe changes occurring during color-mixing activities, (2) the ability to classify and identify primary and secondary colors, (3) the ability to predict the outcomes of color combinations, and (4) the ability to communicate experimental findings verbally. Each indicator was rated using a four-point developmental scale—Not Yet Developed (BB), Beginning to Develop (MB), Developed as Expected (BSH), and Very Well Developed (BSB)—consistent with the assessment guidelines commonly applied in Indonesian early childhood education settings. The observation sheet was developed based on these indicators and its content validity was examined through expert judgment involving early childhood education lecturers, who reviewed the relevance, clarity, and appropriateness of each item in measuring the intended science skills. Revisions to item wording and scoring criteria were made based on expert feedback prior to field use, thereby strengthening the instrument's content validity and its suitability for measuring children's science process skills throughout the research cycles.

The intervention was considered successful when at least 80% of the children achieved the "Very Well Developed" (BSB) category in science learning outcomes.

3. RESULTS AND DISCUSSION

Results

The classroom action research was conducted in two cycles, with each cycle consisting of two learning sessions designed to improve children's science skills through the implementation of the

experimental method. Preliminary observations revealed that the science skills of Group B children at Cempaka Putih Early Childhood Education Center (PAUD) were still underdeveloped. Science learning was predominantly teacher-centered, relying on verbal explanations and worksheet-based activities, which provided limited opportunities for children to actively observe, explore, and investigate scientific concepts. Consequently, many children had difficulty identifying primary and secondary colors and were reluctant to express their ideas or participate actively during classroom activities. To address these issues, the experimental method was introduced using simple color-mixing activities that encouraged children to observe changes, predict outcomes, classify colors, and communicate their findings through direct learning experiences.

During Cycle I, children participated in a series of color-mixing experiments involving combinations of primary colors to produce secondary colors. Although the learning activities generated enthusiasm among several children, classroom observations identified a number of limitations. Some children were hesitant to answer questions or express their observations, while others were still dependent on teacher guidance during the experiments. In addition, the absence of clear group organization and limited teacher demonstrations reduced children's opportunities to participate actively in the learning process. These findings became the basis for reflection at the end of Cycle I and informed the planning of improvements for the subsequent cycle.

Based on the reflection results, several modifications were implemented in Cycle II to enhance the effectiveness of the learning activities. The children were organized into small groups to encourage collaboration, the teacher provided step-by-step demonstrations before each experiment, and positive reinforcement was consistently given to increase children's confidence and participation. Furthermore, children were encouraged to predict the outcomes of color combinations, conduct the experiments independently, observe the resulting color changes, and communicate their observations to their peers and the teacher. These improvements created a more interactive and engaging learning environment, allowing children to participate more actively throughout the science learning activities.

The implementation of these improvements resulted in a substantial increase in children's science skills. As presented in Table 1, the number of children categorized as Very Well Developed (BSB) increased progressively from 1 child (8.3%) in the first meeting of Cycle I to 5 children (41.7%) in the second meeting of Cycle I, followed by 7 children (58.3%) in the first meeting of Cycle II and 10 children (83.3%) in the second meeting of Cycle II—an overall increase of 75.0 percentage points. Conversely, the number of children categorized as Beginning to Develop (MB) decreased from 6 children (50.0%) in the first meeting of Cycle I to 2 children (16.7%) in the second meeting of Cycle I, before reaching zero (0%) by the end of Cycle II. Similarly, the Not Yet Developed (BB) category declined from 3 children (25.0%) at the beginning of the study to none (0%) at the completion of the intervention. These findings demonstrate a consistent positive trend across all research stages and indicate that the predetermined success criterion of the study was achieved. Overall, the classroom action research showed that the experimental method effectively improved children's science skills through systematic, hands-on learning experiences that actively involved children in observation, experimentation, and the recognition of primary and secondary colors.

Table 1. Development of Children's Science Skills Across the Classroom Action Research

Development Category	Cycle I Meeting 1	Cycle I Meeting 2	Cycle II Meeting 1	Cycle II Meeting 2
Very Well Developed (BSB)	1	5	7	10
Developed as Expected (BSH)	2	3	3	2
Beginning to Develop (MB)	6	2	2	0
Not Yet Developed (BB)	3	2	0	0
Total Children	**12**	**12**	**12**	**12**

The findings demonstrate a consistent improvement in children's science skills throughout the implementation of the classroom action research. The number of children classified as Very Well Developed (BSB) increased progressively across the research cycles, from 1 child (8.3%) in the first meeting of Cycle I to 5 children (41.7%) in the second meeting of Cycle I, followed by 7 children (58.3%) in the first meeting of Cycle II and 10 children (83.3%) in the second meeting of Cycle II. At the same time, the number of children categorized as Beginning to Develop (MB) decreased from 6 children (50.0%) to 0 (0%), while the Not Yet Developed (BB) category declined from 3 children (25.0%) in the initial observation to none (0%) by the end of the study. These results indicate a gradual shift in children's developmental achievements across all observed categories. By the completion of Cycle II, 10 of the 12 children had reached the Very Well Developed (BSB) category, fulfilling the predetermined success criterion of the study. Overall, the findings suggest that implementing the experimental method through color-mixing activities was effective in enhancing children's science skills by promoting active participation in observation, experimentation, and the recognition of primary and secondary colors.

Table 2. Comparison of Children's Science Skills Between Cycle I and Cycle II

Development Category	Cycle I	Cycle II
Very Well Developed (BSB)	5	10
Developed as Expected (BSH)	3	2
Beginning to Develop (MB)	2	0
Not Yet Developed (BB)	2	0
Total	**12**	**12**

The improvement in children's science skills can be attributed to the characteristics of the experimental method, which emphasizes active participation and direct experience. Through color-mixing experiments, children were encouraged to observe, predict, classify, and communicate scientific phenomena, allowing them to construct scientific concepts independently. These activities also increased children's curiosity, learning motivation, and cognitive engagement, making the learning process more meaningful than teacher-centered instruction.

The findings support Nugraha (2005), who states that science learning in early childhood should emphasize science process skills, including observing, classifying, experimenting, and communicating scientific findings. Likewise, Prameswari (2019) argues that young children understand scientific concepts more effectively through concrete experiences than through abstract explanations. The present study confirms that color-mixing experiments provide meaningful hands-

on experiences that facilitate children's understanding of primary and secondary colors. These findings are further supported by Zahrah and Winarti (2024), who reported that color-mixing experimental activities effectively develop children's science process skills, including observing, classifying, comparing, communicating, experimenting, and drawing conclusions through direct learning experiences. Their study highlights that active involvement in simple science experiments enables children to construct scientific concepts more meaningfully than passive instructional approaches.

The findings are also consistent with previous studies. Pratiwi (2016) reported that guided discovery learning improved children's science process skills. Similarly, Juita et al. (2024) found that experimental activities using mung bean germination significantly enhanced young children's science skills by encouraging observation, exploration, and direct investigation. In addition, Syafruddin et al. (2024) demonstrated that active learning approaches emphasizing inquiry, collaboration, and problem-solving significantly improve children's critical thinking and participation during learning activities. Although different instructional approaches and learning media were employed, these studies consistently indicate that meaningful, hands-on learning experiences encourage children to actively construct scientific knowledge and strengthen their science competencies from an early age.

Beyond aligning with prior research, several aspects of these findings warrant critical reflection. Rather than being attributable solely to the hands-on nature of color-mixing activities, the observed improvement may also be explained by the cyclical and reflective structure of classroom action research itself, which allowed the teacher to identify specific weaknesses—such as limited group organization and insufficient demonstration during Cycle I—and to address them systematically in Cycle II. This suggests that the effectiveness of the experimental method in this study was reinforced by the iterative refinement process inherent in classroom action research, which enabled instructional strategies to be continuously adjusted in response to children’s needs. It should also be noted that the relatively small number of participants (12 children) and the short duration of the intervention (two cycles) limit the extent to which these findings can be generalized to larger or more diverse early childhood populations. In addition, part of the observed improvement may have been influenced by increased teacher attention and the novelty of the experimental activities, rather than by the experimental method alone. Future studies employing comparison or control groups and longer intervention periods are therefore recommended to clarify the extent to which the observed gains can be attributed specifically to the experimental method rather than to such confounding factors.

4. CONCLUSION

This study demonstrates that the implementation of the experimental method through color-mixing activities effectively improved the science skills of Group B children at Cempaka Putih Early Childhood Education Center (PAUD). The intervention increased the number of children achieving the Very Well Developed (BSB) category from 5 (41.7%) in Cycle I to 10 (83.3%) in Cycle II, an increase of 75.0 percentage points, while the Beginning to Develop (MB) and Not Yet Developed (BB) categories decreased to zero (0%). These findings indicate that hands-on experimental activities encourage active participation, observation, classification, and communication of scientific concepts, making learning more meaningful and engaging for young children. Therefore, the experimental method can be considered an effective instructional strategy for enhancing science learning in early childhood education. Future research is recommended to examine the effectiveness of this method

using different science topics, larger participant groups, or longer intervention periods to strengthen the generalizability of the findings.

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