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THE INFLUENCE OF SCIENCE LEARNING USING THE RAINBOW RAIN EXPERIMENT METHOD TO DEVELOP PROBLEM-SOLVING SKILLS IN 5-6 YEAR-OLD CHILDREN

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Abstract

This study aimed to evaluate the effect of implementing science learning through the rainbow rain experiment on the problem-solving skills of children aged 5–6 years at RA Ubudiyah. A quantitative approach was employed using a quasi-experimental method with a nonequivalent control group design. The participants consisted of 16 children, who were equally divided into an experimental group and a control group, with eight children in each group. Data were collected through structured observations using an assessment sheet designed to measure children's problem-solving skills. The data were then analyzed using descriptive and inferential statistics, including normality testing, homogeneity testing, and the Independent Samples t-test. The findings revealed that the experimental group achieved a mean problem-solving score of 19.875, while the control group obtained a mean score of 14.250. The results of the Independent Samples t-test showed a t-value of 6.625 with a significance level of 0.000 ($p < 0.05$), indicating a statistically significant difference between the two groups. Furthermore, the experimental group demonstrated a higher mean gain score (5.250) than the control group (1.500). These findings indicate that the rainbow rain experiment is an effective science learning strategy for enhancing the problem-solving skills of young children and can be recommended as an alternative approach to support cognitive development in early childhood education.

Keywords: Science Learning, Rainbow Rain Experiment Method, Problem-Solving Ability, Early Childhood.

INTRODUCTION

Early childhood education is a fundamental stage in developing all aspects of a child's development, including cognitive, language, social-emotional, motor skills, as well as thinking abilities that form the foundation for learning success in the next levels of education (Febriana, Chandra, & Prasetyawati, 2025). One of the skills that gets a lot of attention in 21st-century education is problem-solving skills. This skill lets kids recognize a problem, analyze the causes, come up with different solution options, choose the right solution, and evaluate the results they get (Zahra & Sit, 2024). That ability not only plays a role in supporting the development of critical thinking and creativity, but also serves as a tool for kids to adapt to various situations in everyday life (Ruminingsih, Agustina, Purwulan, Sholikhah, & Purwaningsih, 2025). Therefore, developing problem-solving skills needs to be one of the main focuses in early childhood education learning.

The development of problem-solving skills in children aged 5–6 is greatly influenced by learning experiences that give them the chance to explore their environment, observe phenomena, ask questions, try things out, and discover knowledge on their own. According to (Piaget, 1952; Hidayah & Khadijah, 2023), children aged 5–6 years are at the preoperational stage, which is the stage when knowledge is built through concrete experiences and direct interaction with the surrounding environment. This view is supported by (Campbell, et al., 2022; Sitorus, 2023) which states that a child's cognitive development occurs optimally through social interaction and the provision of scaffolding by teachers or adults. Therefore, child-centered learning becomes an effective approach to developing logical thinking, reasoning, and problem-solving skills from an early age.

One area of learning that has great potential for developing these skills is Natural Science (IPA). Teaching science to young children isn't about introducing complex scientific concepts, but rather familiarizing them with natural phenomena through hands-on learning experiences. Through science lessons, children learn to observe, ask questions, make predictions, conduct experiments, compare their observations, and draw conclusions based on the evidence they gather. These activities not only boost scientific thinking skills but also train children to solve problems systematically through simple investigative processes (Batchar, Abad, Tigas, Farro, & Corintin, 2025).

One of the suitable methods to use in teaching science to young children is the experiment method. This method gives kids the chance to gain hands-on learning experiences by trying things out, observing, and discovering concepts on their own. Compared to learning that only focuses on the teacher's explanation, the experiment method can boost kids' curiosity, learning motivation, and analytical thinking skills (Liu, Ye, Gan, & Wang, 2025). One interesting and simple experiment to try is the Rainbow Rain Experiment, which involves using water, oil, and food coloring to show how colors fall into the water like rain. Through this activity, kids are encouraged to observe the changes that happen, make guesses, test predictions, and explain the cause-and-effect relationships of the phenomena they see, making the learning process more meaningful and fun (Parlakyildiz, Seven, & Parlakyildiz, 2022).

Even though science learning has become part of the Early Childhood Education curriculum, its implementation in various institutions still faces several challenges. Learning is still dominated by lectures, teacher demonstrations, and the use of worksheets, so children's opportunities to explore and solve problems independently are still limited. Initial observations at RA Ubudiyah show that the science learning process still relies more on teacher explanations than on experiments. As a result, children's active involvement in discovering scientific concepts is not yet optimal. Most children show curiosity about natural phenomena, but they still have difficulties in identifying problems, making guesses, determining steps to solve them, and explaining the results of their observations. Kids also tend to wait for instructions from the teacher rather than trying to find solutions on their own. This shows that problem-solving skills in 5–6-year-olds still need to be developed through more active, contextual, and hands-on learning.

Various previous studies show that experiment-based learning can boost scientific thinking skills and cognitive development in young children. (Rahayu & Samta, 2022; Dilla, Hestalian, & Sari, 2025) stating that experimental activities give children the opportunity to build science concepts through hands-on experience, thereby improving their observation and reasoning skills. (Ioannou, Kaliampos, & Ravanis, 2024; Engkar, 2024) also explains that scientific exploration in early childhood plays an important role in developing critical thinking and problem-solving skills. In addition, (Nurhafizah, Muthmainnah, & Rahmi, 2023; Nafiqoh, 2025) finding that science learning based on exploration has a positive impact on children's critical thinking, creativity, and problem-solving skills. However, most of these studies still focus on the development of science literacy, cognitive abilities, or general science process skills. Research specifically examining the effect of the Rainbow Rain experiment method on the development of problem-solving skills in children aged 5–6 years, especially in the learning context at RA Ubudiyah, is still very limited.

These limitations indicate that there is a research gap that needs to be explored further. This study not only examines the effectiveness of experimental methods in science learning but specifically analyzes how the Rainbow Rain experiment can develop problem-solving skills in 5–6-year-old children through the stages of observing, identifying problems, making predictions, conducting experiments, evaluating results, and drawing conclusions. Therefore, this study has a novelty in applying the Rainbow Rain experiment as a science learning strategy to develop problem-solving skills in early childhood in the context of RA Ubudiyah, which has not been widely studied in previous research. Based on this explanation, this study aims to analyze the effect of teaching science using the Rainbow Rain experiment method on problem-solving skills in children aged 5–6 years at RA Ubudiyah. The results of the study are expected to provide empirical contributions to the development of science learning in Early Childhood Education, as well as serve as recommendations for teachers in designing more innovative, fun, and child-centered learning activities, so that they can optimize the development of problem-solving skills from an early age.

RESEARCH METHODS

This study employed a quantitative approach using a quasi-experimental design with a nonequivalent control group design. This design was used to measure the significance of the effect of the rainbow rain experiment intervention on children’s problem-solving skills by comparing the development of the intervention group and the comparison group without randomly reassigning participants (Rofiqoh, 2020). This model was selected because the school setting did not allow the researcher to randomly reorganize student composition; therefore, the existing classes were used as the experimental group and the control group. The research design is presented in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental Group	Y1	X	Y2
Control Group	Y3	–	Y4

Note:
Y1 = Pretest of the experimental group
Y2 = Posttest of the experimental group
Y3 = Pretest of the control group
Y4 = Posttest of the control group
X = Science learning treatment using the rainbow rain experiment method

The study was conducted at RA Ubudiyah during the second semester of the 2025/2026 academic year for three weeks. The research participants consisted of all Group B children aged 5–6 years, who were divided into two classes with a total of 16 children. Given the limited population size, this study employed total sampling; therefore, all members of the population were included as research participants. Based on the existing class distribution, eight children were assigned to the experimental group, while the other eight children were assigned to the control group (Asrulla, Syahrul, & Nurdin, 2023).

The experimental group participated in science learning through rainbow rain experimental activities, whereas the control group received conventional instruction consisting of teacher explanations, demonstrations, and question-and-answer sessions without children's direct involvement in experimental activities. Before the learning activities were conducted, both the experimental and control groups completed a pretest to measure their initial problem-solving abilities. After the intervention had been completed, both groups completed a posttest to identify the development and changes in children's problem-solving abilities.

The study was implemented through several stages, beginning with the administration of a pretest, followed by learning activities using the rainbow rain experiment method in the experimental group, and ending with the administration of a posttest for both groups. During the intervention, children in the experimental group were directly involved in observing, trying, predicting, and drawing conclusions from the rainbow rain experiment. Meanwhile, the control group participated in commonly used learning activities, in which the teacher served as the primary provider of instructional material.

Data were collected through structured observations conducted directly during the learning process. The instrument used was an observation sheet designed to measure children's problem-solving abilities. The instrument was developed based on problem-solving indicators proposed by (Hoicka, Butcher, & Gattis, 2023), including:
(1) the ability to complete tasks independently;
(2) the ability to try various alternative solutions;
(3) persistence in facing obstacles; and
(4) the ability to use different strategies after experiencing failure.

Table 2. Indicators of Children's Problem-Solving Ability

No.	**Indicator**	**Sub-Indicator**
1	Completing tasks independently	Children are able to follow the experimental steps independently.
		Children are able to pour the materials according to instructions without assistance.
		Children are able to complete the activity until the end.
2	Trying various alternative solutions	Children try changing the number of color drops.
		Children try different methods when the results do not meet expectations.
		Children suggest other ways to improve the experimental results.
3	Persistence in facing obstacles	Children continue the experiment even when it does not succeed initially.
		Children do not easily give up when the colors do not appear.
		Children remain focused on completing the task until the end.
4	Using different strategies after failure	Children change the way they mix the materials.

No.	Indicator	Sub-Indicator
		Children change the sequence of the experimental steps.
		Children use new ideas after the first attempt is unsuccessful.

The assessment used a 1–4 scale with the following categories:
(1) Not Yet Developed (*Belum Berkembang* / BB);
(2) Beginning to Develop (*Mulai Berkembang* / MB);
(3) Developing as Expected (*Berkembang Sesuai Harapan* / BSH); and
(4) Very Well Developed (*Berkembang Sangat Baik* / BSB).

The research instrument was prepared in the form of an observation sheet containing 12 indicators to measure children's problem-solving abilities. Each indicator was scored from 1 to 4, resulting in a possible total score range of 12–48. Before being used for data collection, the instrument underwent a content validity assessment through expert judgment involving lecturers and Early Childhood Education teachers. The assessment results indicated that the instrument met the eligibility criteria as a measure of problem-solving ability in early childhood. Furthermore, the reliability of the instrument was analyzed using Cronbach's Alpha coefficient to ensure the consistency of the measurement results.

The collected data were analyzed using descriptive and inferential statistics. Descriptive analysis was conducted to provide an overview of the data through the mean, standard deviation, minimum score, and maximum score of the pretest and posttest results in both the experimental and control groups. Before hypothesis testing, the data were tested for normality using the Shapiro–Wilk test and for homogeneity of variance using Levene's test as prerequisites for parametric analysis. After the data were confirmed to be normally distributed and homogeneous, the hypothesis was tested using an Independent Samples *t*-test with the assistance of SPSS software at a 5% significance level ($\alpha = 0.05$). The alternative hypothesis (H_a) was accepted if the significance value was less than 0.05, indicating that the implementation of the experimental method had a significant effect on children's problem-solving abilities.

RESULTS AND FINDINGS

This study aimed to examine the effect of implementing the rainbow rain experiment in science learning on the problem-solving abilities of children aged 5–6 years at RA Ubudiyah. The study involved two groups: an experimental group that received science learning through rainbow rain experimental activities and a control group that received conventional learning. Before the intervention was administered, all participants completed a pretest to determine their initial problem-solving abilities. After the learning process was completed, a posttest was conducted to measure changes and improvements in the problem-solving abilities of both groups.

Table 3. Mean Pretest and Posttest Scores of Children's Problem-Solving Ability

Group	Mean Pretest	Mean Posttest
Experimental Group	14.625	19.875
Control Group	12.750	14.250

Based on Table 3, the analysis showed an improvement in problem-solving ability in both research groups. In the experimental group, the mean score increased from 14.625 in the pretest to 19.875 after participating in science learning through the rainbow rain experiment. Meanwhile, the control group showed an increase in mean score from 12.750 to 14.250 after receiving conventional learning. Although both groups demonstrated improvement in problem-solving ability, the experimental group achieved a greater increase than the control group. These findings indicate that the implementation of the rainbow rain experiment in science learning had a positive effect on improving the problem-solving abilities of children aged 5–6 years.

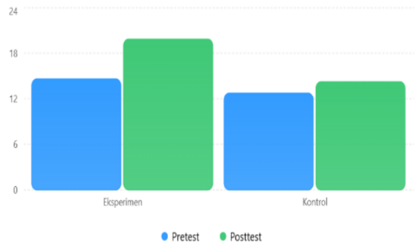

Figure 1. Comparison of Children's Pretest and Posttest Problem-Solving Scores

Based on Figure 1, the increase in the mean problem-solving ability of the experimental group was greater than that of the control group. The mean score of the experimental group increased from 14.625 in the pretest to 19.875 in the posttest. Meanwhile, the control group showed only an increase from 12.750 to 14.250. This difference indicates that the implementation of the rainbow rain experiment in science learning was more effective in improving children's problem-solving abilities than conventional learning.

The Shapiro–Wilk test was used to determine whether the data were normally distributed, which is a prerequisite for parametric statistical analysis.

Table 4. Results of the Normality Test

Group	Shapiro–Wilk Sig.
Experimental Group	0.516
Control Group	0.135

Based on Table 4, the significance value for the experimental group was 0.516, while that of the control group was 0.135. Since both values were greater than 0.05, the data were considered normally distributed and met the prerequisite for analysis using the Independent Samples *t*-test. A homogeneity test was conducted to determine whether the variances of the experimental and control groups were equal. The test was performed using Levene's test.

Table 5. Results of the Homogeneity Test

Levene Statistic	Sig.
–	0.464

Based on the homogeneity test results presented in Table 5, the significance value was 0.464. Since this value was greater than 0.05, it can be concluded that the variances of the data from both groups were homogeneous. Therefore, the data met the requirements for further analysis using the Independent Samples *t*-test. The hypothesis test in this study was conducted using an Independent Samples *t*-test to analyze the effect of science learning through the rainbow rain experiment on the problem-solving abilities of children aged 5–6 years.

Table 6. Results of the Independent Samples *t*-Test

t	df	Sig. (2-tailed)
6.625	14	0.000

Based on the test results presented in Table 6, the calculated *t*-value was 6.625, with a two-tailed significance value of 0.000. Since the significance value was less than 0.05, the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) was accepted. These findings indicate a significant difference in problem-solving abilities between the experimental group and the control group after the intervention. Therefore, it can be concluded that the implementation of the rainbow rain experiment in science learning was effective in improving the problem-solving abilities of children aged 5–6 years at RA Ubudiyah.

The improvement in children's problem-solving abilities was measured using gain scores to determine the level of development in each research group.

Table 7. Gain Scores of Children's Problem-Solving Ability

Group	Mean Gain
Experimental Group	5.250
Control Group	1.500

Based on Table 7, the experimental group demonstrated a greater improvement in problem-solving ability than the control group. The mean gain score of the experimental group was 5.250, whereas the control group achieved a mean gain score of only 1.500. This difference indicates that children who participated in science learning through the rainbow rain experiment experienced better development in problem-solving abilities. These results also reinforce the hypothesis-testing findings, demonstrating that the implementation of the rainbow rain experiment had a positive effect on improving the problem-solving abilities of children aged 5–6 years.

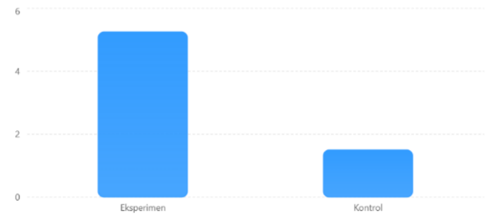

Figure 2. Comparison of Children's Problem Solving Ability Gain Scores

Based on Figure 2, the gain score calculations show that the experimental group experienced an improvement in problem-solving ability with an average of 5.250, while the control group only reached an average of 1.500. These findings indicate that the increase in problem-solving skills is more optimal in children involved in rainbow rain-based science experiments. This finding reinforces the results of the hypothesis test, which showed that the rainbow rain experiment method has a positive effect on the problem-solving abilities of children aged 5–6 years.

Discussion

The findings of this study demonstrate that science learning using the Rainbow Rain Experiment significantly improved the problem-solving abilities of children aged 5–6 years at RA Ubudiyah. This conclusion is supported by the increase in the mean score of the experimental group from 14.625 on the pretest to 19.875 on the posttest, compared with the control group, which improved only from 12.750 to 14.250. Furthermore, the Independent Samples *t*-test yielded a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference between the experimental and control groups. The gain score analysis also revealed that the experimental group achieved a substantially higher improvement (5.250) than the control group (1.500). These findings indicate that learning through direct experimentation provides richer learning experiences, enabling children to observe, predict, investigate, evaluate, and formulate solutions independently. Consequently, the Rainbow Rain Experiment effectively facilitates the development of children's problem-solving abilities through active engagement with scientific phenomena.

These findings are consistent with the constructivist learning theory proposed by (Om, et al., 2025; Salma, Fitriah, Anwar, Nasution, & Mardiana, 2025), which states that children construct knowledge through direct interaction with objects and events in their environment. During the Rainbow Rain Experiment, children actively observed color changes, predicted experimental outcomes, discussed possible explanations, and verified their predictions through experimentation. Such activities encouraged children to construct their own understanding rather than merely receiving information from the teacher. (Aragón, Cubero, & Gozalbo, 2023; Murniati, et al., 2025) argued that children's cognitive development is strengthened through social interaction and instructional support (*scaffolding*). Throughout the experiment, teachers guided children by asking reflective questions and encouraging discussion without directly providing answers, thereby allowing children to independently develop reasoning and problem-solving strategies. This instructional process explains why children in the experimental group demonstrated greater improvement than those receiving conventional instruction.

The present findings also support previous studies emphasizing the importance of inquiry-based science learning in early childhood education. (Carulla, Christodoulakis, & Adb, 2021; Putri, Hamzah, & Putri, 2023) reported that science activities involving observation, experimentation, and questioning significantly enhance children's reasoning and scientific thinking because they encourage active exploration rather than passive learning. Similarly, the National Research (Bakrisuk & Fitri, 2024; Puspita, Satriana, & Maghfirah, 2025) emphasized that scientific inquiry enables children to develop essential cognitive processes, including observation, prediction, evidence-based reasoning, and conclusion drawing. The Rainbow Rain Experiment implemented in this study incorporated these inquiry components, allowing children to investigate scientific phenomena directly while simultaneously developing systematic problem-solving skills.

Furthermore, the results are in agreement with (Schlauch, Sylla, & Gil, 2025), who argued that experimental science activities create meaningful learning experiences because children actively construct scientific concepts through play and exploration. Children involved in the Rainbow Rain Experiment demonstrated high levels of curiosity throughout the learning process. They eagerly observed how colored water gradually penetrated the oil layer, compared the speed of color movement, discussed why the colors changed, and attempted to explain the observed phenomena. These activities indicate that experimental learning not only promotes conceptual understanding but also stimulates analytical thinking, curiosity, and cognitive flexibility, all of which are essential components of problem-solving ability.

The findings also reinforce the study conducted by (Veraksa, Veraksa, & Aslanova, 2024), who found that inquiry-based STEM learning significantly improves young children's critical thinking and problem-solving skills through hands-on exploration. Similar learning processes occurred in the present study, where children were encouraged to formulate predictions before conducting the experiment, compare their predictions with the observed outcomes, and revise their initial understanding when discrepancies occurred. Such reflective learning experiences enabled children to engage in higher-order thinking processes rather than relying solely on memorization. Consequently, children developed greater confidence in solving problems independently while becoming more actively involved in classroom learning.

Although numerous studies have demonstrated the effectiveness of science experiments in improving scientific literacy and cognitive development, relatively few have specifically investigated the Rainbow Rain Experiment as an instructional strategy for enhancing problem-solving abilities among children aged 5–6 years. Previous studies have primarily focused on general inquiry learning or science process skills, whereas the present study specifically examined the influence of the Rainbow Rain Experiment on children's ability to identify problems, formulate hypotheses, conduct investigations, interpret evidence, and draw conclusions. Therefore, this study contributes new empirical evidence that simple science experiments using easily accessible materials can effectively foster children's problem-solving abilities while simultaneously promoting active participation and meaningful learning experiences.

Another important finding concerns the magnitude of improvement observed in the experimental group. The gain score difference between the experimental group (5.250) and the control group (1.500) indicates that experimental science learning provides substantially greater learning benefits than conventional teaching approaches. Conventional instruction tends to position children as passive recipients of information, whereas experimental learning allows children to become active investigators. This active involvement stimulates children's curiosity, encourages collaborative discussion, strengthens logical reasoning, and improves decision-making abilities when confronted with scientific problems. Such findings support the view that meaningful learning occurs when children actively participate in constructing knowledge through authentic experiences rather than merely receiving explanations from teachers (Åkerblom & Thorshag, 2021; Soleha, Hasanah, & Ashadi, 2024).

Overall, the results demonstrate that the Rainbow Rain Experiment is an effective instructional strategy for improving the problem-solving abilities of children aged 5–6 years. The significant differences identified through statistical analysis, supported by higher gain scores in the experimental group, indicate that experiment-based science learning provides meaningful opportunities for children to think critically, investigate phenomena, and solve problems independently. Therefore, integrating simple science experiments into early childhood education can become an effective pedagogical approach for developing twenty-first-century competencies, particularly problem-solving skills, scientific reasoning, creativity, and independent learning.

CONCLUSION AND SUGGESTIONS

Conclusions

Based on the findings, it can be concluded that the implementation of the rainbow rain experiment in science learning had a significant effect on the problem-solving abilities of children aged 5–6 years at RA Ubudiyah. The experimental group obtained a mean problem-solving score of 19.875, which was higher than that of the control group, which obtained a mean score of 14.250. The results of the Independent Samples t-test showed a calculated t-value of 6.625 with a significance level of 0.000 ($p < 0.05$); therefore, the research hypothesis was accepted. In addition, the mean gain score of the experimental group reached 5.250, whereas the control group achieved only 1.500. These findings indicate that science learning through the rainbow rain experiment was more effective in improving children's problem-solving abilities than conventional learning. The effectiveness of this method was supported by children's active involvement in observing phenomena, conducting experiments, evaluating results, and identifying solutions to problems that emerged during the learning process.

Therefore, the rainbow rain experiment is recommended as an alternative science learning strategy to optimize the development of problem-solving abilities in early childhood.

Suggestions

Teachers are encouraged to incorporate the rainbow rain experiment as an engaging science-learning activity to support children's problem-solving skills. Future studies should involve larger samples and broader research settings to strengthen the generalizability of the findings.

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