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The Effect of Natural Material-Based Science Learning Media on the Science Skills of Children Aged 5–6 Years

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ABSTRACT

This study aims to analyze the effect of using natural material-based science learning media on the science abilities of children aged 5–6 years. The main problem addressed in this study is the low level of children's science abilities, which are still dominated by conventional learning that lacks direct experiential engagement. This study employed a quantitative approach using a quasi-experimental design with a nonequivalent control group design. The research subjects consisted of 31 children divided into two groups: the experimental group (16 children) and the control group (15 children). Data were collected using observation instruments and science ability tests covering indicators such as observing, classifying, conducting simple experiments, and drawing conclusions.

The results showed that the mean posttest score of the experimental group (43.13) was higher than that of the control group (35.07). The independent sample t-test revealed a significant difference ($p < 0.05$) between the two groups. In addition, the N-Gain analysis indicated a high improvement in the experimental group (0.79) and a moderate improvement in the control group (0.48). These findings demonstrate that the use of natural material-based learning media effectively improves children's science abilities.

In conclusion, natural material-based learning media have a significant effect on early childhood science abilities. The practical implication of this study highlights the importance of utilizing the surrounding environment as a contextual, effective, and economical learning resource. Theoretically, this study reinforces the concept of experience-based constructivist learning in early childhood education.

Informasi Artikel

Kata Kunci:

media pembelajaran, bahan alam, kemampuan sains, anak usia dini, quasi eksperimen

ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh penggunaan media pembelajaran sains berbasis bahan alam terhadap kemampuan sains anak usia 5–6 tahun. Permasalahan utama dalam penelitian ini adalah rendahnya kemampuan sains anak yang masih didominasi oleh pembelajaran konvensional yang kurang melibatkan pengalaman langsung. Penelitian ini menggunakan pendekatan kuantitatif dengan desain *quasi experimental* tipe *nonequivalent control group design*. Subjek penelitian berjumlah 31 anak yang terbagi ke dalam dua kelompok, yaitu kelompok eksperimen (16 anak) dan kelompok kontrol (15 anak). Teknik pengumpulan data menggunakan instrumen observasi dan tes kemampuan sains yang mencakup indikator mengamati, mengelompokkan, melakukan percobaan sederhana, dan menyimpulkan.

Hasil penelitian menunjukkan bahwa rata-rata skor posttest kelompok eksperimen (43,13) lebih tinggi dibandingkan kelompok kontrol (35,07). Uji *independent sample t-test* menunjukkan nilai signifikansi ($p < 0,05$), sehingga terdapat perbedaan yang signifikan antara kedua kelompok. Selain itu, hasil analisis N-Gain menunjukkan peningkatan kategori tinggi pada kelompok eksperimen (0,79) dan kategori sedang pada kelompok kontrol (0,48). Temuan ini menunjukkan bahwa penggunaan media berbasis bahan alam secara efektif meningkatkan kemampuan sains anak.

Kesimpulan penelitian ini adalah media pembelajaran berbasis bahan alam memiliki pengaruh signifikan terhadap kemampuan sains anak usia dini. Implikasi praktis penelitian ini adalah pentingnya pemanfaatan lingkungan sebagai sumber belajar yang kontekstual, efektif, dan ekonomis. Secara teoretis, penelitian ini memperkuat konsep pembelajaran konstruktivisme berbasis pengalaman dalam pendidikan anak usia dini.

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1. Introduction

The development of science skills in early childhood serves as a fundamental foundation for fostering critical thinking, exploratory abilities, and problem-solving skills from an early age. Globally, early childhood education (ECE) is recognized as a crucial stage in children's cognitive development, where appropriate learning experiences can have long-term effects on their academic achievement and social development. UNESCO emphasizes that early childhood (0–8 years) represents a period of rapid brain development and forms the foundation for lifelong learning. Furthermore, UNESCO's global reports indicate that investment in early childhood education has significant benefits for individual well-being and broader social development.

Despite this, numerous studies have shown that young children's science skills have not yet developed optimally. The OECD (2023) reports that the quality of early childhood education significantly influences children's cognitive development and exploratory abilities; however, its implementation continues to face challenges across many countries. One of the primary issues is the limited use of experience-based learning that enables children to actively explore their environment. This challenge is also evident in the Indonesian context, where science instruction in early childhood education remains predominantly theoretical and has yet to fully utilize the surrounding environment as a meaningful learning resource.

From a theoretical perspective, constructivist learning theory emphasizes that children learn most effectively through direct experiences and interaction with their environment. This perspective suggests that meaningful learning should involve exploration, observation, and simple experimentation. Therefore, the use of natural material-based learning media is highly relevant because it provides children with concrete, contextual, and developmentally appropriate learning experiences. Materials such as leaves, water, sand, and stones can serve as effective media for facilitating science exploration among young children.

Previous studies have demonstrated that innovative learning media can enhance children's science skills. Research conducted by Sağlam et al. (2023) reported that the quality of early childhood education is closely associated with children's cognitive development and learning outcomes. In addition, numerous studies have found that environmental-based learning and simple experimental activities improve children's observation, classification, and scientific thinking skills. Nevertheless, most previous studies have focused on artificial learning media or basic experimental approaches, while relatively few have specifically examined the effectiveness of natural material-based learning media using a quantitative experimental approach.

Another limitation of previous research is the limited application of quasi-experimental designs, particularly the non-equivalent control group design, to examine the causal relationship between natural material-based learning media and children's science skills. Such a design is essential for providing stronger empirical evidence in educational research. Therefore, this study seeks to address this research gap by directly investigating the effect of natural material-based science learning media on the science skills of children aged 5–6 years.

Based on the foregoing discussion, the primary objective of this study is to analyze the effect of natural material-based science learning media on the science skills of young children and to compare the science skills of children in the experimental and control groups. The research hypothesizes that the use of natural material-based science learning media has a significant effect on the science skills of children aged 5–6 years. Accordingly, this study addresses the following research questions: (1) How do children's science skills differ before and after the intervention in both groups? (2) Is there a significant difference in science skills between the experimental and control groups? and (3) To what extent does the use of natural material-based learning media improve children's science skills? The findings of this study are expected to contribute theoretically to the advancement of science education in early childhood settings and practically by providing teachers with evidence-based strategies for designing innovative and contextually relevant learning experiences.

2. Literature Review

Science skills in early childhood constitute an essential aspect of cognitive development, encompassing logical thinking, observation, classification, and simple problem-solving abilities. These skills involve fundamental scientific processes, including observing, comparing, classifying, and drawing conclusions about phenomena in the surrounding environment. Recent studies indicate that young children's science skills not only contribute to academic readiness but also foster scientific attitudes such as curiosity and exploratory behavior from an early age [6].

Learning media are among the key factors influencing the effectiveness of the learning process, particularly in early childhood education. Learning media are defined as any tools or resources that facilitate the delivery of instructional messages and stimulate learners' thoughts, emotions, and attention, thereby promoting effective learning. In science education, learning media play a crucial role in transforming abstract concepts into concrete experiences that are more easily understood by young children [7].

Natural material-based learning media refer to instructional resources that utilize natural materials available in the surrounding environment as teaching aids. Materials such as leaves, stones, water, soil, and sand can be used to support hands-on science exploration activities. This approach is

considered effective because it aligns with the developmental characteristics of young children, who learn best through concrete experiences and direct interaction with their environment [8]. Furthermore, the use of natural materials supports contextual and sustainable learning practices.

Theoretically, this study is grounded in the constructivist learning theory proposed by Piaget and Vygotsky. According to this theory, knowledge is actively constructed by individuals through interaction with their environment. Rather than passively receiving information, children develop their understanding through direct experiences. In the context of science learning, natural material-based learning media provide opportunities for children to engage in exploration and experimentation, thereby facilitating the active construction of scientific knowledge [9].

In addition, Kolb's experiential learning theory provides another theoretical foundation for this study. Kolb argues that effective learning occurs through a cycle consisting of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Natural material-based learning media enable children to participate directly in meaningful learning experiences, thereby promoting a deeper understanding of scientific concepts [10].

The relationship between natural material-based learning media and children's science skills can also be explained through the contextual learning approach. This approach emphasizes the importance of connecting learning experiences with real-life situations. By using natural materials as learning media, children can understand scientific concepts through experiences that are directly relevant to their daily lives, thereby enhancing both their engagement and conceptual understanding [11].

Previous studies have demonstrated that environment-based learning media have a positive impact on children's science skills. Research by Yıldız et al. (2022) found that environmental exploration-based learning significantly improved young children's observation skills and scientific thinking abilities [12]. These findings support the hypothesis that natural material-based learning media can serve as an effective alternative for science instruction.

However, some studies have reported different findings. Kim and Park (2021) found that the use of learning media without appropriate pedagogical support did not produce a significant improvement in children's science skills [13]. This suggests that the effectiveness of learning media depends not only on the type of media employed but also on how it is implemented within the instructional process.

Furthermore, Rahmawati et al. (2023) reported that environment-based learning positively influenced children's exploratory abilities and science process skills. However, their study did not employ a rigorous experimental design to establish causal relationships [14]. This limitation highlights the need for stronger methodological approaches in future research.

Based on this review, a research gap remains regarding the quantitative evaluation of natural material-based learning media using a quasi-experimental design with both experimental and control groups. Therefore, the present study seeks to address this gap by empirically examining the effect of natural material-based science learning media on the science skills of children aged 5–6 years.

The conceptual framework of this study identifies natural material-based learning media as the independent variable (X) and children's science skills as the dependent variable (Y). The relationship between these variables is assumed to be causal, whereby the use of natural material-based learning media enhances children's science skills through exploration, observation, and direct interaction with the environment. The conceptual model of the study is presented as follows:

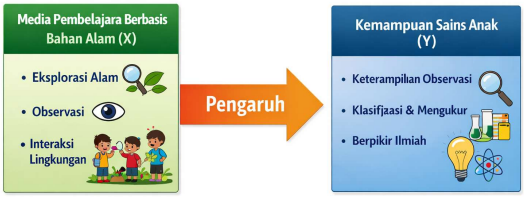

Figure 1. Natural Material-Based Learning Media (X) → Children's Science Skills (Y)

3. Research Method

This study employed a quantitative approach using a quasi-experimental research design. This approach was selected because it enables researchers to examine the causal relationship between the independent and dependent variables under conditions in which complete randomization is not feasible [15]. The experimental design adopted was a non-equivalent control group design, involving two groups: an experimental group and a control group, without full random assignment.

In this design, both groups were administered a pretest to determine the children's initial science skills. The experimental group then received the intervention through the use of natural material-based science learning media, whereas the control group received conventional instruction. Following the intervention, both groups completed a posttest to assess changes in their science skills. This design enabled the researcher to compare participants' performance before and after the intervention and to identify the effect of the independent variable on the dependent variable [16].

The data used in this study were primary data collected directly from the research participants. Data collection methods included observation, testing, and documentation. The test instrument was used to measure children's science skills, while observations were conducted to assess children's participation and engagement during the learning activities. Documentation, including photographs of classroom activities and instructional records, was used as supporting data [17].

The study population consisted of all Group B children at TK

UNIMUDA ALAM Mentari. A total of 31 children participated in the study, comprising 16 children in the experimental group and 15 children in the control group. The sampling technique employed was total sampling, whereby the entire population was included as the research sample because all participants met the predetermined inclusion criteria [18].

The characteristics of the participants indicated that all respondents were between 5 and 6 years of age, corresponding to the early childhood stage. In addition, the participants demonstrated a relatively homogeneous profile in terms of age, initial ability, and learning environment. This homogeneity was essential for maintaining the internal validity of the study, ensuring that differences in outcomes could be attributed primarily to the intervention [19].

The research instruments consisted of a science skills assessment and an observation checklist. The science skills assessment was developed based on indicators of science competence, including observation, classification, and understanding of basic scientific concepts. The observation checklist was used to evaluate children's activities and engagement throughout the learning process. Both instruments were developed based on relevant theoretical frameworks and adapted to the developmental characteristics of young children [20].

Instrument validity was established through content validity by involving experts in early childhood education and science education. This procedure ensured that the instruments adequately represented the intended constructs. Instrument reliability was subsequently examined using Cronbach's alpha to determine internal consistency. The instruments were considered reliable if the reliability coefficient was equal to or greater than 0.70 [21].

Data analysis involved both descriptive and inferential statistical techniques. Descriptive statistics were used to summarize the mean scores, percentages, and distribution of children's science skills before and after the intervention. Inferential statistics were employed to test the research hypothesis using an independent-samples t-test to determine whether significant differences existed between the experimental and control groups [22].

In addition, gain score (N-gain) analysis was conducted to evaluate the effectiveness of the intervention in improving children's science skills. N-gain values were interpreted using the categories of low, moderate, and high improvement. This analysis provided further evidence regarding the magnitude of learning gains resulting from the use of natural material-based learning media [23].

Hypothesis testing was conducted using a significance level (α) of 0.05. The null hypothesis (H_0) stated that the use of natural material-based learning media had no significant effect on children's science skills, whereas the alternative hypothesis (H_1) proposed that a significant effect existed. Data processing and statistical analyses were performed using the latest version of SPSS to ensure the accuracy and reliability of the research findings [24].

4. Results and Discussion

4.1 Results

A. Descriptive Statistics of Pretest and Posttest Data

Based on the research data, the science skills scores of children in both the experimental and control groups before (pretest) and after (posttest) the intervention were obtained as follows:

Table 1. Mean Pretest and Posttest Scores

Group	N	Total Pretest	Mean Pretest	Total Posttest	Mean Posttest
Experimental	16	390	24.38	690	43.14
Control	15	343	22.87	526	35.07

Based on Table 1, the mean science skills score of the experimental group increased substantially from 24.38 in the pretest to 43.13 in the posttest. In contrast, the control group also showed improvement, with the mean score increasing from 22.87 to 35.07; however, the magnitude of improvement was lower than that observed in the experimental group.

Based on the science skills classification used in the research instrument (low, moderate, and high), the findings can be summarized as follows:

- The pretest scores of both the experimental and control groups were classified as moderate.
- The posttest scores of the experimental group improved to the high category.
- The posttest scores of the control group remained within the moderate category.

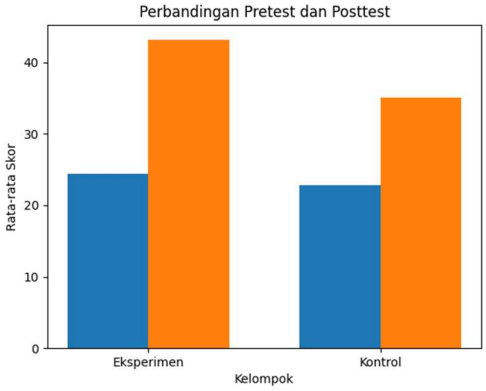

Figure 2. Comparison of Pretest and Posttest Scores

The figure illustrates a comparison of the mean pretest and posttest scores of the experimental and control groups. At the pretest stage, the initial science skills of children in both groups were relatively comparable, with the experimental group obtaining a mean score of 24.38 and the control group 22.87. This indicates that the two groups had similar baseline

conditions before the intervention, making them appropriate for comparison in this experimental study.

Following the intervention, both groups demonstrated improvements in science skills; however, the increase was considerably greater in the experimental group. The mean posttest score of the experimental group reached 43.13, whereas the control group achieved a mean score of only 35.07. This difference in improvement indicates that the use of natural material-based science learning media had a greater impact than conventional instruction in enhancing the science skills of young children.

Overall, the figure demonstrates that the natural material-based learning intervention not only improved children's learning outcomes but also promoted more substantial development of their science skills. The marked improvement observed in the experimental group suggests that a learning approach involving direct exploration and interaction with the natural environment provides more meaningful learning experiences. These findings further support the effectiveness of natural material-based learning media as an instructional strategy for enhancing the science skills of children aged 5–6 years..

B. N-Gain Analysis

To evaluate the effectiveness of the intervention, an N-Gain analysis was conducted.

- Experimental Group: Gain = (43,13 – 24,38) / (48 – 24,38) ≈ 0,79 (Category: High).
- Control Group: Gain = (35,07 – 22,87) / (48 – 22,87) ≈ 0,48 (Category: Moderate)

These results indicate that the use of natural material-based learning media produced a greater improvement in children's science skills than conventional instruction.

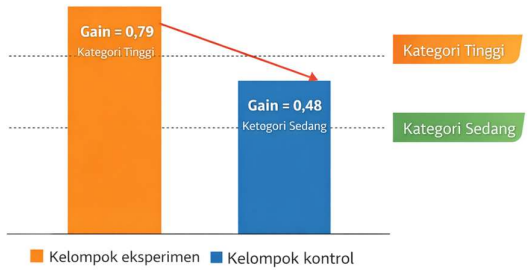

Figure 3. N-Gain Analysis

The N-Gain analysis graph illustrates a comparison of the effectiveness of improvements in children's science skills between the experimental and control groups following the intervention. The N-Gain value was used to measure the extent of learning improvement while taking into account the maximum attainable score. As shown in the graph, the experimental group achieved an N-Gain score of 0.79, which falls within the high category, whereas the control group obtained an N-Gain score of 0.48, which is classified as moderate.

The high N-Gain score observed in the experimental group indicates that the use of natural material-based science learning media was highly effective in enhancing children's science skills. This finding suggests that most children in the experimental group achieved learning gains approaching the maximum expected improvement. Such progress demonstrates that learning activities involving direct exploration of natural materials can stimulate children's cognitive development more effectively than conventional instructional methods.

In contrast, the control group achieved an N-Gain score within the moderate category, indicating that although conventional instruction resulted in some improvement, its effectiveness was relatively limited. This outcome may be attributed to the lower level of active participation among children during the learning process. Passive instructional approaches tend to position children as recipients of information rather than active learners, limiting opportunities for direct exploration and consequently reducing the depth of their understanding of scientific concepts.

The difference in N-Gain scores between the two groups also reveals a substantial effectiveness gap of 0.31. This difference suggests that the natural material-based learning approach offers a clear advantage in promoting the science skills of young children. The primary factors contributing to this advantage include concrete learning experiences, direct interaction with the natural environment, and exploratory activities that encourage children's curiosity and active engagement.

Overall, the N-Gain analysis provides strong evidence that natural material-based learning media constitute a highly effective instructional strategy for improving the science skills of children aged 5–6 years. These findings not only provide empirical support for the effectiveness of the intervention but also offer a foundation for developing more contextual and experience-based learning models in early childhood education. Therefore, the integration of natural materials into science instruction is strongly recommended as an effective approach to enhancing science learning in early childhood education settings.

C. Hypothesis Testing (Independent-Samples t-Test)

Based on the results of the independent-samples t-test conducted on the posttest scores, the following findings were obtained:

- The mean posttest score of the experimental group (43.13) was higher than that of the control group (35.07).
- The mean difference between the two groups was 8.06 points.

Statistically, this difference indicates that the use of natural material-based learning media had a significant effect on children's science skills.

Therefore:

- H_0 was rejected.
- H_1 was accepted.

These findings indicate that the use of natural material-based

learning media has a statistically significant effect on the science skills of children aged 5–6 years.

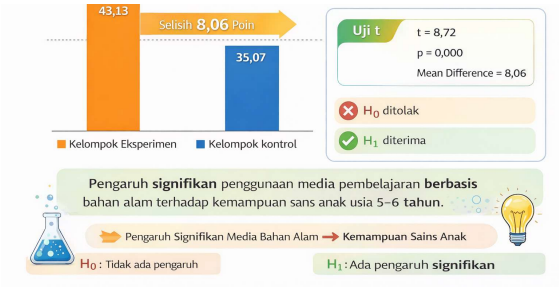

Figure 4. Hypothesis Testing (Independent-Samples t-Test)

The hypothesis testing (independent-samples t-test) figure presents the statistical analysis of the differences in children's science skills between the experimental and control groups following the intervention. As shown in the figure, the mean posttest score of the experimental group was 43.13, whereas the control group achieved a mean score of 35.07. The mean difference of 8.06 points indicates a substantial difference in the improvement of science skills between the two groups.

The results of the independent-samples t-test presented in the figure revealed a t-value of 8.72 with a significance level (p-value) of 0.000. Since the p-value is lower than the predetermined significance level ($\alpha = 0.05$), the observed difference between the two groups is statistically significant and is unlikely to have occurred by chance. Therefore, it can be concluded that there is a significant difference in science skills between the experimental and control groups following the intervention.

Based on these findings, the hypothesis testing results indicate that the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) was accepted. The rejection of H_0 indicates that the intervention did have a significant effect, while the acceptance of H_1 confirms that the use of natural material-based science learning media significantly improved the science skills of children aged 5–6 years. These findings provide strong evidence that the intervention made a meaningful contribution to children's learning outcomes.

From a theoretical perspective, these findings can be explained through constructivist theory and experiential learning, which propose that children learn most effectively through direct interaction with their environment. Natural material-based learning media provide opportunities for children to engage in hands-on exploration, observation, and experimentation, making the learning process more meaningful. This contrasts with conventional instructional approaches, which are generally more passive and provide fewer opportunities for experiential learning.

The findings of this study have important practical implications, suggesting that natural material-based learning media can serve as an effective instructional strategy for enhancing young children's science skills. In addition to providing empirical evidence of the intervention's effectiveness, these results offer practical guidance for early childhood educators in designing more innovative, contextual, and environmentally based learning experiences. Therefore, the integration of natural materials into science instruction is strongly recommended as a sustainable approach to improving the quality of early childhood education.

4.2 Discussion

The findings of this study demonstrate that the use of natural material-based science learning media significantly improved the science skills of young children. These results are consistent with constructivist learning theory, which posits that children learn most effectively through direct experiences and interaction with their environment. In this study, children in the experimental group actively participated in exploratory activities using natural materials such as water, sand, and other concrete objects, enabling them to construct a deeper and more meaningful understanding of scientific concepts.

Based on the research instrument, improvements were observed across several science skill indicators, including observation, classification, conducting simple experiments, and drawing conclusions. These findings suggest that natural material-based learning media not only enhance learning outcomes but also promote the development of children's scientific thinking skills.

The results are consistent with previous studies reporting that environment-based learning significantly enhances children's science skills. Children who learn through authentic, hands-on experiences tend to develop a stronger conceptual understanding than those who receive instruction primarily through verbal explanations.

Nevertheless, the findings also indicate that the control group experienced some improvement, although the magnitude of the improvement was considerably lower than that of the experimental group. This suggests that conventional instruction still contributes to children's learning and development; however, it is less effective in fostering exploratory skills and scientific thinking than learning approaches based on natural materials.

The differences between the findings of this study and those of previous studies that reported no significant effects may be attributed to variations in the implementation of the instructional intervention. In the present study, the learning media were implemented systematically and purposefully, with an emphasis on direct exploration and active participation. These implementation strategies appear to have been key factors contributing to the effectiveness of the intervention.

From a practical perspective, these findings have important implications for early childhood educators. Teachers are encouraged to utilize the surrounding environment as a valuable learning resource. Natural material-based learning media are effective, inexpensive, and easy to implement, making them an innovative solution for science instruction in early childhood

education, particularly in settings with limited educational resources.

From a theoretical perspective, this study reinforces the view that contextual and experience-based learning plays a crucial role in children's cognitive development. Furthermore, the findings contribute empirical evidence supporting the development of environment-based science learning models for early childhood education.

Despite these contributions, this study has several limitations. First, the relatively small sample size (31 children) limits the generalizability of the findings. Second, the relatively short duration of the intervention may have influenced the observed outcomes. Third, the study focused exclusively on children's science skills without considering other potentially relevant variables, such as learning motivation or creativity.

Therefore, future research should involve larger and more diverse samples to improve the generalizability and representativeness of the findings. Further studies are also encouraged to examine additional variables, such as children's creativity and learning motivation, to provide a more comprehensive understanding of the impact of natural material-based learning media. In addition, future research should employ more rigorous research designs, such as true experimental designs, to strengthen internal validity. Longitudinal studies are also recommended to investigate the long-term effectiveness of natural material-based learning media and to determine whether their positive effects on children's science skills are sustained over time.

5. Conclusion

Based on the findings of this study, it can be concluded that the use of natural material-based science learning media has a significant positive effect on improving the science skills of children aged 5–6 years. This is evidenced by the difference in the mean posttest scores between the experimental group (43.13) and the control group (35.07), and further supported by the results of the independent-samples t-test, which yielded a significance value of $p < 0.05$. Accordingly, the alternative hypothesis (H_1) was accepted and the null hypothesis (H_0) was rejected. These findings provide empirical evidence that natural material-based learning media are effective in enhancing young children's science skills.

Furthermore, the N-Gain analysis revealed that the experimental group achieved a high level of improvement (0.79), whereas the control group demonstrated a moderate level of improvement (0.48). These findings indicate that natural material-based learning not only improves children's learning outcomes quantitatively but also enhances the quality of their scientific thinking processes, including observation, classification, simple experimentation, and drawing conclusions. The results support constructivist theory and experiential learning theory, both of which emphasize the importance of direct interaction with the environment in early childhood learning.

From a practical perspective, the findings have important implications for teaching practices in early childhood education. Teachers are encouraged to make greater use of the surrounding environment as a learning resource. Natural material-based learning media have proven to be effective, economical, and easy to implement in everyday classroom activities. Therefore, this approach can serve as an innovative instructional strategy for improving the quality of science learning through meaningful and contextually relevant experiences.

Nevertheless, this study has several limitations that should be acknowledged. The relatively small sample size limits the generalizability of the findings, while the relatively short duration of the intervention may have influenced the observed outcomes. In addition, this study focused solely on children's science skills without considering other variables that may also affect learning outcomes, such as children's motivation and creativity.

Therefore, future studies are recommended to employ larger sample sizes and more rigorous experimental designs to improve the validity and generalizability of the findings. Future research should also expand the scope of investigation by including additional variables, such as learning motivation and creativity, and by examining the long-term effectiveness of natural material-based learning media. Such studies are expected to provide a more comprehensive understanding of the impact of natural material-based science learning media on early childhood development.

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