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# Science Learning Perceptions and Perceived Readiness of Preservice Early Childhood Teachers

**Wa Ode Siti Hamsinah Day[1]*, Hafsemi Rapsanjani[2]**
[1]Early Childhood Education Teacher Education Study Program, Universitas Musamus, Indonesia
[2]Elementary School Teacher Education Study Program, Universitas Musamus, Indonesia

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*Corresponding author: hamsinah.day@unmus.ac.id

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***ABSTRACT***
*Science learning in early childhood requires prospective teachers who understand its importance and are prepared to design and implement developmentally appropriate learning experiences. This study aimed to examine Pendidikan Guru Pendidikan Anak Usia Dini students' perceptions and perceived readiness for early childhood science learning and to explore the experiences and challenges underlying these perceptions. The study employed a descriptive survey with a quantitative approach supported by qualitative data from semi-structured interviews. The survey involved 179 students, while six students were purposively selected for interviews. Quantitative data were collected using a 20-item five-point Likert-scale questionnaire and analyzed descriptively, while interview data were analyzed thematically. The results showed that students' overall perception was categorized as high (70,82%). The highest score was found for the perceived importance of science learning (74,32%), followed by perceptions of implementation (72,11%), perceived readiness (68,32%), and understanding of early childhood science learning (67,63%). Interview findings indicated that students recognized the importance of hands-on experiences, exploration, simple experiments, and environmental resources, but still needed practical experience, examples of learning activities, and guidance. These findings indicate a descriptive gap between students' positive perceptions of the importance of science learning and their perceived readiness to implement it. Strengthening authentic pedagogical experiences, mentoring, and opportunities to design and practice science activities is therefore important in preparing prospective early childhood teachers.*

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## INTRODUCTION

Science learning in early childhood education (ECE) is an important component in building the foundation of children's ability to understand the world around them. At this developmental stage, science learning is not directed toward mastering complex scientific concepts, but rather toward providing learning experiences that enable children to observe, explore, ask questions, try things out, compare, and draw simple conclusions based on phenomena encountered in everyday life. These characteristics are consistent with the principles of early childhood education, which emphasize direct experiences, play, exploration, and interaction with the environment as integral parts of the knowledge construction process (Romadhoni et al., 2024). Recent empirical evidence also demonstrates the contribution of science learning to the development of children's scientific literacy. A meta-analysis by Gangal et al. (2026) of 17 intervention studies found that science activities had a large overall effect on early childhood scientific literacy (*Hedges' g* = 0,891), with activities utilizing outdoor environments showing particularly strong effects. These findings indicate that science learning designed according to children's developmental characteristics has considerable potential to serve as an important means of fostering thinking skills and scientific literacy from an early age.

The success of science learning in ECE is closely related to teachers' competencies and perspectives toward science. Teachers do not merely serve as transmitters of information but also as facilitators who create opportunities for children to ask questions, make observations, explore objects, conduct simple experiments, and develop explanations based on their experiences. In this process, teachers' perceptions, beliefs, and understanding of the nature of science learning may influence the pedagogical decisions they make when interacting with children. Haber et al. (2021), in a study involving 209 early childhood educators, including practicing and preservice teachers, found that educators' responses to children's science-related questions were associated with their views regarding how scientific knowledge is constructed. This finding suggests that educators' perspectives toward science are not merely a matter of knowledge but may also be reflected in classroom practices and pedagogical responses to children's scientific activities.

These implications make Pendidikan Guru Pendidikan Anak Usia Dini (PGPAUD) a strategic component in strengthening science learning. Students in the PGPAUD Study Program are prospective educators who will directly encounter children's needs for meaningful science learning experiences. The perceptions developed through coursework, teaching practice, and field experiences may influence how students understand the purposes, characteristics, and implementation of science learning in ECE. In this context, science teaching self-efficacy is also a relevant aspect because it relates to prospective teachers' beliefs in their ability to conduct science instruction. Simsar and Jones, (2021), through a study involving 96 early childhood preservice teachers, found associations among field experiences, mentoring activities, and science teaching self-efficacy. These findings suggest that pedagogical experiences during teacher education play an important role in shaping prospective teachers' readiness to teach science.

In addition to self-efficacy, students' perceptions of science learning deserve specific attention. Perceptions reflect how students understand the value, purposes, characteristics, and implementation of science learning. Positive and appropriate perceptions of the nature of science learning may serve as one of the foundations for developing pedagogical readiness, whereas inappropriate perceptions may lead to a narrow understanding of science learning, for example, viewing it merely as conducting experiments or conveying scientific facts. Therefore, prospective teachers' understanding of science learning needs to encompass the view that science at the ECE level is a process of exploration and investigation through which children construct knowledge through direct experiences, interactions with their environment, questions, observations, and simple experiments.

The development of science learning in ECE has also increasingly moved toward more exploratory and contextual approaches, including problem-based learning, project-based learning, and integration with STEM approaches. A systematic review by Larkin and Lowrie (2023) of STEM education in preschool and primary school highlighted the importance of authentic approaches, including problem-based learning and project-based learning, in supporting the integration of various STEM disciplines. This development has important implications for early childhood teacher education. Prospective teachers need not only to possess knowledge of scientific concepts but also to understand

how science can be presented through learning experiences that are appropriate to children's developmental characteristics, surrounding environments, and everyday lives. Therefore, examining students' perceptions of science learning is important because it can provide an initial picture of their understanding and readiness to implement science learning as prospective early childhood teachers.

Although research on early childhood science education continues to develop, previous studies have predominantly examined either children's science learning outcomes, STEM implementation, teachers' beliefs, or science teaching self-efficacy. Gangal et al. (2026), for example, focused on the effectiveness of science activities in promoting children's scientific literacy, whereas Larkin and Lowrie (2023) examined the implementation and integration of STEM approaches in preschool and primary education. Meanwhile, Simsar and Jones (2021) investigated the relationship between field experiences, mentoring, and science teaching self-efficacy among early childhood preservice teachers, while Haber et al. (2021) examined educators' beliefs and their responses to children's science-related questions. These studies have provided important insights into children's learning outcomes, STEM practices, and psychopedagogical factors related to science teaching; however, they have not specifically examined how prospective early childhood teachers perceive science learning across multiple dimensions of understanding, perceived importance, implementation, and readiness.

This gap is particularly relevant in early childhood teacher education in Indonesia, where prospective teachers' positive perceptions of science may not necessarily indicate that they are sufficiently prepared to translate their understanding into pedagogical practice. Previous research has provided limited evidence on how these dimensions are simultaneously experienced by PGPAUD students, particularly in relation to the transition from recognizing the value of science learning to feeling prepared to implement it. Moreover, quantitative descriptions of prospective teachers' perceptions are rarely complemented by qualitative evidence that explains the experiences, practical challenges, and forms of support underlying their perceived readiness. Therefore, examining these dimensions together can provide a more comprehensive picture of the condition of prospective early childhood teachers.

The present study extends this literature by simultaneously examining four perceptual dimensions among prospective early childhood teachers: understanding of early childhood science learning, perceived importance of science learning, perceptions of implementation, and perceived readiness to implement science learning. In addition, qualitative evidence from semi-structured interviews is used to explain the experiences and challenges underlying the quantitative patterns, particularly the difference between perceived importance and perceived readiness. Thus, rather than merely identifying whether students hold positive or negative perceptions of science learning, this study provides a multidimensional empirical profile of prospective early childhood teachers and identifies a perceived readiness gap between recognizing the value of science learning and feeling prepared to implement it.

The distinctive contribution of this study is therefore not simply that PGPAUD students have positive perceptions of science learning, but that the findings reveal a descriptive gap between recognizing the importance of science learning and feeling ready to translate that recognition into pedagogical practice. This multidimensional perspective provides an empirical basis for strengthening early childhood teacher education through authentic pedagogical experiences, practical activities, mentoring, and opportunities for students to design and practice developmentally appropriate science learning.

Accordingly, this study aims to describe PGPAUD Study Program students' perceptions of early childhood science learning and to explore their readiness as prospective early childhood teachers to implement science learning. Specifically, the study analyzes students' perceptual tendencies across four aspects: understanding of early childhood science learning, the importance of science learning, science learning implementation, and readiness for implementation. Quantitative data are analyzed descriptively to provide an overview of students' perceptual tendencies, while interview data are used to strengthen and contextualize the quantitative findings, particularly with regard to students' experiences and challenges. The findings are expected to provide an empirical basis for the development of learning within the PGPAUD Study Program, particularly in designing coursework, practical activities, and field experiences that can prepare prospective teachers with an appropriate

understanding, positive perceptions, and pedagogical readiness to conduct meaningful, contextualized science learning that is appropriate to the characteristics of young children.

## METHOD

### Research Design

This study employed a descriptive survey design with qualitative enrichment through semi-structured interviews (Banha et al., 2022; Karatsareas, 2022). This design was selected because the study aimed to obtain an empirical description of students' perceptions in the PGPAUD Study Program regarding early childhood science learning, while also exploring the experiences and challenges underlying those perceptions. The quantitative approach was used to identify students' perceptual tendencies based on the scores obtained from the questionnaire instrument, while the qualitative data were used to provide further explanation and context for the quantitative findings (Ahmad et al., 2019).

The study was descriptive in nature and was not intended to examine causal relationships among variables. The focus was on mapping students' perceptions across four aspects: understanding of early childhood science learning, perceptions of the importance of early childhood science learning, perceptions of science learning implementation, and readiness to implement science learning as prospective early childhood teachers. The interview data were used as qualitative enrichment, namely, to enrich the interpretation of the survey findings through students' experiences, reasons, and challenges.

Data were collected using a Likert-scale questionnaire and semi-structured interviews. The quantitative data were analyzed descriptively, while the interview data were analyzed thematically. The two sources of data were subsequently integrated at the interpretation stage to obtain a more comprehensive understanding of students' perceptions. This approach is consistent with the principle that research design should be aligned with the research objectives, research questions, characteristics of the data, and the analytical strategies employed (Creswell & Creswell, 2023).

### Participants and Sampling

The participants in this study were students enrolled in the PGPAUD Study Program at Universitas Musamus who had completed courses or gained learning experiences related to early childhood science. This criterion was established to ensure that the participants had relevant academic experiences that enabled them to provide informed assessments of early childhood science learning.

The study population consisted of all PGPAUD students who met these criteria during the 2025/2026 academic year, totaling 322 students. The sampling technique employed was proportionate stratified random sampling based on students' academic semesters to ensure adequate representation of students with different levels of academic experience. A sample of 179 students was selected using the Slovin formula with a 5% margin of error (Majdina et al., 2024; Santoso, 2023).

For the qualitative component, interview participants were selected purposively from among the questionnaire respondents. The selection considered variations in academic semester, experience with science learning practices, and tendencies in perception and readiness scores. This selection strategy was intended to obtain participants who could provide relevant and diverse information to enrich the interpretation of the quantitative findings. The interviews were conducted with six student participants.

### Research Instruments

The main research instrument was a questionnaire assessing students' perceptions of early childhood science learning and their readiness as prospective early childhood teachers. The questionnaire was developed based on a review of the literature on early childhood science learning, prospective teacher education, and *science teaching self-efficacy*. The questionnaire was developed based on the research objectives and relevant literature concerning early childhood science learning and prospective teacher education. The questionnaire items were developed based on the research objectives and relevant literature concerning early childhood science learning and prospective teacher education. Because the questionnaire was used primarily for descriptive purposes, the results should be interpreted

as students' self-reported perceptions rather than as measurements from a formally validated psychometric instrument.

Table 1. Indicators of the student perception instrument for early childhood science learning

| No. | Indicator | Description | Number of Items |
|---|---|---|---|
| 1 | Understanding of early childhood science learning | Students' understanding of the nature, characteristics, and purposes of science learning for young children | 4 |
| 2 | Importance of early childhood science learning | Students' views regarding the benefits of science learning for children's development and thinking skills | 5 |
| 3 | Implementation of early childhood science learning | Students' perceptions of methods, media, exploration, experimentation, observation, environmental resources, and contexts for science learning | 6 |
| 4 | Readiness as prospective early childhood teachers | Students' perceived confidence in designing, selecting media, and implementing science learning for young children | 5 |
| | | Total | 20 |

The questionnaire consisted of 20 statements using a five-point Likert scale: 5 (strongly agree), 4 (agree), 3 (uncertain), 2 (disagree), and 1 (strongly disagree). Higher scores indicated more positive perceptions and greater perceived readiness to implement science learning (Ateş et al., 2024; Xie et al., 2026).

The instrument covered four indicators: (1) understanding of early childhood science learning; (2) perceptions of the importance of early childhood science learning; (3) perceptions of the implementation of early childhood science learning; and (4) readiness to implement early childhood science learning as prospective early childhood teachers (Choiriyah et al., 2021; Marsetyaningrum, 2018).

**Data Collection Procedure**

Data collection was conducted through four main stages. First, the instrument preparation stage. The researchers developed a questionnaire to assess students' perceptions of early childhood science learning and their perceived readiness as prospective early childhood teachers. The questionnaire consisted of 20 statements organized into four aspects: understanding of early childhood science learning, perceptions of the importance of science learning, perceptions of science learning implementation, and perceived readiness to implement science learning. The items were developed with reference to the research objectives and relevant literature on early childhood science learning and prospective teacher education.

Second, the questionnaire distribution stage. The questionnaire was distributed online using Google Forms to students who met the predetermined participant criteria. Before completing the questionnaire, participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of the information they provided. Participants were then asked to complete relevant demographic information, such as their academic semester and teaching practice experience, followed by the 20 questionnaire statements. The questionnaire used a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Third, the interview stage. After the questionnaire data had been collected, students were selected purposively to participate in semi-structured interviews. The selection considered variations in academic semester, practical experience, and questionnaire response tendencies. The interviews were conducted either face-to-face or through online communication media, depending on the participants' circumstances. Each interview lasted approximately 15-30 minutes. With the participants' consent, the interviews were recorded and subsequently transcribed for analysis. The interviews focused on students' understanding of science learning, their views regarding its importance, their experiences in

implementing science activities, and the challenges they experienced in preparing and conducting science learning activities.

Fourth, the data integration stage. The quantitative and qualitative findings were integrated at the interpretation stage. The quantitative results were used to describe the general tendencies in students' perceptions and perceived readiness, while the interview findings were used to provide explanations and contextual information regarding the quantitative results. For example, when questionnaire results indicated relatively high perceived readiness but students reported difficulties in independently designing science activities, the interview findings were used to explain the experiences and challenges underlying this pattern.

**Data Analysis**

Quantitative data were analyzed using descriptive statistics. The analysis included frequencies, percentages, minimum and maximum scores, means, and standard deviations. The analysis was conducted for both the total score and each indicator to provide an overview of students' perceptual tendencies.

Perception scores were calculated by summing the scores for all questionnaire items. Since the instrument consisted of 20 items rated on a five-point scale, the theoretical score range was 20-100. The scores were subsequently converted into percentages using the following formula:

$$P = \frac{\text{Obtained score}}{\text{Maximum possible score}} \times 100\% \quad (1)$$

The percentage scores were interpreted using the following categories:

Table 2. Interpretation of percentage scores, adapted from Riduwan (2022)

| Percentage | Category |
|---|---|
| 81–100% | very high |
| 61–80% | high |
| 41–60% | moderate |
| 21–40% | low |
| 0–20% | very low |

These categories were used as an aid for interpretation and were not intended as a basis for statistical inference. Interview data were analyzed using thematic analysis through the stages of data familiarization, generation of initial codes, grouping codes into themes, reviewing themes, defining and naming themes, and producing the report. Thematic analysis can be used to systematically identify patterns of meaning emerging from interview data (Braun & Clarke, 2021).

The interview findings were subsequently used to strengthen, explain, and contextualize the quantitative results. Thus, the study did not merely present the percentages of students' perceptions but also explained the experiences and reasons underlying those perceptions. This analytical approach enabled the study to provide both a quantitative description and contextual explanation of students' perceptions and readiness. This approach is consistent with the principle that data collection and analysis methods should be aligned with the research questions and objectives of the study (Creswell & Creswell, 2022).

## RESULTS AND DISCUSSION

**Overview of PGPAUD Students' Perceptions and Readiness**

This study involved 179 students enrolled in the PGPAUD Study Program who had previously obtained learning experiences related to early childhood science. The analysis of the 20 questionnaire items showed that students' perception scores ranged from 22 to 100, with a mean score of 70,82. Based on the categories used in this study, this score falls within the high category. Nevertheless, the distribution of scores indicated considerable variation among students, with a standard deviation of 1,48. These findings suggest that students' perceptions were generally positive, although the levels of

perception and readiness were not entirely uniform. The individual data also showed that some students obtained very high scores, whereas others obtained relatively low scores.The analysis across the four aspects revealed the following pattern:

Table 3. Students' perceptions of early childhood science learning

| Aspect | N | Mean | SD | Percentage | Category |
|---|---|---|---|---|---|
| Understanding of early childhood science learning | 179 | 3,38 | 1,41 | 67,63% | high |
| Importance of early childhood science learning | 179 | 3,72 | 1,55 | 74,32% | high |
| Implementation of early childhood science learning | 179 | 3,61 | 1,53 | 72,11% | high |
| Readiness as prospective early childhood teachers | 179 | 3,42 | 1,38 | 68,32% | high |
| Overall | 179 | 3,54 | 1,48 | 70,82% | high |

The findings indicate that PGPAUD students generally held positive perceptions of early childhood science learning. However, the findings become more meaningful when the four aspects are compared. Perceptions of the importance of science learning obtained the highest score (74,32%), whereas readiness as prospective teachers was 68,32%. Thus, there was a 6-percentage-point gap between students' awareness of the importance of science and their perceived readiness to implement science learning.

This pattern represents an important finding because it demonstrates that positive perceptions of the value of science learning do not necessarily correspond to the same level of pedagogical readiness. The interview findings further supported this pattern. Students generally stated that science was important for young children because it could foster curiosity, encourage children to ask questions, and help them understand their surrounding environment. However, when asked about their ability to independently design science learning activities, students acknowledged that they still needed examples, practical experience, and guidance.

Thus, the findings indicate that the process of moving from awareness of the importance of science toward readiness to teach it has not yet been fully achieved. This finding provides an important basis for understanding the results of each aspect analyzed in the subsequent sections.

**Students' Understanding of Early Childhood Science Learning**

The understanding aspect obtained a score of 67,63%, which was the lowest score among the four aspects examined, although it remained within the high category. This finding indicates that students had a positive basic understanding of early childhood science learning, but their conceptual understanding still needs to be strengthened.

The interview findings showed that students generally understood science learning as a process that enables children to see, observe, try, explore, and discover things directly. Students also recognized that science learning does not necessarily require specialized equipment and can utilize the surrounding environment, such as plants, water, animals, and various objects encountered by children in their daily lives.

However, the interviews also indicated that some students still primarily associated science learning with experimental activities. After gaining experience through coursework, their understanding began to develop toward the view that experiments represent only one form of science activity, while observation, exploration, questioning, comparison, and discovering simple cause-and-effect relationships are also important components of children's science experiences.

This finding helps explain why the understanding score was lower than those of the other aspects. Students had developed a functional understanding of science learning, but some still required further strengthening of the pedagogical nature of early childhood science learning.

This finding is relevant to the study by Haber et al. (2021); Ansya and Salsabilla (2025); Komala (2025), which showed that educators' views regarding how knowledge is constructed are associated with how they respond to children's science-related questions. In their study, teachers and

preservice teachers tended to provide explanations in response to children's scientific questions, while educators' epistemic beliefs were associated with how they viewed interactions in science learning.

In relation to the present findings, students' understanding of science is important not only because it determines what they know but also because it may influence how they respond to children's curiosity. Students who view science as a process of exploration are more likely to provide opportunities for children to observe and seek answers, whereas an understanding that is overly oriented toward the transmission of facts may result in more teacher-centered learning.

Thus, the findings of this study support Haber et al. (2021); Ansya and Salsabilla (2025); Komala (2025) findings regarding the importance of educators' beliefs and perspectives in science learning, while also extending them to the context of students in the PGPAUD Study Program by demonstrating that strengthening conceptual understanding should be an integral part of prospective teacher education.

**Students' Strong Perceptions of the Importance of Science Learning**

The importance of science learning obtained the highest score, namely 74,32%. This finding indicates that students generally had a strong awareness of the value of science learning for young children. The interview findings provided consistent explanations. Students perceived that young children live in environments rich in scientific phenomena. Rain, plant growth, water, animals, changes in objects, and various everyday phenomena were viewed as potential learning resources that could encourage children to ask questions and explore. Students also perceived that science learning could develop children's curiosity and thinking skills. In other words, students did not view science merely as a collection of facts but were beginning to recognize it as a process that can help children understand the world around them.

This finding has strong relevance to the meta-analysis conducted by Gangal et al. (2026). Based on 17 intervention studies, their research found a large overall effect of science activities on early childhood scientific literacy (Hedges' g = 0,891). The activities examined included hands-on, minds-on, technology-integrated, and outdoor learning activities. The findings of Gangal et al. provide empirical support for the students' perceptions in the present study. If students perceive science experiences as important for young children, this perception is supported by empirical evidence showing that science activities can make a substantial contribution to the development of children's scientific literacy.

However, there is a difference in focus between the two studies. Gangal et al. (2026) examined the effectiveness of science activities for children, whereas the present study examined students' perceptions and readiness as prospective teachers. Therefore, this study complements previous research by demonstrating that successful science learning for young children also needs to be supported by the readiness of those who design and implement the learning experiences.

***Perceptions of Exploratory and Contextual Science Learning Implementation***

The implementation aspect of science learning obtained a score of 72,11%, which falls within the high category and represents the second-highest score among the four aspects examined. The interview findings showed that students generally supported learning approaches that provide children with opportunities to learn through direct experiences. Students stated that children tend to understand concepts more easily when they can see, touch, try, and directly observe objects. They also perceived that simple experimental activities could increase children's interest, provided that the activities are safe and age-appropriate. The surrounding environment was also viewed as a potential learning resource that does not necessarily require expensive instructional media.

These findings indicate that students demonstrated an orientation toward science learning that is active, contextual, exploratory, and based on direct experience. This pattern is consistent with the review by Larkin and Lowrie (2023); Kotsis (2025); Monteira (2026), which indicates that STEM learning approaches in preschool and primary education need to move toward more authentic approaches. They specifically highlight the importance of approaches such as problem-based learning and project-based learning in creating more authentic integration, compared with approaches in which disciplines remain separated.

The findings of the present study support this perspective at the level of students' perceptions. Students tended to view science learning as something that should not be limited to teacher-led explanations but should instead involve activities that allow children to interact directly with objects and their surrounding environment. However, an important issue needs to be considered. Positive perceptions of an instructional model do not automatically indicate students' ability to design and implement such learning. This is reflected in the lower readiness score compared with the implementation score. Thus, the present study adds an important nuance to the findings of Larkin and Lowrie (2023); Kotsis (2025); Monteira (2026), students may already understand the characteristics of ideal science learning but still require practical experience to translate these principles into concrete learning designs.

**Students' Readiness as Prospective Early Childhood Teachers**

The readiness aspect obtained a score of 68,32%, which falls within the high category. Nevertheless, this aspect scored lower than students' perceptions of the importance of science and the implementation of science learning. The interview findings showed that students generally felt reasonably prepared to teach simple science activities. However, they still lacked confidence when required to independently design activities, determine appropriate experiments, select suitable instructional media, and ensure that activities were safe and developmentally appropriate for young children. Students reported that their confidence was associated with previous practical experiences. They felt more prepared when they had previously tried an activity or received examples and guidance. Conversely, learning that focused primarily on theory did not fully develop their confidence when they were required to design activities independently.

These findings are closely related to the study by Simsar and Jones (2021). In their study involving 96 early childhood preservice teachers, they examined science teaching self-efficacy in relation to field experiences and mentoring. Their research emphasized teaching and observing science, as well as mentoring support, as important components in developing confidence in teaching science. The findings of the present study support the direction of Simsar and Jones's research. Students in the present study explicitly associated their confidence with practical experience. Thus, the relatively lower level of readiness compared with the perceived importance of science does not indicate that students hold negative attitudes toward science. Rather, it may indicate that they have not yet obtained sufficient pedagogical experience to transform their knowledge and positive attitudes into confidence in implementing science learning.

However, an important distinction exists between the present study and that of Simsar and Jones (2021). Simsar and Jones specifically measured *science teaching self-efficacy*, whereas the present study examined students' perceptions and readiness in the broader context of early childhood science learning. Therefore, the findings of this study should not be interpreted as a direct measure of *self-efficacy*. The more appropriate term is students' perceived readiness.

**The Gap Between Awareness, Understanding, and Readiness**

When the four aspects are compared simultaneously, a pattern emerges that represents one of the important contributions of this study: importance of science (74,32%), science learning implementation (72,11%), readiness (68,32%) and understanding (67,63%). This pattern indicates that students were relatively stronger in recognizing why science learning is important than in developing a deeper understanding of the nature of science learning and feeling fully prepared regarding how to implement it.

The interview findings further clarified this pattern. Students generally did not question the importance of science. They understood that science learning could develop children's curiosity and thinking skills. The challenge emerged when they had to translate this understanding into concrete learning designs.

For example, students could state that experiments were important but still ask what types of experiments would be safe for young children. Students could understand that the environment could serve as a learning resource but still require examples of how to transform environmental resources into activities with clear pedagogical objectives. Students could also understand that children should be encouraged to ask questions but still require practice in developing appropriate prompting questions.

This is where the findings provide a more specific contribution. The main issue does not lie in students' low appreciation of science but rather in the process of transforming positive perceptions into pedagogical capacity.

These findings can be considered alongside the studies of Haber et al. (2021) and Simsar and Jones (2021). Haber et al. emphasized the relationship between educators' beliefs and their responses to children's science-related questions, whereas Simsar and Jones demonstrated the importance of field experiences and mentoring for *science teaching self-efficacy*. By bringing these two perspectives together, the present study indicates that prospective teacher education needs to develop three interconnected layers of competence: (1) understanding of the nature of early childhood science learning, (2) positive beliefs and perceptions regarding the value of science learning; and (3) pedagogical experience for translating this understanding into practice. If one of these layers remains underdeveloped, readiness for implementation may not reach its optimal level.

**Variation in Students' Perceptions and Implications for Teacher Education**

Although the overall mean was in the high category, the distribution of individual scores indicated considerable variation. Some students obtained very high scores, whereas others obtained relatively low scores. These data indicate that the group average does not fully represent the condition of every individual student. This finding is important for the study program because prospective teacher education should not be designed solely on the basis of the average ability or perception of the group. Students who have greater practical experience may demonstrate higher levels of readiness, whereas those with limited experience may require greater scaffolding.

The interview findings support this interpretation, as students identified the need for examples of activities, practical experience, instructional media, simple experiments, and guidance. This suggests that the study program could develop early childhood science learning that provides repeated opportunities for students to design, try, observe, reflect on, and improve their learning activities.

This implication is consistent with the findings of Simsar and Jones (2021) regarding the importance of field experiences and mentoring, as well as Larkin and Lowrie (2023) emphasis on authentic approaches in STEM learning. Thus, strengthening science learning within prospective teacher education should not be limited to increasing theoretical content. More importantly, it should provide authentic pedagogical experiences that allow students to experience firsthand how science learning is designed and implemented.

**Limitations**

This study has several limitations. First, the findings are based primarily on self-reported perceptions and perceived readiness, which may not fully represent students' actual pedagogical competence. Second, the study was conducted within one PGPAUD Study Program, limiting the transferability of the findings to other teacher education contexts. Third, the qualitative component involved only six interview participants and was intended to enrich rather than generalize the survey findings. Future studies should incorporate direct observation, teaching performance assessment, or microteaching evaluation to examine whether perceived readiness corresponds to actual teaching competence.

## CONCLUSION AND SUGGESTION

The findings indicate that PGPAUD Study Program students generally have a positive perception of science learning in early childhood education, with an overall achievement of 70,82%, categorized as high. Among the four aspects examined, the perception of the importance of science learning obtained the highest score (74,32%), followed by the implementation of science learning (72,11%), perceived readiness as prospective early childhood teachers (68,32%), and understanding of early childhood science learning (67,63%). Interview findings reinforce these results by showing that students recognize science as important for developing children's curiosity, thinking abilities, and understanding of their environment, and they generally support exploratory, contextual, and hands-on learning. However, students also reported limitations in designing science activities independently,

selecting appropriate media, and conducting simple and safe experiments. Thus, the main finding of this study is that positive perceptions of the importance of science learning have not yet been fully accompanied by equivalent pedagogical readiness to implement it. Practical experience, mentoring, and opportunities to design and practice science learning are therefore important in bridging the gap between students' understanding, perceptions, and readiness.

Based on these findings, PGPAUD study programs are recommended to strengthen science education courses by integrating conceptual understanding with authentic and practice-based learning experiences. Students should be provided with opportunities to design and implement simple science activities, conduct experiments, explore the surrounding environment, develop concrete learning media, and reflect on their teaching experiences. Lecturers can provide systematic mentoring and feedback to strengthen students' confidence and pedagogical competence. Future research should involve larger and more diverse samples and, where possible, complement self-reported perceptions with direct observation or performance assessment to examine whether students' perceived readiness corresponds to their actual ability to implement science learning in early childhood education.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest related to the research, authorship, or publication of this article.

## AUTHOR CONTRIBUTIONS STATEMENT

Wa Ode Siti Hamsinah Day contributed to the conceptualization, methodology, investigation, data analysis, and writing of the original draft. Hafsemi Rapsanjani contributed to the investigation, data interpretation, manuscript review, and editing. Both authors reviewed and approved the final version of the manuscript and agree to be accountable for its contents.

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## DECLARATION OF GENERATIVE AI SOURCES

The authors declare that generative artificial intelligence (AI) tools were not used to generate the research data, conduct the data analysis, or produce the scientific findings reported in this article. Any use of AI-assisted tools for language editing or manuscript preparation, if applicable, was limited to improving linguistic clarity and readability. The authors take full responsibility for the accuracy, integrity, and originality of the manuscript.

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