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# Development of Virtual Reality Media with a Deep Learning Approach to Improve Early Childhood Science Literacy Skills

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**Abstract:** This study aims to develop Virtual Reality (VR)-based learning media integrated with a deep learning approach to improve early childhood science literacy skills. The research employed a Research and Development (R&D) method using the ADDIE model, consisting of analysis, design, development, implementation, and evaluation stages. The study was conducted at Bunda Musnidar Kindergarten, Padang, involving children aged 5–6 years. Data were collected through observations, interviews, questionnaires, and science literacy tests, and analyzed using validity, practicality, and effectiveness tests, including N-Gain and paired sample t-test analysis. The results indicate that the developed VR media achieved a media validity score of 91.25% and material validity of 95%, both categorized as very valid. The practicality test showed a score of 94.44%, indicating that the media is highly practical for classroom use. Furthermore, the effectiveness test revealed an N-Gain score of 0.78 (high category), supported by a significant difference between pre-test and post-test results. These findings demonstrate that VR-based learning media integrated with a deep learning approach effectively enhances early childhood science literacy. The study concludes that immersive and meaningful learning experiences facilitated through VR significantly support children's ability to observe, explore, and understand scientific concepts in real-life contexts.

**Keywords:** Deep learning approach; Early childhood education; Learning media; Science literacy; Virtual reality

## Introduction

Early childhood education (ECE) represents a critical phase in human development, particularly in shaping cognitive, social, and emotional competencies (Barnes, 2022; Ridgeway, 2001). At this stage, children experience rapid brain development, making it essential to provide meaningful and stimulating learning experiences. In the context of 21st-century education, learning is expected to foster higher-order thinking skills, including creativity, critical thinking, communication, and collaboration (Ananda et al., 2025; Faiza et al., 2024; Muliyadi et al., 2023). Consequently, literacy development in early childhood extends beyond basic reading and writing skills to encompass the ability to reason, interpret information, and construct knowledge (Eliza et al., 2024; Purba et al., 2024).

Science literacy is a fundamental component of early childhood learning, as it enables children to understand natural phenomena through inquiry-based processes such as observing, questioning, and experimenting (Eliza et al., 2025; Yaswinda et al., 2019). Science literacy in early childhood supports the development of logical thinking and problem-solving abilities (Eliza et al., 2022; Noor, 2020). However, existing practices in early childhood science learning remain predominantly teacher-centered, with limited integration of technology and experiential learning (Az-Zahra et al., 2025; Malinski, 2004; Solum et al., 2020). This condition reduces opportunities for children to engage in meaningful and contextual learning experiences.

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Theoretically, constructivist learning emphasizes that children actively build knowledge through interaction with their environment. This perspective aligns with deep learning approaches, which focus on conceptual understanding rather than rote memorization (Bruner, 1974; Jannah et al., 2026; Shen et al., 2022). In addition, multimedia learning theory suggests that combining visual, auditory, and interactive elements enhances comprehension, especially in young learners. Therefore, integrating immersive technologies such as Virtual Reality (VR) can provide concrete and multisensory learning experiences that support children's cognitive development (Hamilton et al., 2021; Radianti et al., 2020).

Previous studies have demonstrated that digital learning media, including videos and interactive applications, can improve early childhood literacy skills (Ironsi, 2023; Rusdawati et al., 2022; Suryana et al., 2025). Moreover, VR technology has been shown to enhance conceptual understanding by presenting abstract phenomena in a more tangible form (Dede et al., 2014; Erita et al., 2024; Rahmawati et al., 2024). However, research integrating VR with a deep learning approach specifically targeting early childhood science literacy remains limited.

Based on these gaps, this study is conducted to develop VR-based learning media integrated with a deep learning approach. The rationale for this research lies in the need to address the limitations of conventional teaching methods, enhance the quality of science learning, and provide innovative pedagogical solutions aligned with technological advancements. This study is expected to contribute both theoretically and practically by offering an effective model for improving early childhood science literacy through immersive and meaningful learning experiences.

## Method

*Research Design*

This study employed a Research and Development (R&D) approach using the ADDIE model, which includes Analysis, Design, Development, Implementation, and Evaluation stages (Rayanto et al., 2020). This model was selected due to its systematic structure in developing and evaluating educational products.

*Time and Location of the Research*

The research was conducted at Bunda Musnidar Kindergarten, Padang, during the 2025/2026 academic year. The selection of this location was based on preliminary findings indicating limited use of technology in science learning.

*Research Subjects*

The research subjects were children aged 5–6 years (Group B). The sample was determined using purposive sampling, considering children's readiness to engage in structured learning activities.

*Research Procedures*

The study followed the ADDIE stages: Analysis: Identification of learning needs and children's characteristics. Design: Development of VR media framework and science literacy indicators. Development: Media production and expert validation. Implementation: Limited classroom trials. Evaluation: Assessment of validity, practicality, and effectiveness.

This procedure refers to the steps in the ADDIE model research and development procedure as shown in figure 1.

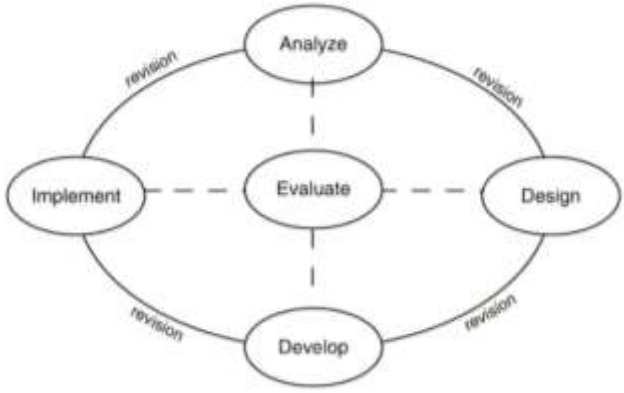


**Figure 1.** Research procedure

*Data Collection Techniques*

Data were collected through observation, interviews, questionnaires, and science literacy tests (pre-test and post-test).

*Data Analysis*

Data analysis included: Validity and practicality analysis: Percentage-based evaluation. Effectiveness analysis: N-Gain test and paired sample t-test All statistical analyses were conducted using SPSS to ensure accuracy.

## Result and Discussion

*Media Validity Results*

Before presenting Table 1, it is important to note that validity testing aims to determine the feasibility of the developed media based on expert judgment. This process ensures that both content and design aspects meet educational standards. The validation results provide a foundation for further implementation and testing.

**Table 1.** Develop Assessment Instrument

| Validity | Percentage (%) | Feasibility Criteria |
|---|---|---|
| Media | 91.25 | very valid |
| Material | 95 | very valid |

The results in Table 1 indicate that the VR media achieved a validity score of 91.25% for media aspects and 95% for material aspects, both categorized as very valid. These findings suggest that the developed media is appropriate for use in early childhood learning.

*Media Practicality*

The practicality test evaluates the ease of use and implementation of the media in classroom settings.

**Table 2.** Practicality Test of Virtual Reality Media

| No | Total Score | Max Score | Percentage |
|---|---|---|---|
| 1 | 34 | 36 | 94.44 |
| 2 | 34 | 36 | 94.44 |
| Total | 68 | 72 | |
| Average | | | 94.44% |
| Categories | | | Very Practical |

Based on Table 2, the VR media obtained a practicality score of 94.44%, indicating that it is highly practical. Teachers reported that the media is easy to use and supports interactive learning.

Researchers conducted large-scale trials taking pretest and posttest data to see the ability of numerical literacy in large-class trial children after learning with the developed product. Figure 2 below explains the data description of the results of using virtual reality media.

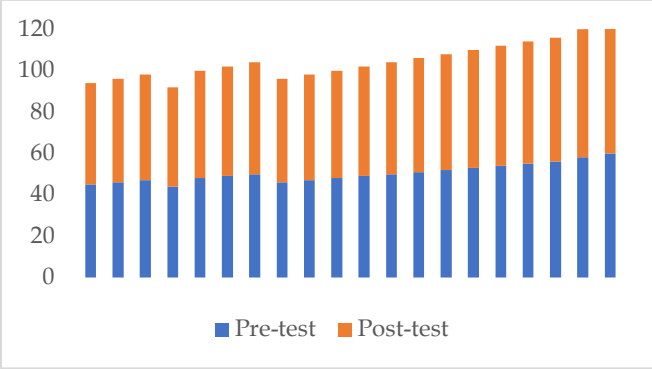


**Figure 2.** Large scale test pre-test post-test comparison

*Media Effectiveness*

The effectiveness of the media was analyzed using N-Gain and paired sample t-test.

$$N - gain = \frac{Mean\ posttest - mean\ pretest}{Max\ Skor - mean\ pretest} \quad (1)$$

The N-Gain score of 0.78 indicates a high level of improvement in children's science literacy skills. Additionally, the increase in mean scores from pre-test (50.40) to post-test (54.40) demonstrates a positive learning impact.

**Table 3**. Paired Sample T-test Results

| | Paired Samples Statistics | | | | |
|---|---|---|---|---|---|
| | | Mean | N | Hours of deviation | Std. Error Mean |
| Pair 1 | Pretest | 50.4000a | 20 | 4.42957 | .99048 |
| | Posttest | 54.4000a | 20 | 4.42957 | .99048 |

The following are the results of product development "Virtual Reality" with a deep learning approach to improve early childhood science literacy skills. The findings confirm that immersive learning environments significantly enhance children's engagement and understanding. VR technology provides concrete representations of abstract concepts, aligning with constructivist learning theory (Radianti et al., 2020).

Furthermore, the integration of deep learning approaches encourages children to actively construct knowledge, supporting previous findings that emphasize the importance of meaningful learning in developing critical thinking skills (Jannah et al., 2026; Khowiyah et al., 2023).

These results are also consistent with prior studies indicating that VR-based learning improves conceptual understanding and student engagement (Papic et al., 2026; Taroreh, 2024). Compared to conventional methods, this approach offers a more interactive and contextual learning experience.


**Figurer 3.** Opening display


**Figure 4.** Science literacy virtual reality media content

Importantly, this study addresses a gap in previous research by integrating VR technology with a deep learning approach specifically for early childhood science literacy. The results demonstrate that such integration not only improves learning outcomes but also enhances children's curiosity and exploration skills.

## Conclusion

This study concludes that the development of Virtual Reality-based learning media integrated with a deep learning approach is valid, practical, and effective in improving early childhood science literacy skills. The findings demonstrate that immersive and interactive learning environments significantly enhance children's ability to observe, explore, and understand scientific concepts. The integration of technology and meaningful learning approaches provides a strong pedagogical foundation for improving the quality of science education in early childhood. Therefore, VR-based media can be recommended as an innovative learning solution to support the development of science literacy in early childhood education.

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**Author Contributions**

Siti Aisyah: Research concept, media design, data collection, analysis, article writing. Delfi Eliza: Theory development, methodology, data analysis, article revision. Yaswinda: Initial media design, product trial, data collection, analysis. Setiyo Utoyo: Field testing, data processing, media evaluation, writing trial results.

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**Conflicts of Interest**

The authors declare no conflict of interest.

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