

Development of Infographic Media in Simple Science Experiments to Enhance Science Literacy in Early Childhood

Retno Wuri Sulistyowati^{1*}, Abdul Rachman Tiro², Maya Pujowati³, Wa Ode Siti Hamsinah Day¹, and Diah Harmawati¹

¹Early Childhood Education, Faculty of Teacher Training and Education, Universitas Musamus, Merauke, Indonesia

²Natural Sciences Education Departement, Faculty of Exact Education, Universitas Pendidikan Muhammadiyah Sorong, Sorong, Indonesia

³Elementary School Teacher Program, Faculty of Teacher Training and Education, Cenderawasih University, Jayapura, Indonesia

*retnowuri@unmus.ac.id

Received
06/07/2026

Accepted
02/09/2026

Published
11/10/2026

DOI
[10.59329/gawi.v6i2.395](https://doi.org/10.59329/gawi.v6i2.395)

ABSTRACT

This study aims to develop and evaluate the feasibility, practicality, and outcomes associated with infographic media implemented within a Project-Based Learning (PjBL) context to enhance science literacy among early childhood students. Through this approach, it is expected that children can actively engage in simple, safe experiments using kitchen materials to understand fundamental science concepts. The research method employed is Research and Development (R&D) using the ADDIE model, which includes analysis, design, development, implementation, and evaluation. The subjects of the study consist of 20 students from Group B (ages 5-6 years) at a formal Early Childhood Education (PAUD) institution in Southern Papua, selected through a combination of purposive and total sampling techniques. The results of the validation of the infographic media by experts indicate that the media is very feasible to use, with an average feasibility score of 89.5%. During implementation, the practicality level of the infographic media was rated at 87.67%, categorized as "Practical." Paired t-test results show a significant increase in children's science literacy, with an average N-gain score of 0.67, indicating a "Moderate" (approaching high) category. These findings suggest that the use of infographics in project-based learning can enhance understanding, independent thinking, and children's engagement in science. This research is expected to provide significant contributions to PAUD educational practices in Indonesia, offering a more interactive and enjoyable approach to science education.

Keywords: *early childhood science, simple science experiments, infographics, PjBL, science literacy*

How to cite:

Sulistyowati, W. R., Tiro, A. R., Pujowati, M., Day, W. O. S. H., & Harmawati, D. (2026). Development of Infographic Media in Simple Science Experiments to Enhance Science Literacy in Early Childhood. *Gawi: Journal of Action Research*, 6(2), 486-498



INTRODUCTION

Early childhood education (ECE) represents a crucial stage in human development, as children begin to establish the foundations of cognitive, affective, and psychomotor abilities. At this stage, children are highly responsive to stimuli from their surrounding environment. Science education plays an important role in helping young children understand natural phenomena and the world around them ([Siry, 2014](#); [Bustamante et al., 2018](#)). Scientific literacy is not limited to the acquisition of scientific concepts, but also includes the development of scientific attitudes, curiosity, inquiry skills, and problem-solving abilities ([Lederman et al., 2014](#); [Eliza et al., 2025](#)). However, in practice, science learning in early childhood settings is often overlooked or delivered through conventional approaches, such as teacher-centered explanations and student worksheets. Such methods may limit children's opportunities to explore, observe, and interact directly with their environment ([Al-Abdullatif, 2022](#); [Aisyah and Novita, 2025](#)).

In the specific field of science, particularly chemistry, there remains a common assumption that the subject is too difficult and potentially unsafe for young children. Many parents and educators worry that chemistry-related experiments may expose children to unnecessary risks. In fact, several basic chemistry concepts, such as acid-base reactions, capillarity, and changes in matter, can be introduced through simple green chemistry experiments using safe and familiar household materials ([Rudolph, 2018](#); [Tiro, 2024](#); [Febriandani et al., 2025](#)). Previous studies have shown that experiment-based learning can make learning activities more enjoyable while increasing children's participation in the learning process ([Setiasih et al., 2024](#)). By using safe materials, children can engage in meaningful, enjoyable, and educational experiments that help them understand scientific concepts more concretely. For example, a simple experiment using vinegar and baking soda can demonstrate an acid-base reaction through the formation of gas bubbles that attract children's attention. Likewise, an experiment using celery and colored water can introduce the concept of capillarity by allowing children to observe how water moves through plant stems. These hands-on activities make abstract concepts more visible and understandable while encouraging curiosity, observation, and critical thinking. Therefore, learning activities that combine simple science experiments with developmentally appropriate approaches are needed in early childhood education. Such integration supports exploration and discovery, which are essential elements of effective learning during children's formative years and may foster long-term interest in science.

The urgency of this research is based on the need to develop innovative, engaging, and child-friendly learning media through experiment-based activities and infographics. The Project-Based Learning (PjBL) model offers a relevant approach because it enables children to participate in authentic investigative activities. Through PjBL, children can be involved in planning, conducting, and presenting simple experiments, which may strengthen their understanding and interest in science ([Krajcik and Blumenfeld, 2006](#); [Aisyah and Novita, 2025](#); [Tiro et al., 2025](#)). In addition, PjBL encourages collaboration among children and supports the development of social and communication skills. The use of infographics as visual media can also help children understand complex scientific concepts in a simpler and more attractive way ([Williamson, 2015](#)). Infographics can present scientific ideas in visual forms that are easier for young learners to grasp ([Afify, 2018](#)). For instance, an infographic about the water cycle can illustrate processes such as evaporation and condensation, helping children understand these concepts more intuitively. Therefore, this study seeks to develop engaging visual learning media through infographics to support simple science experiments within a PjBL context. By providing clear visual roadmaps, this approach aims to address the lack of child-friendly scientific exploration tools and accommodate the cognitive developmental needs of children in early childhood education.

Existing research gaps show that although studies on science education in early childhood have been conducted, only a limited number have specifically examined the integration of simple science experiments within a PjBL framework supported by infographic media. Many previous studies have focused on conventional learning approaches that provide limited opportunities for children to innovate, create, and conduct direct exploration. This study aims to address this gap by developing learning media that are valid, practical, and effective in improving young children's scientific literacy. The novelty of this research lies in the integration of simple science experiments,

visual infographics, and the PjBL model, an approach that has not been widely examined in the context of early childhood education in Indonesia. By combining these elements, this study is expected to contribute to the development of more effective and engaging science learning practices for young children.

Therefore, this research aims to produce learning tools based on simple science experiments integrated with infographic media within the Project-Based Learning model. These learning tools are expected to support the development of children's scientific literacy during their golden age of development. The findings of this study are expected to contribute to early childhood education practices in Indonesia by offering a more interactive, enjoyable, and meaningful approach to science learning. In addition, the results may serve as a reference for teachers and curriculum developers in designing learning programs that are more effective, engaging, and aligned with the principle of learning through play, while encouraging children to be more active in exploring and understanding the world of science.

METHOD

Research Design

This research was conducted as a Research and Development (R&D) study aimed at producing innovative learning media. The ADDIE model was adopted for development, consisting of five main stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation (Branch, 2010). This model was chosen for its systemic and iterative nature, allowing for continuous control mechanisms at each phase of product development ([Kabadayi et al., 2023](#)). The research flow diagram can be seen in [Figure 1](#).

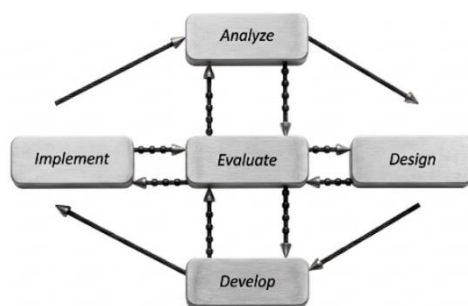


Figure 1. Research flow diagram

[Figure 1](#) represents the ADDIE development model, which is designed in a systematic and iterative manner, with the Evaluate stage serving as the main control center. The placement of Evaluate in the center of the diagram indicates that evaluation is not merely a final stage, but a control mechanism carried out continuously throughout every phase of the research. The two-way connections shown by the lines linking Evaluate to the Analyze, Design, Develop, and Implement stages confirm the existence of an intensive feedback loop; any findings from the evaluation can be directly used to improve or adjust the other stages. Additionally, diagonal arrows connecting the stages on the outer side indicate flexibility in the development process, allowing researchers to move forward or return to a previous stage if inconsistencies in data are found. Overall, this visualization illustrates a dynamic and quality-oriented development cycle, where each stage is interdependent and continuously refined to ensure the validity, practicality, and effectiveness of the resulting product before it undergoes empirical testing in the field.

Subject of Research or Population and Sample (Research Target)

The research location was purposively selected considering its limited access to adequate science learning resources. Within this selected institution, total sampling was applied to Group B, meaning all 20 students in the class were included as research subjects to obtain comprehensive data for this specific cohort ([Teddle and Tashakkori, 2009](#); [Campbell et al., 2020](#)).

Instruments

Data collection was conducted by developing a blueprint for instruments that included both test and non-test instruments. The instrument grid was designed to ensure the representation of science literacy indicators in each assessment item, as presented in [Table 1](#).

Table 1. Science literacy instrument grid

Science Literacy Dimension	Material/Experiment	Competency Indicator	Assessment Technique
Concept Knowledge	Acid-Base Reaction	Children understand that mixing certain materials (vinegar & baking soda) produces gas (bubbles).	Interview/Questioning
Concept Knowledge	Capillarity	Children understand that water can rise through narrow spaces (celery stalk/flower) against gravity.	Interview/Questioning
Concept Knowledge	Phase Change	Children understand the process of phase change of matter from solid to liquid (ice melting) due to temperature.	Interview/Questioning
Process Skills	PjBL Experiment	Children are able to follow the steps of the experiment in order (PjBL stages).	Performance Observation
Process Skills	Prediction & Observation	Children are able to predict outcomes before trying and observe changes that occur.	Performance Observation
Scientific Attitude	Communication (Reflect & Share)	Children are able to recount their observations to peers or teachers.	Performance/Presentation

The test instrument used was a Performance Observation Sheet to measure children's science literacy before (pretest) and after (posttest) the intervention. This observation sheet consisted of 12 items assessed on a 1-4 rating scale (maximum score of 48), with an established inter-rater reliability (Cohen's Kappa = 0.82) and content validity index (CVI = 0.85). The non-test instruments included an Expert Validation Sheet utilizing a 5-point Likert scale to assess content and media feasibility, and a Teacher Response Questionnaire to measure the practicality of the media ([Hapidin et al., 2023](#)).

Procedure for Developing Science (Chemistry) Experiments for Early Childhood Education

This procedure outlines the systematic steps taken to develop engaging and age-appropriate chemistry experiments tailored for early childhood education. Utilizing the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) ensures a comprehensive framework that guides the creation of innovative learning experiences. Each stage of this model is designed to address the unique cognitive characteristics of young learners, enabling them to participate in meaningful scientific exploration.

1. Analysis

This stage focused on conducting an in-depth needs analysis in Early Childhood Education (ECE) through participatory observation and interviews with educators. The main barriers were identified, including the dominance of conventional methods and the lack of access to interactive science media. The results of this analysis became the empirical foundation for designing learning solutions relevant to the cognitive characteristics of young children in Southern Papua ([Kaize et al., 2025](#)).

2. Design

A blueprint for the development of infographic media was prepared by researchers, integrating green chemistry principles with safe kitchen-based experiments ([Hurst, 2020](#)). The visual design was systematically organized to be aesthetically appealing and easily understood by children. The selection of experiments was made considering safety aspects, availability of materials, and alignment with the science literacy indicators to be achieved.

3. Development

The product was validated by four experts in total: two early childhood science content experts and two instructional media experts. The experts were selected based on their qualifications (minimum doctoral degree) and experience in early childhood education. ([Ristanti and Isdaryanti, 2024](#)).

4. Implementation

The validated media was implemented in Project-Based Learning (PjBL) activities in the Group B classroom over five sessions (one session per experiment), with each session lasting 45 minutes. Children were divided into small groups of four. The teacher acted as a facilitator providing scaffolding, while children used printed infographics as an independent visual roadmap to conduct simple science experiments ([Quro and Choiriyah, 2022](#)).

5. Evaluation

This stage served as a control mechanism to assess the effectiveness and practicality of the media. Data on N-gain was analyzed by the researchers to measure improvements in science literacy, and teacher response questionnaires regarding the ease of use of the product were processed. Continuous formative evaluations allowed for final adjustments to ensure that the produced product was of high quality, practical, and positively impactful for learning ([Ristanti and Isdaryanti, 2024](#)).

Data Analysis Technique

Data from expert validation and teacher practicality questionnaires were analyzed using average percentage techniques. Children's science performance data were first tested for normality before conducting a paired sample t-test to determine the significance of improvements in children's science abilities. The effectiveness improvement was calculated using the N-gain score formula as follows:

$$Ngain = \frac{\text{Skor Posttest} - \text{Skor Pretest}}{\text{Skor Maksimal} - \text{Skor Pretest}}$$

The criteria for obtaining the N-gain score were classified into three categories: high (N-gain > 0.70), moderate ($0.30 \leq \text{N-gain} \leq 0.70$), and low (N-gain < 0.30).

RESULT AND DISCUSSION

Results of Media Development (Analysis, Design, & Development Stages)

The initial phase produced a draft of infographic media containing five themes of green chemistry-based science experiments specifically designed for early childhood education. The five experiments included: (1) "Fizzling Volcano!" which demonstrated the acid-base reaction between vinegar and baking soda, (2) "Thirsty Plants" or "Colored Celery," which visualized the phenomenon of capillarity through the ascent of colored water in celery stalks, (3) "Melting Ice" to explain the concept of phase change from solid to liquid, (4) "Magical Purple Cabbage," which utilized purple cabbage extract as a natural indicator to identify acid-base properties, and (5) "Simple Lava Lamp," which introduced the basic concepts of solutions and mixtures through the interaction between oil and water.

These experiments were selected because they used safe, easily accessible kitchen materials that are highly relevant in stimulating curiosity and basic science understanding in children. The product was validated by four experts, consisting of two subject matter experts and two media

experts. The infographic product serves as an effective educational tool, as it aligns with Piaget's theory of cognitive development, which emphasizes the importance of visual representations in learning for children in the preoperational phase. By employing safe and familiar materials, the experiments not only engage children but also facilitate their comprehension of scientific concepts through hands-on experiences. Overall, the validation by experts indicates that the infographic media is well-designed and suitable for enhancing early childhood science education. The results of the validation assessment are presented in [Table 2](#) below.

Table 2. Results of product feasibility validation

No.	Assessment Aspect	Content Expert Validation Score	Media Expert Validation Score	Feasibility Category
1	Suitability for child development	85%	-	Highly Feasible
2	Safety of Experiment Materials (Food-Grade)	92%	-	Highly Feasible
3	Visual Quality and Layout	-	90%	Highly Feasible
4	Readability of Symbols and Step Icons	-	92%	Highly Feasible
Average Cumulative Score		88%	91%	Highly Valid

Based on the data from [Table 2](#), the average feasibility percentage from content experts reached 88%, indicating that the experimental content presented aligns with the cognitive development stage of young children, as expressed in Piaget's research ([1977](#)), which emphasizes the importance of visual representation in learning for children in the preoperational phase. On the other hand, the average feasibility score from media experts reached 91%, suggesting that the visual aspects and layout of the infographic were well-designed, facilitating children's understanding.

Both scores fall into the "Highly Valid" category, indicating that this infographic is not only safe for use (with a score of 92% for the safety of experimental materials) but also effective in conveying information in an engaging and easily understandable manner. This finding is consistent with previous research by Aisyah and Novita ([2025](#)), which states that learning media designed with consideration for visual aspects and readability can enhance student motivation and understanding in science education.

Feedback for improvements from media validators, such as increasing the text size in the safety warning section and clarifying the color contrast of the arrows in the experiment sequence flow, demonstrates a commitment to enhancing product quality. This aligns with recommendations by Williamson ([2015](#)), which emphasize the importance of visual clarity in educational media to ensure that information is easily accessible to children. The results of this validation indicate that the developed infographic media not only meets feasibility standards but also has the potential to positively impact early childhood science education, consistent with findings in existing literature. The results of the infographic product can be seen in [Figure 2](#).

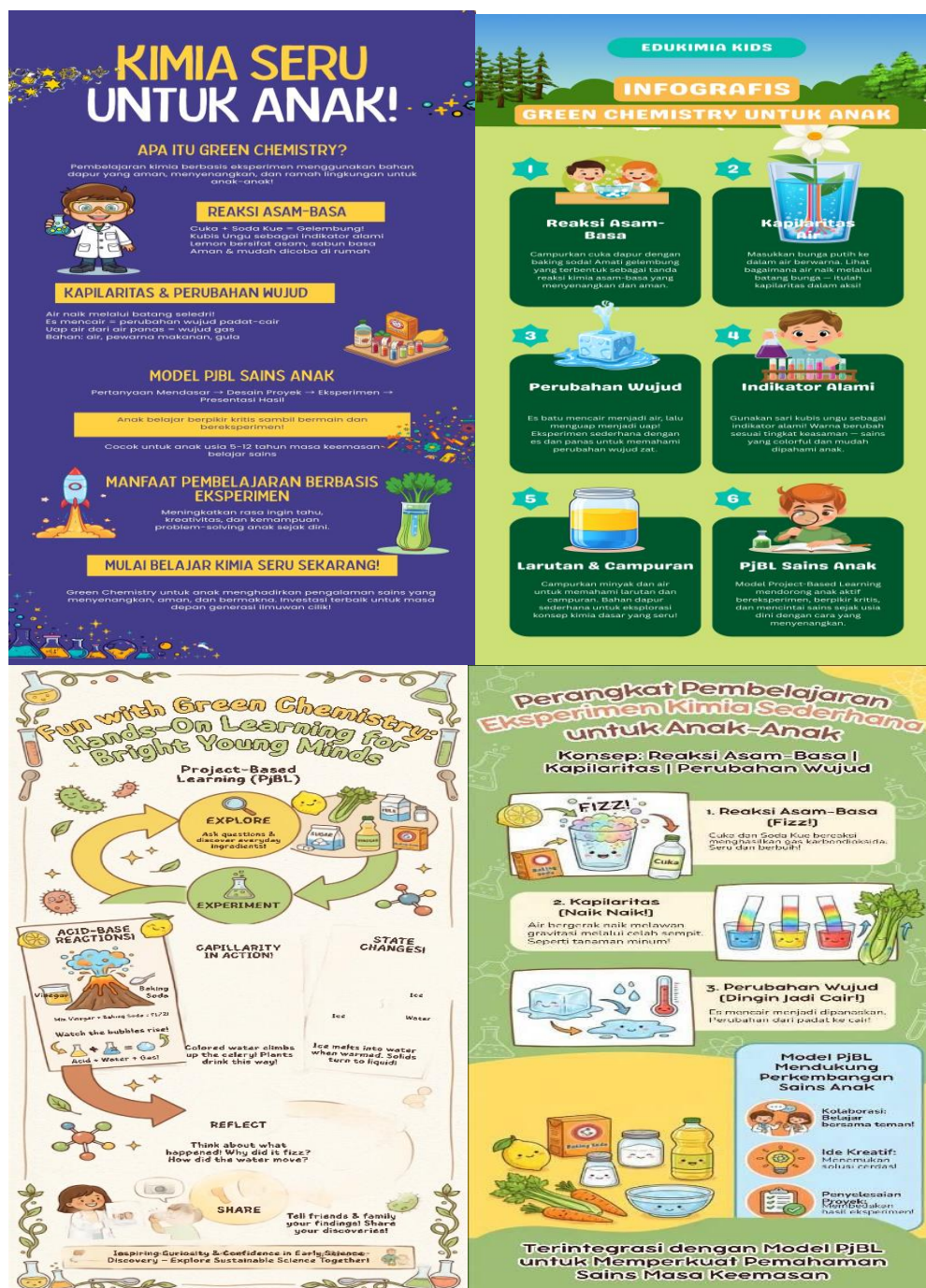


Figure 2. Developed infographic media for Simple Science Experiments: (a) Fizzing Volcano!, (b) Colored Celery, (c) Melting Ice, (d) Magical Purple Cabbage, and (e) Simple Lava Lamp.

Figure 2 presented a draft of the infographic media containing five themes of green chemistry-based science experiments specifically designed for early childhood education. The five experiments included: "Fizzing Volcano!", "Thirsty Plants" or "Colored Celery," "Melting Ice," "Magical Purple Cabbage," and "Simple Lava Lamp." These experiments were selected because they utilized safe, easily accessible kitchen materials that are highly relevant in stimulating curiosity and basic science understanding in children.

Before being implemented, the product was validated by four assessors (asesor), consisting of two early childhood science content assessors and two instructional media assessors. These

assessors were selected based on their doctoral qualifications and a minimum of five years of experience in early childhood education. Feasibility scores were calculated by dividing the total obtained score by the maximum score, converted into percentages. This validation process ensured that the content was appropriate for the cognitive development of young children, aligning with Piaget's theory (1977), which emphasizes the significance of visual representation in learning during the preoperational phase. The use of familiar and safe materials in these experiments not only engages children but also facilitates their comprehension of scientific concepts through hands-on experiences. This approach supports the idea that effective educational media must be both visually appealing and developmentally appropriate to enhance learning outcomes in early childhood education.

Implementation Results and Practicality (Implementation Phase)

The implementation phase was conducted in Group B, consisting of 20 students. The practicality of the infographic media was assessed by two practitioners (teachers) through a questionnaire filled out after the project-based learning (PjBL) cycle was completed. The analysis of the questionnaire results showed that the practicality level of the infographic media reached 87.67%, which is categorized as "Practical."

Table 3. Results of infographic media practicality assessment

No.	Practicality Assessment Aspect	Score (%)	Category
1	Ease of Media Use	85%	Practical
2	Clarity of Instructions for Teachers	90%	Very Practical
3	Efficiency of Experiment Time Allocation	88%	Practical
Average		87.67%	Practical

The teachers involved in this study indicated that the infographic served as a self-guided roadmap that significantly assisted in directing students during the experiments. With the infographic, students could focus more on the experimental activities without relying on repetitive verbal instructions. This allowed them to actively collaborate in groups, enhancing their science literacy skills and independent thinking abilities.

These implementation results are consistent with research by Hasanah and Sudira (2021), which demonstrated that the use of visual media in science education can increase student engagement and facilitate a better understanding of concepts. Their study found that well-designed media supports students in exploring and comprehending scientific phenomena more deeply, while also providing opportunities for group collaboration. This alignment with existing literature underscores the effectiveness of the infographic media in promoting active learning and cognitive development in early childhood education.

Results of Effectiveness Testing on Children's Science Literacy (Evaluation Phase)

The effectiveness of the media was measured based on changes in the science literacy scores of children before and after the intervention of project-based learning (PjBL) integrated with infographic-based chemistry experiments. Prior to hypothesis testing, the data was confirmed to be normally distributed using the Shapiro-Wilk test ($p > 0.05$). The paired-sample t-test showed a significant pre-post increase in the children's science literacy scores ($t(19) = 12.45$, $p < 0.001$, Cohen's $d_z = 1.8$), with the mean score increasing from 44.50 (SD = 5.2) to 81.65 (SD = 6.1). The effectiveness was calculated using the individual average N-gain formula, resulting in a mean score of 0.67 (SD = 0.12). To assess the significance of the quality of this improvement, the N-gain score was calculated for the test subject group. A summary of the effectiveness analysis is presented in [Table 4](#).

Table 4. Analysis of Science Literacy Effectiveness

Number of Students	Average Pretest	Average Posttest	Actual Score Improvement	Mean N-gain Score	Effectiveness Category
20 Students	44.50	81.65	37.15	0.67	Moderate (Approaching High)

The analysis results in [Table 4](#) show an increase in the average science literacy score of children, which rose from 44.50 to 81.65. The effectiveness calculation using the Hake formula confirms an average N-gain score of 0.67. This score falls within the "Moderate" category but is very close to the upper threshold of the high index (>0.70). This indicates that the integration of visual media facilitates cognitive retention of basic chemistry practical science content.

These findings align with existing literature that emphasizes the importance of visual aids in enhancing understanding and retention of scientific concepts. The significant improvement in scores suggests that the infographic media not only engages students but also effectively supports their learning process, consistent with theories on active learning and cognitive development in science education.

Discussion

The success of the Project-Based Learning (PjBL) model supported by infographic media can be observed from various aspects that foster cognitive development in early childhood. Jean Piaget's theory of cognitive development explains that children are in the pre-operational phase moving towards concrete operational, where they require semiotic visual representations to understand abstract concepts. In this context, infographics serve as cognitive aids that enhance children's comprehension of phenomena they experience, such as in the experiment of mixing vinegar and baking soda. Through direct experiences, children can observe the formation of carbon dioxide (CO₂) gas bubbles that inflate a balloon, allowing them to relate functional cause-and-effect relationships without relying on complex texts.

This approach aligns with Piaget's assertion that children learn best through active engagement and manipulation of their environment. By utilizing infographics, educators can provide a visual representation of scientific concepts, making them more accessible to young learners. Additionally, this method encourages inquiry-based learning, where children ask questions and seek answers through exploration. The integration of visual aids not only supports cognitive development but also fosters critical thinking and problem-solving skills, essential for their overall growth and understanding of the world around them.

The application of the PjBL syntax provides children with the opportunity to experience a complete inquiry cycle. In the 'Fizzling Volcano!' project, children collaborate in small groups, which not only provides opportunities to practice collaborative skills but also fosters curiosity and exploration. Infographics serve as an independent roadmap that assists students in understanding the steps they need to take during the experimental process. When children forget the next step, they instinctively refer to the infographic indicators available on their tables. This reduces dependence on verbal instructions from the teacher, which can often dominate classroom interactions ([van de Pol, Volman and Beishuizen, 2010](#)), and is associated with an improvement in children's independent thinking and science literacy.

This approach resonates with Vygotsky's social constructivist theory ([1978](#)) which emphasizes the importance of social interaction in learning. By working in groups, children engage in dialogue, share ideas, and negotiate meaning, which deepens their understanding of scientific concepts. Furthermore, the use of infographics aligns with the principles of visual learning, enabling children to grasp complex processes through visual representation. This method not only promotes autonomy in learning but also equips children with essential skills for lifelong learning, such as critical thinking, problem-solving, and effective communication. Overall, the integration of PjBL with visual aids like infographics creates a rich learning environment that supports holistic development in early childhood education.

The research results indicate that the practicality level of infographic media reaches 87.67%, categorized as "Practical." This demonstrates that the teachers involved in this study found infographics to be extremely helpful in guiding students during experiments. Teachers reported that infographics allowed students to focus more on the experimental activities, aligning with findings by Shabiralyani *et al.* (2015) and Yıldırım (2016) that visual media can significantly enhance student engagement and facilitate better conceptual understanding.

The high practicality score suggests that infographics effectively meet the needs of both educators and learners in a classroom setting. The moderate N-gain score (0.67) and high practicality rating (87.67%) indicate that infographics functioned effectively as visual scaffolds during the experiments. By replacing repetitive verbal instructions with clear visual cues, the infographics reduced children's cognitive load, allowing them to focus on the physical manipulation of the materials. This mechanism supports Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2014), demonstrating that integrating structured visual information with hands-on activities helps young students process scientific concepts more efficiently than conventional teacher-centered explanations. Furthermore, the emphasis on student engagement highlights the importance of active learning strategies in education. When students are engaged, they are more likely to retain information and develop a deeper understanding of the material. Overall, the integration of infographics in educational practices not only supports practical teaching methods but also reinforces the significance of visual aids in fostering a productive learning environment.

The integration of infographics in the PjBL model also supports Huda *et al.* (2026) findings, which state that project-based approaches supported by appropriate visualization can enhance active engagement of children in science from an early age. Therefore, the success of this learning model lies not only in the delivery of information but also in how students interact with that information, ultimately facilitating deeper and more meaningful learning. The use of infographics in project-based learning significantly contributes to the development of early childhood science skills, strengthening their abilities to collaborate, think critically, and understand scientific concepts in a fun and interactive way.

This perspective aligns with constructivist learning theories, which emphasize the importance of active participation and social interaction in the learning process. By engaging with infographics, students are encouraged to explore and manipulate information, fostering a hands-on approach that enhances their understanding. Additionally, the interactive nature of infographics supports various learning styles, making science more accessible and enjoyable for young learners. Consequently, this method not only cultivates scientific literacy but also prepares children for future learning experiences by building essential skills such as teamwork and critical thinking. Overall, the combination of infographics and project-based learning creates a dynamic educational environment that promotes holistic development in early childhood education.

CONCLUSION

In summary, this research demonstrates the effectiveness of the Project-Based Learning (PjBL) model supported by infographic media in enhancing engagement and understanding of science concepts among early childhood learners. The findings indicate that the developed infographic media is highly feasible and practical for guiding simple science experiments in early childhood education. Furthermore, its implementation within a PjBL context is associated with a significant improvement in children's science literacy scores. This research provides empirical evidence supporting the integration of visual aids to foster a deeper understanding of scientific concepts in early childhood.

For future recommendations, it is suggested that further research be conducted to explore the long-term effects of using infographics in various educational settings and subjects beyond science. Additionally, expanding the sample size and diversity of participants could enhance the generalizability of the findings. Implementing professional development programs for educators on effectively utilizing infographics in their teaching practices may also be beneficial. Overall, this research lays a foundation for ongoing exploration into innovative teaching methods that can enrich early childhood education.

This study has several limitations that must be acknowledged. First, the research utilized a single-group pretest-posttest design without a control group, meaning the improvements in science literacy cannot be definitively attributed to the infographic media alone, as factors like maturation, novelty effect, or teacher bias may play a role. Second, the small sample size (20 children) from a single institution limits the generalizability of the findings to broader early childhood education contexts in Indonesia. Finally, the study only measured short-term outcomes without a follow-up assessment for knowledge retention. Future research should employ quasi-experimental designs with larger samples, include control groups, and measure long-term retention of science concepts.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, R.W.S. and A.R.T.; methodology, R.W.S. and A.R.T.; validation, R.W.S., M.P., W.O.S.H.D., and D.H.; formal analysis, R.W.S. and A.R.T.; investigation, R.W.S., W.O.S.H.D., and D.H.; writing, original draft preparation, R.W.S.; writing, review and editing, all authors; supervision, A.R.T.; project administration, R.W.S. All authors have read and agreed to the published version of the manuscript.

AI DISCLOSURE STATEMENT

The authors used ChatGPT (OpenAI) as a language-editing and proofreading tool during the preparation of this manuscript. The authors reviewed and edited the AI-assisted output and take full responsibility for the accuracy, integrity, and final content of the published work.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the participating early childhood education institution, teachers, and children who supported the implementation of this study.

FUNDING

This research received no external funding.

REFERENCES

- Afify, M. K. (2018). The Effect of the Difference Between Infographic Designing Types (Static vs Animated) on Developing Visual Learning Designing Skills and Recognition of its Elements and Principles. *International Journal of Emerging Technologies in Learning (iJET)*, 13(09), pp. 204–223. <https://doi.org/10.3991/ijet.v13i09.8541>
- Aisyah, S., & Novita, D. (2025). Teachers' perception of the implementation of project-based learning in early childhood education in Indonesia: Project-Based Learning: a perspective from Indonesian early childhood educators. *Cogent Education*, 12(1). <https://doi.org/10.1080/2331186X.2025.2458663>
- Al-Abdullatif, A. M. (2022). Towards Digitalization in Early Childhood Education: Pre-Service Teachers' Acceptance of Using Digital Storytelling, Comics, and Infographics in Saudi Arabia. *Education Sciences*, 12(10), 702. <https://doi.org/10.3390/educsci12100702>
- Branch, R. M. (2010). *Instructional design: The ADDIE approach*. Springer. <https://doi.org/10.1007/978-0-387-09506-6>
- Bustamante, A. S., White, L. J., & Greenfield, D. B. (2018). Approaches to learning and science education in Head Start: Examining bidirectionality. *Early Childhood Research Quarterly*, 44, 34–42. <https://doi.org/10.1016/j.ecresq.2018.02.013>
- Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, 25(8), 652–661. <https://doi.org/10.1177/1744987120927206>

- Eliza, D., Mulyeni, T., Yulsyofriend, Mahyuddin, N., Erita, Y., & Dhanil, M. (2025). Implementation of project-based learning in improving scientific literacy in early childhood education: Systematic literature review. *Journal of Baltic Science Education*, 24(1), 71–91. <https://doi.org/10.33225/jbse/25.24.71>
- Febriandani, R., Yetti, E., & Utami, A. D. (2025). Exploring science literacy for early childhood. *PAUDIA: Jurnal Penelitian dalam Bidang Pendidikan Anak Usia Dini*, 14(1), 24–37. <https://doi.org/10.26877/paudia.v14i1.1118>
- Hapidin, Pujiyanti, Y., Syarah, E. S. ., & Gunarti, W. (2023). Teacher's Understanding of Project Learning Models through Children's Comics with STEAM Content in Indonesia. *JPUD - Jurnal Pendidikan Usia Dini*, 17(1), 82–97. <https://doi.org/10.21009/JPUD.171.06>
- Hasanah, U., & Sudira, P. (2021). Use of -Based Interactive Learning Media Visuals in Science Learning. *Journal of Education Technology*, 5(4), 563–570. <https://doi.org/10.23887/jet.v5i4.35364>
- Huda, K., Hartati, S., & Dwi Utami, A. (2026). Development of a Project-Based Learning Model Using Science Games to Enhance Social Skills in Early Childhood. *Journal of Educational Studies*, 4(2), 507–514. <https://doi.org/10.58218/jes.v4i2.2495>
- Hurst, G. A. (2020). Systems thinking approaches for international green chemistry education. *Current Opinion in Green and Sustainable Chemistry*, 21, 93–97. <https://doi.org/10.1016/j.cogsc.2020.02.004>
- Kabadayi, A. et al. (2023) *Researches in Education*. Lyon: Livre de Lyon. Available at: <https://doi.org/10.5281/zenodo.10433505>.
- Kaize, B. R., Sulistiyowati, R. W., & Suteki, M. (2025). Eksplorasi kearifan lokal Papua Selatan sebagai basis pengembangan media pembelajaran IPA kontekstual pada jenjang PAUD dan sekolah dasar. *SCIENCE: Jurnal Inovasi Pendidikan Matematika dan IPA*, 5(4), 1645–1657. <https://doi.org/10.51878/science.v5i4.7545>
- Krajcik, J. S., & Blumenfeld, P. C. (2006). Project-based learning. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 317–334). Cambridge University Press.
- Lederman, N. G., Antink, A., & Bartos, S. (2014). Nature of science, scientific inquiry, and socio-scientific issues arising from genetics: A pathway to developing a scientifically literate citizenry. *Science & Education*, 23(2), 285–302. <https://doi.org/10.1007/s11191-012-9503-3>
- Mayer, R. E. (2014). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed., pp. 43–71). Cambridge University Press.
- Piaget, J. (1977). *The development of thought: Equilibration of cognitive structures* (A. Rosin, Trans.). Viking Press.
- Quro, Q., & Choiriyah, C. (2022). Exploration of the application of story-based science literacy learning strategies and experimental projects in early childhood. *Journal of Early Childhood Education (JECE)*, 3(2), 75–89. <https://doi.org/10.15408/jece.v3i2.22202>
- Ristanti, S., & Isdaryanti, B. (2024). Development of Canva-based science infographic learning media to improve students' learning outcomes. *Jurnal Penelitian Pendidikan IPA*, 10(10), 7984–7992. <https://doi.org/10.29303/jppipa.v10i10.9506>
- Rudolph, J. L. (2018). Innocent experiments: Childhood and the culture of popular science in the United States [Review of the book *Innocent experiments: Childhood and the culture of popular science in the United States*, by R. Onion]. *Technology and Culture*, 59(1), [pages]. <https://doi.org/10.1353/tech.2018.0001>
- Setiasih, O., Setiawardani, W., Hidayat, A. N., Djoehaeni, H., Robayanti, D., Ibrohim, M. M., Rasilah, & Sholeh, M. (2024). Development of a design learning management system (LMS) to improve student skills: Case study in a science learning media development course. *Journal of Engineering Science and Technology*, 19(4), 1389-1400. https://jestec.taylors.edu.my/Vol%2019%20Issue%204%20August%202024/19_4_16.pdf
- Shabiralyani, G., Hasan, K., Hamad, N., & Iqbal, N. (2015). Impact of visual aids in enhancing the learning process case research: District Dera Ghazi Khan. *Journal of Education and Practice*, 6(19), 226-233. <https://eric.ed.gov/?id=EJ1079541>

- Siry, C. (2014). Towards multidimensional approaches to early childhood science education. *Cultural Studies of Science Education*, 9(2), 297–314. <https://doi.org/10.1007/s11422-012-9445-8>
- Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. SAGE Publications.
- Tiro, A. R. (2024). Pemanfaatan sains dalam kehidupan sehari-hari [Utilizing science in everyday life]. In D. Eriani (Ed.), *Panduan belajar IPA* (1st ed., pp. 127–166). CV Lauk Puyu Press.
- Tiro, A. R. (2025). *Pengembangan program perkuliahan pengetahuan lingkungan bertema revitalisasi ekosistem hutan sagu (PPPL-REHS) dalam usaha meningkatkan key competencies for sustainability (KCS) untuk berkontribusi pada Sustainable Development Goals (SDGs)*. Universitas Pendidikan Indonesia.
- van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher–student interaction: A decade of research. *Educational Psychology Review*, 22(3), 271–296. <https://doi.org/10.1007/s10648-010-9127-6>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press.
- Williamson, B. (2015, March 10). Educational data, digital policy instruments and policy labs. *Code Acts in Education*. <https://codeactsineducation.wordpress.com/2015/03/10/education-digital-data-labs/>
- Yıldırım, S. (2016). Infographics for educational purposes: Their structure, properties and reader approaches. *Turkish Online Journal of Educational Technology*, 15(3), 98–110.