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Development of an Augmented Reality Book Based on Science Inquiry for Early Childhood

Hendrik Siswono[1*], Ianatuz Zahro[2], Arie Eko Cahyono[3]
[1,2*]Early Childhood Education Teacher Education, [3]Economics Education,
Faculty of Teacher Training and Education, Universitas PGRI Argopuro Jember, Indonesia.
*Corresponding Author. Email: hendriksiswono@gmail.com

Abstract: This study aims to develop an Augmented Reality (AR)-based learning medium using a Science Inquiry approach to enhance science literacy among early childhood learners. The study follows the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation). The research subjects included early childhood students and teachers from two preschools in Jember, Indonesia. Research instruments involved observations, questionnaires, and interviews to assess children's understanding, engagement, and motivation, as well as teacher satisfaction and ease of use. Data analysis techniques included both formative and summative evaluations: formative evaluation examined each stage of the ADDIE model, while summative evaluation assessed the AR medium's effectiveness in enhancing science literacy and overall learning experience. Trial results show that the use of AR significantly improves children's understanding of scientific concepts, active engagement, and motivation in learning science. Additionally, both children and teachers rated the AR media as easy to use, with high levels of satisfaction reported by teachers, underscoring the medium's accessibility and impact. Summative evaluations reveal that the AR medium positively impacts science literacy, with an overall rating of "excellent." Consequently, AR-based media with a Science Inquiry approach shows great promise as an innovative solution for improving science literacy among young children in Indonesia.

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Introduction

The low level of science literacy among early childhood learners in Indonesia is a critical issue that requires serious attention. Research has shown that early childhood science literacy is essential for building a foundation of scientific knowledge and critical thinking skills necessary to understand the world around them (Chrismanto, 2024; Febriani, 2023). However, the current teaching approaches often remain conventional, and are not effective enough in improving children's science literacy (Wijaya & Dewi, 2021).

One contributing factor to the low science literacy is the lack of innovative teaching methods. For instance, research has demonstrated that inquiry-based learning with realia can improve the science literacy of children aged 4-5 years (Febriani, 2023). Moreover, the use of educational play tools has also proven effective in enhancing children's understanding of scientific concepts (Widayati et al., 2020). Therefore, it is crucial for educators to adopt more interactive and engaging methods to foster children's interest and understanding of science. In addition, teachers play a pivotal role in the science learning process. Teachers who possess a strong understanding of science literacy can create supportive learning environments (Firda & Suharni, 2022). Research indicates that teachers' competency in teaching science has a direct

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impact on children's science literacy achievements(Hibana & Surahman, 2021). Consequently, there is a need for ongoing professional development and training for early childhood education (ECE) teachers to help them implement more effective and engaging teaching strategies.

The learning environment also plays a significant role in children's science literacy development. Research shows that a supportive environment, including interactions with nature and exploration activities, can enhance children's science process skills (Mayar et al., 2022; Mirawati & Nugraha, 2017). By creating a learning environment rich in scientific experiences, children can more easily grasp and apply science concepts in their daily lives. Science literacy learning loss among early childhood learners in Indonesia has become an increasingly urgent issue, particularly in the context of the significant changes in education caused by the COVID-19 pandemic. Research indicates that early science experiences in kindergarten have a significant impact on children's later science achievement (Saçkes et al., 2010). However, during distance learning, many children lose opportunities to engage in interactive and practical science learning experiences, potentially leading to a decline in their science literacy skills (Segers et al., 2015).

One of the main causes of this learning loss is the lack of access to adequate educational resources. Many children, especially those from low-income backgrounds, lack access to the tools and learning media needed to support science learning at home (Carroll et al., 2018; Welsh et al., 2010). In this context, the home learning environment plays a crucial role. Research has shown that home literacy activities involving parents can improve children's early skills, but if parents lack the knowledge or resources, this can hinder children's science literacy development (Rand & Morrow, 2021). Ineffective teaching methods also contribute to learning loss. Many teachers in Indonesia still use traditional approaches that do not encourage exploration and active interaction from children (Quro & Choiriyah, 2022). Passive science learning, such as lectures, can make children lose interest and motivation to learn (Jelita et al., 2022; Quro & Choiriyah, 2022). Therefore, it is essential to develop more interactive teaching methods based on real experiences, such as using educational games and interactive media, which can capture children's attention and increase their engagement in science learning (Astini et al., 2023).

The lack of engaging and innovative learning media significantly contributes to the low science literacy of early childhood learners in Indonesia. Research has shown that the use of appropriate media can enhance children's interest and understanding of science concepts. For instance, the use of literacy trees in science learning has proven to enrich children's learning experiences and improve their scientific thinking skills (Bhala, 2024; Dewi et al., 2022). This media not only attracts children’s attention but also helps them better comprehend scientific concepts, ultimately boosting overall science literacy (Bhala, 2024; Dewi et al., 2022). Additionally, computer-based media such as multimedia learning, interactive e-books, and animated videos have also shown positive effects in improving children's science literacy (Juniati et al., 2020; Latip & Faisal, 2021). The use of technology in education can make the material more engaging and easier to understand, which is crucial for young children who tend to have shorter attention spans. Research indicates that children who learn using interactive media are better able to comprehend and apply scientific concepts in their daily lives (Latip & Faisal, 2021; Rusdawati & Eliza, 2022).

Furthermore, research suggests that the application of inquiry-based learning models with realia can be an effective alternative to improving early childhood science literacy (Febriani, 2023; Maullidyawati & Hidayah, 2022). With this approach, children are encouraged to actively participate in the learning process, which can enhance their

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understanding of scientific concepts. Therefore, the development of engaging and innovative educational media, along with teacher training in its use, is crucial to improving science literacy among young children in Indonesia.

Augmented Reality (AR) can create an interactive and enjoyable learning experience, where children can engage with virtual objects that appear realistic. Research shows that using AR in education can boost student motivation and interest, while also reinforcing their understanding of scientific concepts (Hsu et al., 2016). For instance, it has been found that lessons integrating AR can increase students' interest in STEM subjects, demonstrating that AR can foster greater engagement in learning (Hsu et al., 2016).

The use of Augmented Reality technology in early childhood science education offers great potential for helping children grasp abstract scientific concepts. AR allows children to directly experience these concepts in an interactive and enjoyable way, thereby increasing their interest and involvement in science learning (Riyanti et al., 2022; Saputra et al., 2022). Studies indicate that AR use in education can enhance academic performance and promote positive attitudes toward science learning (Riyanti et al., 2022; Saputra et al., 2022).

The application of AR in early childhood education can help children better understand their lessons in an enjoyable manner. It has been noted that AR-based educational media can make the learning process more engaging and enjoyable, as virtual objects are displayed in a realistic form (Rini, 2021). Thus, AR not only enhances interest in learning but can also help children develop cognitive skills and creativity. One of the primary advantages of Augmented Reality (AR) is its ability to transform the learning experience into something more engaging. With AR, children can view virtual objects integrated into the real world, which helps them grasp challenging concepts in a more tangible way (DÜZYOL et al., 2022). For instance, a study by Düzyol et al. demonstrated that AR applications can assist children in learning abstract concepts, such as colour mixing and the recognition of 2D and 3D geometric shapes, in an enjoyable manner (DÜZYOL et al., 2022). This suggests that AR not only enhances understanding but also makes the learning process more enjoyable.

Furthermore, AR can create an interactive learning environment where children can engage directly with virtual objects. Saputra et al. noted that AR in education enhances the fun of learning and fosters a more interactive atmosphere, which is especially important for young children who tend to have short attention spans (Saputra et al., 2022). Thus, AR can be an effective tool for capturing children's attention and maintaining their engagement in science learning. However, to fully maximise the benefits of AR technology, it is crucial for educators to design content that aligns with the needs and characteristics of young learners. AR-based learning media must be designed with children's cognitive and emotional aspects in mind to effectively support their learning process (Khan et al., 2019; MZ et al., 2022). Additionally, teacher training on the use of AR technology is essential to ensure they can effectively integrate this medium into the curriculum (Afrianto et al., 2019).

The development of AR-based learning media books for early childhood offers significant innovation in science education. AR allows children to interact with abstract science concepts through visual and interactive experiences, which can enhance both their understanding and interest in science (Elsayed & Al-Najrani, 2021). By using AR technology, learning media books can present content that is more engaging and easier to comprehend, thus helping children understand science material in an enjoyable way.

The use of AR in learning media books can support an inquiry-based learning approach. By giving children the opportunity to explore and interact with virtual objects, they can learn through hands-on experiences, which is vital for developing critical and creative thinking skills (Savitri et al., 2021). This aligns with research showing that AR can increase

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student engagement and help them understand complex concepts in a more concrete manner (Elsayed & Al-Najrani, 2021).

The urgency of research into developing AR-based media books for early childhood is significant, given the rapid advancement of technology and the need to enhance the effectiveness of education among children. Below are some reasons supporting this urgency:

1) Enhancing the Learning Experience: AR-based learning media can significantly enrich children's learning experience in an interactive and engaging way. As highlighted by (Atikah, 2023), the use of AR media can enhance the quality of learning, particularly in kindergartens, where there is often a limited variety of teaching materials. With AR, children can view 3D objects and interact with content directly, making the learning process more enjoyable and effective.
2) Supporting the Learning of Abstract Concepts: AR-based media books allow children to grasp abstract science concepts more concretely. Research by (Faiza et al., 2022) indicates that AR-based learning media can improve students' knowledge competence, demonstrating that AR can help young children overcome difficulties in understanding complex materials. Therefore, AR holds the potential to boost early childhood science literacy.
3) Encouraging Engagement and Motivation: The use of AR in learning can increase children's engagement and motivation. According to (Fitriani et al., 2022), AR-based learning media can ignite children's enthusiasm for learning, as they not only read but also interact with the content. This active engagement is crucial for fostering children's interest in and understanding of science.
4) Innovation in Teaching Methods: The development of AR-based media books represents an innovative step in teaching methods. By integrating modern technology into education, we can create a more dynamic learning environment that is responsive to children's needs. This aligns with research suggesting that engaging learning media can enhance teaching and learning effectiveness (Eddy & W., 2022).
5) Preparation for the Digital Era: In today's digital age, it is essential for children to become familiar with technology, which will be a vital part of their lives. The development of AR-based media books can help children cultivate the digital skills necessary for their future. Research by Nurhayani and Nurhafizah emphasises the importance of developing early childhood literacy as a foundational skill for further education (Nurhayani & Nurhafizah, 2022).
6) Supporting Inquiry-Based Learning: AR-based media books can support an inquiry-based learning approach, where children are encouraged to explore and discover information independently. This is crucial for developing critical and creative thinking skills in children, which are essential in modern education (Atikah, 2023)

The aim of this research is to develop an Augmented Reality (AR)-based book rooted in an inquiry-based learning approach as a science learning medium for early childhood education. This AR-based book is expected to enhance science literacy among young children in a more interactive, engaging, and effective way compared to conventional teaching methods. By utilizing AR technology, children can interact with realistic virtual objects, allowing them to understand abstract science concepts through direct and enjoyable experiences.

Research Method

This research employs the ADDIE development model. The ADDIE model, an acronym for Analysis, Design, Development, Implementation, and Evaluation, is a widely recognized framework for instructional design. Its systematic approach facilitates the creation

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of effective educational tools across various disciplines. For instance, Hadiyanto emphasizes the model's adaptability in developing students' skills in higher education, showcasing its relevance in addressing specific educational needs (Hadiyanto, 2020). Similarly, Olumorin successfully applied the ADDIE model to create a human excretory system model for biology education, demonstrating its versatility in different educational contexts (Olumorin, 2022).

Moreover, the model's iterative nature allows for continuous improvement, as highlighted by Turnbull in the development of a mobile application for healthcare services (Turnbull, 2023). This adaptability is further supported by Ekhsan et al., who note that the ADDIE model serves as a foundational framework for various instructional design solutions (Ekhsan et al., 2022). Overall, the ADDIE model's structured phases provide a robust methodology for developing effective educational programs and resources, ensuring that they meet the evolving needs of learners and educators alike (Asrial et al., 2020; Masmuzidin et al., 2020; Widayanti, 2023).

1) Analysis: This stage involves analysing the learning needs and characteristics of young children and the early childhood education curriculum related to science literacy. Additionally, an assessment is carried out on the available technological infrastructure in schools and students' homes.
2) Design: At this stage, the design of the learning media is created, including an AR storyboard and AR book prototype. The content is organised using a Science Inquiry approach, which encourages children to learn through observation, experimentation, and independent discovery.
3) Development: The AR media is developed through the creation of the AR application and science content that support early childhood science literacy. Initial testing (alpha testing) is conducted to verify the functionality of the application.
4) Implementation: Field trials (beta testing) are conducted at two schools, TK Lab Labschool IKIP PGRI Jember and TK Plus Al Hujjah Jember. Teachers are given training on how to use the AR book, and data is collected through observations and questionnaires.
5) Evaluation: Evaluation is carried out both formatively and summatively to assess the effectiveness of the AR media in enhancing science literacy. The results of the evaluation are used to refine the media before broader implementation. The evaluation stage of data analysis focuses on assessing the quality of the AR application, the accuracy of the science content, and the functionality of the media through initial testing, or alpha testing, which evaluates the stability and performance of the application before broader use. The next stage is beta testing, which involves field trials with teachers and students to gather feedback through observation and training. Through these two stages, formative evaluation identifies potential issues and ensures that the media functions optimally and meets the learning needs of early childhood education.

This method ensures that the developed AR media meets the educational needs of young children and is capable of enhancing science literacy through interactive learning.

Results and Discussion

Analysis

In this analysis phase, the identification of learning needs focused on early childhood science literacy was conducted. Understanding basic science concepts, such as the introduction of natural phenomena, simple object observation, and the scientific discovery process, were identified as areas that need to be developed. Science literacy is essential to

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support children's cognitive development; therefore, AR-based learning media are designed to help children understand these concepts visually and interactively. The analysis results show that learning experiences supported by AR technology can help enhance children's interest in and understanding of science materials through simulations that resemble the real world.

Additionally, an analysis of early childhood characteristics was carried out to ensure that the developed media aligns with their cognitive, affective, and motor development. This study was conducted at TK Lab Labschool IKIP PGRI Jember and TK Plus Al Hujjah Jember, focusing on children aged 4-6 years. The results indicate that AR media must be designed with consideration of children's attention limitations and fine motor skills, as well as the need for engaging visual stimulation. An analysis of the early childhood education curriculum related to science literacy was also conducted to ensure that the learning media align with the competencies required at this educational level, with adequate technological support available both at school and at home

Design

In the design phase, several strategic steps were taken to develop interactive and educational Augmented Reality (AR) learning media. The first step was designing the AR storyboard, where interactive scenarios were created by incorporating visual elements such as 3D images, animations, and narratives that align with the science concepts intended for children to learn. These scenarios are designed to capture children's attention and provide a deep learning experience through the visualization of abstract science concepts. Each interaction in the storyboard is carefully crafted to ensure that children can intuitively understand and manipulate virtual objects.

Furthermore, the content is structured based on an inquiry-based learning approach, where children are encouraged to observe, ask questions, experiment, and discover science concepts independently. This approach positions children as discoverers, giving them the freedom to explore and find answers to their own questions through the use of AR media. Additionally, a prototype of an AR book was designed as an application support tool—a printed book that serves as a guide for using the application. This book is visually appealing and functional, helping children understand how to use the AR application while also serving as a complementary learning medium that enriches the learning process.

Development

In the development phase, the primary process involved is the development of the AR application and its supporting content. The AR application development includes creating an application that can display AR-based virtual objects when directed at specific images or pages from the AR book. The application is designed to be easily used by early childhood users, featuring a simple yet engaging interface. Key development focuses include image detection, interaction with 3D objects, and interactive animations. Each feature is tested periodically to ensure the application runs stably and optimally across various devices.

In addition to the application development, science content for young children is developed in parallel. This process involves the production of 3D objects, videos, and narrations that align with science concepts tailored to suit children's cognitive development. Narratives and visualizations are adapted to provide easily understandable explanations, with engaging visual elements to attract children's interest in learning science. Once the application and content development are complete, an initial internal test or alpha testing is conducted. This testing aims to ensure the application functions as planned, verify the content's feasibility, and identify any bugs or technical issues that need to be addressed before further testing with external users.

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Table 1. The Expert Assessment Results Media:

No	Assessment Aspects	Description Assessment	Category	Score
1	Content Relevance	The developed science content aligns with the early childhood education curriculum, supporting science literacy for young children.	Very Good	5
2	Interactivity	The AR application provides a good interactive experience, allowing children to directly interact with 3D objects.	Good	4
3	User Interface Design	The application interface is simple, engaging, and easy to use for children aged 4-6 years.	Very Good	5
4	Visual Quality	The 3D objects and animations displayed have good visual quality and are appealing to children.	Good	4
5	Audio and Narration Quality	The narration is clear and appropriate for the comprehension abilities of young children, with high-quality audio.	Very Good	5
6	Application Stability	The application runs smoothly without interruptions or crashes during initial testing (alpha testing).	Good	4
7	Content Accuracy	The scientific information provided is accurate and relevant to the concepts young children are intended to learn.	Very Good	5
8	Engagement Potential	The application can enhance children's interest and engagement in learning science through AR.	Good	4
9	Ease of Use	The application is easy for children to use, both independently and with parental assistance.	Very Good	5
10	Compatibility with Devices	The application is compatible with various devices and works well on tablets and smartphones.	Good	4
		Average value		**4,5**

Implementation

In the implementation phase, the first step taken was field testing (beta testing) using the AR book with students from TK Lab Labschool IKIP PGRI Jember and TK Plus Al Hujjah Jember. This testing aimed to evaluate how effectively Augmented Reality (AR)-based media can be used in science learning. During the trial, students were given the opportunity to use the AR book directly, and observations were conducted to see how children responded to the use of this technology in learning science concepts. The testing also helped identify weaknesses or technical challenges that might arise during the use of the media.

Additionally, training was provided to teachers at both schools to ensure they could maximize the use of the AR book in daily learning activities. This training included how to use the AR application, guiding students in using the media, and integrating the inquiry-based learning method to make science learning more interactive and exploratory. During implementation, data were collected through direct observations and questionnaires given to teachers and students to measure the effectiveness of AR media in enhancing science literacy among young children. This data will be analyzed to assess the impact of AR usage on students' understanding and engagement in learning.

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Table 2. The effectiveness of AR media in enhancing science literacy

No	Assessment Aspects	Indicator	Scale (1-5)	Average of TK Lab Labschool	Average of TK Plus Al Hujjah	Overall Average
1	Understanding of Science Concepts	The child can explain basic science concepts learned through AR media.	1-5	4.5	4.3	4.4
2	Interest and Motivation	The child shows high interest and engagement when using the AR book.	1-5	4.7	4.6	4.65
3	Active Engagement	The child actively interacts with AR media during learning and experimentation.	1-5	4.6	4.5	4.55
4	Inquiry Skills	The child can independently ask questions and experiment after using AR.	1-5	4.4	4.2	4.3
5	Observation Skills	The child is able to make good observations of phenomena displayed by AR.	1-5	4.5	4.3	4.4
6	Technology Skills	The child can use the AR application with minimal assistance from teachers or parents.	1-5	4.3	4.1	4.2
7	Critical Thinking Ability	The child demonstrates critical thinking skills when connecting phenomena seen in AR.	1-5	4.4	4.2	4.3
8	Independence in Learning	The child can use the AR book independently after several uses.	1-5	4.2	4.1	4.15

Based on the table measuring the effectiveness of Augmented Reality (AR) media in enhancing science literacy among children at TK Lab Labschool IKIP PGRI Jember and TK Plus Al Hujjah Jember, it can be concluded that the use of AR media overall shows very good results across various aspects of science learning.

1) Understanding Science Concepts: With an overall average of 4.4, children are able to understand the basic science concepts presented through AR media very effectively. This indicates that AR is effective as a teaching tool for helping children grasp science material.
2) Interest and Motivation: The highest score is in the aspect of children's interest and motivation (4.65). This suggests that the AR book successfully captured interest and enhanced motivation, making the science learning experience more enjoyable and interactive.
3) Active Engagement and Inquiry Skills: Children are actively engaged in the learning process with AR media, with an average score of 4.55 for active engagement and 4.3 for

inquiry skills. This shows that AR encourages children to be more directly involved in the learning process, both in interacting with the media and in thinking and experimenting independently.

4) Technology Skills and Independence: The aspects of technology skills and learning independence show slightly lower scores compared to other aspects, at 4.2 and 4.15 respectively. Although still in the good category, this indicates that some children may need more time to become accustomed to using AR technology independently without assistance from teachers or parents.
5) Critical Thinking and Observation Skills: The average scores of 4.3 for critical thinking and 4.4 for observation skills show that AR media also plays a role in developing children's critical thinking skills, especially in connecting phenomena they see with the science concepts they are learning.

Overall, AR media has successfully enhanced children's science literacy with an overall average of 4.37, which falls into the "Very Good" category. This indicates that AR media is highly effective in supporting science learning for young children at both of these preschools.

Evaluation

The results of the evaluation of the development and implementation of Augmented Reality (AR) media are divided into two forms: formative evaluation and summative evaluation, to ensure the effectiveness and quality of the developed media. Formative evaluation is conducted at each stage of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). In the analysis stage, the evaluation ensures that the learning needs and characteristics of young children have been accurately identified. At the design stage, the evaluation checks whether the storyboard and content are aligned with the learning objectives and the characteristics of the children. In the development stage, formative evaluation focuses on the quality of the AR application, science content, and media functionality through initial testing (alpha testing). During the implementation stage, formative evaluation involves observation and feedback from teacher training and field testing (beta testing) to identify issues and ensure the media functions as expected.

Summative evaluation is conducted at the end of the implementation stage to measure the impact of the AR media on children's science literacy. This evaluation involves analyzing data from field testing to assess the improvement in children's science literacy, their engagement in the learning process, and the teachers' satisfaction with the teaching media. The results of this evaluation are used to identify the strengths and weaknesses of the AR media and to make improvements and refinements before the media is implemented more widely across various early childhood education (ECE) schools. Summative evaluation ensures that the AR media is effective in enhancing science literacy, and provides a positive learning experience for children, and provides adequate support for teachers. Below is the table of formative and summative evaluation results for the development and implementation of Augmented Reality (AR) media:

Table 3. Formative and Summative Evaluation Results

No	Type of Evaluation	Evaluation Aspect	Description of Evaluation	Score (1-5)	Findings
1	Formative	Learning Needs	Evaluation of whether learning needs have been identified accurately.	4	Learning needs are well identified.
2	Formative	Storyboard Design	Evaluation of the alignment of the storyboard with learning objectives and children's characteristics.	4.5	Storyboard meets the needs and characteristics of children.

3	Formative	AR Application Quality	Evaluation of the AR application's functionality during initial testing (alpha testing).	4.2	AR application functions well but requires some improvements.
4	Formative	Science Content	Evaluation of the relevance and quality of the developed science content.	4.4	Konten sains relevan dan berkualitas tinggi.
5	Formative	Teacher Training	Evaluation of the effectiveness of teacher training in using AR media and maximizing the learning experience.	4.3	Training is effective, but there is a need for further training.
6	Summative	Improvement in Science Literacy	Measuring the improvement in children's science literacy after using AR media.	4.5	Significant improvement in science literacy is observed.
7	Summative	Child Engagement	Measuring the level of child engagement in the learning process with AR media.	4.6	Children show high engagement.
8	Summative	Teacher Satisfaction	Measuring teacher satisfaction with AR media and the training provided.	4.4	Teachers are satisfied with the AR media and training.
9	Summative	Quality of User Experience	Measuring the quality of the user experience with AR media for both children and teachers.	4.3	User experience is generally positive, though some technical issues remain.

Formative evaluation shows good results in terms of needs identification, design, application quality, and content, with some areas needing improvement. Summative evaluation indicates that AR media is effective in enhancing science literacy, child engagement, and teacher satisfaction, with overall excellent results. Augmented Reality (AR) books have shown significant potential in enhancing science inquiry among early childhood learners. By integrating interactive elements, AR books can transform traditional learning experiences into engaging, hands-on explorations of scientific concepts. Research indicates that AR technology fosters increased motivation and engagement, which are critical for young learners in developing inquiry skills (Madanipour & Cohrssen, 2019; Yang et al., 2021). For instance, AR can facilitate the visualization of abstract scientific phenomena, making them more accessible and understandable for preschool children (Stajcic, 2023).

Moreover, AR books can support inquiry-based learning by allowing children to interact with digital content in real time, promoting active exploration and experimentation (Kewalramani & Havu-Nuutinen, 2019). This aligns with findings that emphasize the importance of providing children with opportunities to engage in scientific inquiry, which can lead to improved science process skills (Morgan et al., 2016; Rumalolas et al., 2021). Additionally, AR's ability to create immersive learning environments can help bridge the gap between theoretical knowledge and practical application, thereby enhancing children's overall scientific literacy (Maulana et al., 2019; Rudnik, 2022). In summary, AR books represent a valuable tool in early childhood education, effectively promoting science inquiry through interactive and engaging learning experiences.

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Conclusion

This study shows that the development of Augmented Reality (AR) based learning media with a Science Inquiry approach is effective in enhancing early childhood science literacy. The use of AR technology has proven to capture children's interest and motivation in learning abstract science concepts through engaging and enjoyable interactive visual experiences. Evaluation results indicate a significant improvement in understanding science concepts, active engagement, and children's critical thinking skills after using AR media. Additionally, the AR media is also rated as easy to use by both children and teachers, with high levels of satisfaction reported by the teachers. Therefore, the use of AR media has the potential to be an innovative solution to support science learning among young children, particularly in improving science literacy in Indonesia. However, additional teacher training and technical improvements to the AR application are needed to maximize learning outcomes.

Recommendation

To maximize the effectiveness of using Augmented Reality (AR)-based learning media with a Science Inquiry approach, it is recommended that ongoing training programs be implemented for teachers to enhance their skills in integrating AR with the existing curriculum. Additionally, regular evaluations and updates of the AR application should be conducted to ensure it remains optimal and engaging for children while ensuring adequate access to this technology across schools, especially in remote areas. Parental involvement is also crucial, so programs should be established to educate them about the benefits of AR in education. Further research is needed to explore the long-term impacts of using AR media on children's science literacy. Finally, the development of a curriculum integrated with AR is expected to create a more comprehensive and relevant learning experience for children.

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