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Literature Review: The Utilization of Augmented Reality (AR) and Virtual Reality (VR) in Learning Media at Elementary Schools

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ABSTRAK

Kemajuan perkembangan teknologi dewasa ini telah mengubah masyarakat era society 5.0 berbasis teknologi. Hal tersebut harus sejalan dengan kemajuan trend di dunia pendidikan. Peserta didik menanti pembelajaran yang memiliki sentuhan kebaruan dalam pelaksanaannya. Penggunaan media berbasis teknologi dapat menjadi alternatif untuk mendukung pembelajaran optimal. Salah satu perkembangan yang dapat diterapkan saat ini dengan menggunakan salah satu media berbasis teknologi *Augmented Reality (AR)* dan *Virtual Reality (VR)*. Pemanfaatan media pembelajaran berbasis *Augmented Reality (AR) dan Virtual Reality (VR)* memberikan dampak positif terhadap proses dan hasil belajar siswa di tingkat sekolah dasar. Media AR dan VR terbukti mampu meningkatkan pemahaman konsep, motivasi belajar, keaktifan, hingga kemampuan pemecahan masalah melalui penyajian materi yang lebih visual, interaktif, dan imersif. Meskipun terdapat beberapa tantangan teknis dalam implementasinya.

Kata Kunci: Augmented Reality; Virtual Reality; Media Pembelajaran.

ABSTRACT

The advancement of technology today has transformed society into a technology-based Society 5.0 era. This development must align with current trends in the world of education. Students now expect learning experiences that incorporate innovative elements in their implementation. The use of technology-based media can serve as an alternative to support optimal learning. One such development that can be applied today involves the use of technology-based media such as *Augmented Reality (AR) and Virtual Reality (VR)*. The use of AR and VR-based learning media has a positive impact on both the learning process and outcomes for elementary school students. AR and VR media have been proven to enhance conceptual understanding, learning motivation, engagement, and problem-solving skills through the presentation of material in a more visual, interactive, and immersive manner — although there are some technical challenges in their implementation.

Keywords: Augmented Reality; Virtual Reality; Learning Media.

INTRODUCTION

Education is a structured process designed to develop individuals' physical and spiritual potential so that they can grow into better versions of themselves. This development includes cognitive, affective, and psychomotor domains, serving as a foundation to navigate life more effectively.

In today's era, known as the Society 5.0 era, education refers to a concept of a society that is technology-oriented. Technology is embedded in all aspects of life to assist human beings in their daily activities, ultimately aiming to improve the quality of life and address various social challenges.

Education in the Society 5.0 era emphasizes learning that focuses on the development of 21st-century skills, such as critical thinking, creativity, communication, collaboration, and the ability to solve complex problems.

To respond to the evolving needs of education in this advanced era, it is essential that educational systems align with technological advancements required by education practitioners. One such development that can currently be implemented is the integration of technology-based media, particularly Augmented Reality (AR) and Virtual Reality (VR). The use of media is closely linked to the need for more effective and optimal learning. Instructional media is a key component of the teaching and learning process and plays a crucial role in the success of learning outcomes. Media can help students better understand lesson material, as learning with media can be designed to be engaging and enjoyable. This helps prevent boredom, motivates students, and stimulates their enthusiasm for learning, thereby supporting the achievement of effective and efficient educational goals (Haryani et al., 2024).

Augmented Reality (AR) and Virtual Reality (VR) are digital technology features that combine systems in real time. In-depth application of this technology provides exciting experiences through the presentation of multi-information in virtual space (Hidayat & Khotimah, 2019). AR is a form of virtual object capable of delivering information and assisting human activities in daily life. Endarto, I. A., & Martadi, M. (2022) stated that Augmented Reality (AR) offers new opportunities to facilitate teaching and learning processes, especially in illustrating abstract concepts. They successfully developed an AR application to help students learn the human respiratory and digestive systems effectively, which also enhanced children's language skills, particularly writing (Hermawan & Hadi, 2024).

Augmented Reality (AR) and Virtual Reality (VR) media integrate digital elements (such as images, videos, or 3D models) into the real world, providing users with an interactive experience as though they are part of it. While AR does not fully recreate a virtual world, it overlays digital information onto the real-world view of the user. This media is expected to enhance enjoyment in learning practices. AR is considered an engaging educational medium, as it provides new perspectives and learning environments that stimulate student enthusiasm and increase motivation (Nursyafitri et al., 2024).

The use of AR technology in elementary school learning has proven effective in improving the learning process by making it more interesting, interactive, and easier for students to understand. Additionally, it is argued that the use of AR technology holds great potential to transform the learning paradigm in elementary schools into a more innovative, engaging, and effective one (Rinaldi et al., 2024).

This article presents an analysis of various related studies discussing the essence of using AR media as an interactive digital learning alternative that can be directly utilized by students. The expectation is that such interactive media will make learning more enjoyable and, at the same time, provide meaningful learning experiences to help achieve optimal learning outcomes.

METHOD

This study employs a **literature review method**, which involves examining and analyzing various scholarly sources to gain a comprehensive understanding of a particular topic. The focus of this review is on the utilization of **Augmented Reality (AR)** and **Virtual Reality (VR)** technologies as learning media at the elementary school level.

The literature review process in this study follows the stages outlined by Rinaldi, Fahmi, & Masyitah (2024), which consist of four main steps:

1. **Formulating the research problem**, which begins by identifying the central topic regarding the use of AR and VR in the context of interactive learning in elementary schools;
2. **Conducting literature searches**, using keywords such as "Augmented Reality," "Virtual Reality," "interactive learning media," and "elementary school" through academic search engines such as Google Scholar and the Publish or Perish application (version 8);
3. **Evaluating data**, by filtering articles based on publication year (2020–2025), topic relevance, and publication quality, resulting in eight scholarly articles considered eligible for analysis; and
4. **Analyzing and interpreting**, by synthesizing information from the selected articles to identify patterns, trends, strengths, weaknesses, and the relevance of implementing AR and VR in elementary education.

Each selected article was thematically analyzed to identify aspects such as media implementation, its impact on learning outcomes, technical and pedagogical challenges, and future development strategies. Through this method, the researcher aims to present a clear overview of the role of Augmented Reality (AR) and Virtual Reality (VR) technologies in enhancing the effectiveness and engagement of learning experiences at the elementary school level.

RESULTS

The following is a summary of research findings derived from a literature review of various scholarly journals related to the application of **Augmented Reality (AR)** and **Virtual Reality (VR)** technologies as interactive learning tools at the elementary school level. These studies indicate a positive trend in integrating digital technologies into teaching and learning processes, particularly in visualizing abstract materials and enhancing students' motivation and comprehension.

The study by **Haryani et al. (2024)** is one example that explores the application of AR in the context of mathematics education. This study reveals that the interactive 3D visualization of mathematical objects significantly aids students in understanding complex geometric concepts. By combining AR with the Project-Based Learning (PjBL) model, student engagement and critical thinking skills improved, ultimately enhancing their problem-solving abilities.

In line with these findings, **Leliavia (2023)**, through her literature review, emphasized that AR is an innovation aligned with the demands of the Fourth Industrial Revolution (Industry 4.0). A review of 20 scientific articles concluded that AR is not only effective in increasing retention and learning outcomes but also cultivates students' curiosity. In practice, AR is suitable for all educational levels, especially for content that is not easily observable directly, although challenges such as limited access and device availability remain.

Expanding on previous discussions, **Rachim et al. (2024)** highlighted the impact of AR on student learning activity. Through a Systematic Literature Review of nine recent articles, they found that AR fosters active and contextual learning by presenting content in a more visually appealing and understandable form. Nevertheless, implementing this technology requires support from various stakeholders, including teacher training and infrastructure provision.

In the context of Social Studies (IPS) learning, **Nursyafitri et al. (2024)** conducted a quantitative study on the effect of AR media on student motivation. The results showed a significant increase in motivation among students who used AR media compared to those

who learned through conventional methods. Students became more enthusiastic, gained better understanding of the material, and enjoyed a more interactive and engaging learning experience.

Alongside AR, Virtual Reality (VR) has also become the focus of several studies. **Aini et al. (2023)** evaluated the effectiveness of VR media in Science (IPA) learning through a quasi-experimental approach. Although the results were not statistically significant in absolute terms, there was a noticeable improvement in learning outcomes and class participation among students who used VR compared to the control group. This highlights the potential of VR to create a more immersive and enjoyable learning environment.

Furthermore, **Rohyadi et al. (2025)** implemented 3D VR media in teaching the Solar System. The results indicated a significant improvement in students' understanding after using VR, as it provided a realistic simulation of phenomena such as Earth's rotation and revolution. Students appeared more enthusiastic, and the learning process became more interactive and effective in explaining abstract concepts.

Adding a developmental perspective, **Pradana and Ansori (2025)** designed an animated VR-based video using a Problem-Based Learning (PBL) approach for teaching food chains. This media was tested on a limited scale and showed improved learning outcomes in both small and large groups. Expert validation also confirmed that the media was highly feasible for use in IPAS (Science and Social Integrated Learning).

Finally, the study by **Attalina et al. (2024)** further reinforced the evidence that VR media enhances students' understanding of IPAS material. Using a pretest-posttest design, the findings showed significant improvement, indicating that VR not only raises students' academic performance but also provides a realistic and enjoyable learning experience.

Based on the literature review of the aforementioned articles, a summary of the use and application of **Augmented Reality (AR)** and **Virtual Reality (VR)** can be compiled, as presented in table 1 below.

Table 1. Previous Research Findings Related to AR and VR

No	Reference	Title and Year	Research Method	Data Collection Method	Research Findings
1	Haryani, et al.	Implementation of AR Learning Media in Mathematics (2024)	Literature Study	Review of 15 national & international articles	AR and PjBL proved to improve problem-solving skills, creativity, and student engagement
2	Leliavia	AR Learning Media as an Innovation in the Industrial Revolution 4.0 Era (2023)	Literature Review	Review of 20 articles via Publish or Perish & Google Scholar	AR effectively improves retention, learning outcomes, and student motivation; suitable for all educational levels
3	Rachim, et al.	Utilization of AR to Increase Learning Activeness (2024)	Systematic Literature Review	Analysis of 9 articles published from 2019–2024	AR enhances interest, motivation, and learning performance through visual and interactive experiences

4	Nursyafitri, et al.	Effect of AR Media on Elementary Students' Learning Motivation (2024)	Quasi Experiment (Nonequivalent Control Group)	Tests, questionnaires, observations	AR significantly influences increased student learning motivation (sig. 0.003 < 0.05)
5	Aini, et al.	Effectiveness of VR Media on Science Learning Outcomes (2023)	Quasi Experiment (Posttest Only Control Group Design)	Learning outcome test	VR shows positive influence on science learning outcomes, though not statistically significant (p = 0.096)
6	Rohyadi, et al.	Application of 3D VR Media on Solar System Material (2025)	Quasi Experiment (One Group Pretest-Posttest)	Pretest-posttest	VR significantly improves learning outcomes (sig. 0.000 < 0.05); students are more enthusiastic
7	Pradana & Ansori	Development of VR-Based Animation Video with PBL for Food Chains (2025)	Research & Development (ADDIE Model)	Expert validation, pretest-posttest	N-Gain of small group (56%) and large group (40%) shows improvement; media is highly feasible
8	Attalina, et al.	Effectiveness of VR Media on Understanding IPAS Material (2024)	Quasi Experiment (One Group Pretest-Posttest)	Pre-test and post-test, observation	Average scores increased from 51.88 to 80; VR effectively enhances students' material understanding (sig. 0.000 < 0.05)

Based on the research findings from the eight articles summarized in the table above, it can be concluded that the use of Augmented Reality (AR) and Virtual Reality (VR)-based learning media has an overall positive impact on both the learning process and outcomes at the elementary school level. AR and VR media have been proven to enhance conceptual understanding, learning motivation, student engagement, and problem-solving skills by presenting content in a more visual, interactive, and immersive manner.

Although certain technical challenges exist in the implementation such as device availability and teachers' digital literacy the potential of these technologies remains substantial in supporting the transformation of 21st-century learning. Therefore, these findings serve as a crucial foundation for formulating conclusions and practical implications, which will be discussed in the following section.

CONCLUSION

Based on the literature review of eight relevant scholarly articles, it can be concluded that the utilization of **Augmented Reality (AR)** and **Virtual Reality (VR)** technologies in

elementary school learning media has a significant impact on both the learning process and student outcomes. AR and VR have been proven to create learning environments that are more engaging, enjoyable, and interactive. These technologies are effective in helping students understand abstract concepts, increasing motivation and active participation, and supporting the development of 21st-century skills such as **critical thinking**, **creativity**, and **problem-solving**.

AR media is particularly beneficial in delivering learning content in a visual and contextual manner, while VR offers immersive and realistic learning experiences. Both technologies have been successfully applied in various subjects such as Mathematics, Science, and Social Studies, with positive results in terms of retention, motivation, and improved learning outcomes. However, the implementation of AR and VR still faces several challenges, including limited access to technological devices, infrastructure readiness, and teachers' competence in operating digital tools. Nevertheless, with adequate support, AR and VR hold great potential as future learning media aligned with the demands of the Society 5.0 era.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. For Teachers: It is recommended that teachers improve their digital literacy and technological skills to effectively utilize AR and VR in the classroom. Regular training on the use of interactive digital media should be conducted to enhance the effectiveness of its implementation.
2. For Schools and Policymakers: Adequate infrastructure should be provided, including supporting devices (such as smartphones, tablets, and VR headsets), internet access, and the development of AR/VR-based learning content that aligns with the curriculum.
3. For Future Researchers: Further research should be conducted using experimental approaches in real classroom settings to quantitatively and qualitatively measure the effectiveness of AR and VR in improving learning outcomes. Additionally, researchers are encouraged to develop AR/VR-based applications or media that are integrated with students' local needs and cultural backgrounds.
4. For Technology Developers: It is suggested that developers continue to innovate user-friendly, accessible, and pedagogically appropriate AR and VR applications tailored to the characteristics of elementary school learning.

With proper implementation, the integration of AR and VR technologies can drive digital transformation in basic education and serve as an adaptive, effective, and enjoyable learning solution for 21st-century learners.

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