

The Utilization of Augmented Reality as an Innovative Learning Media for PGMI Teacher Candidates: A Literature Review

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Keywords	ABSTRACT
Augmented Reality, Interactive Learning Media, Aspiring Teachers, TPACK	This research aims to comprehensively examine the use of Augmented Reality (AR) as an innovative learning medium for prospective teachers, especially in the context of Madrasah Ibtidaiyah Teacher Education. A literature review (LR) was conducted in 2021–2025, with literature searches through Google Scholar, ResearchGate, ScienceDirect, and DOAJ databases. Studies show that AR has great potential to increase students' desire to learn, student involvement, concept understanding, and pedagogical technology competencies of future teachers' knowledge content (TPACK). AR technology can transform abstract ideas into concrete, three-dimensional objects. This makes the learning experience more interactive and meaningful. The study found that incorporating AR into the PGMI curriculum is essential to improve the quality of education of prospective teachers, foster creativity, and increase readiness to face the challenges of 21st-century education. To optimize the use of AR, institutions must help through the provision of infrastructure, educational technology training, and supportive policies.
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INTRODUCTION

Education is an effort made by a person to change behavior, knowledge, and character after taking it. Law No. 20 of 2003 concerning national education functions to develop and shape the character and civilization of a dignified nation to educate the life of the nation, aiming to develop the potential of students to become human beings who believe and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens.¹

The development of digital technology in the era of the Industrial Revolution 4.0 has brought significant changes in the world of education, including in the learning process in universities that prepare prospective teachers. Integrating technology into learning is an

¹ Sunarti., Ratmiati, R., & Husaini, H. (2021). Integrasi Nilai Religius dalam 2Pembelajaran MI/SD untuk Membangun Karakter Siswa. *el-Ibtidaiy:Journal of Primary Education*, 4(1), 65. <https://doi.org/10.24014/ejpe.v4i1.12372>

inevitable need to improve the quality of education and prepare students to face the challenges of the 21st century.²

According to Bowers, Augmented Reality (AR) is a technology that combines two-dimensional or three-dimensional virtual objects with the real world while simultaneously projecting certain objects virtually. This means that Augmented Reality (AR) combines the physical world with virtual elements, creating an environment that allows the relationship between the factual world and digital information, therefore Augmented Reality (AR) technology with such content can offer the potential for the paradigm to transform traditional learning into a more interactive and interesting experience with Augmented Reality (AR) as a learning medium that has an impact on students' learning activity by presenting information visually, but also creates an immersive and dynamic experience for students.

Augmented Reality has been widely used as a learning medium because it can present abstract material in a more concrete and easier-to-understand way. Through the visualization of three-dimensional objects, learners can observe phenomena or concepts that are difficult to explain only through static text and images. Various studies show that the use of AR can increase learning motivation, student involvement, and learning outcomes at various levels of education and fields of science.³

Online learning requires the use of electronic devices such as mobile phones, tablets, or laptops, as well as an internet connection during learning activities. Starting with the use of smartphones and other devices by teachers and students, educational technology is also moving towards Android-based mobile media. Android-based educational apps allow teachers to use a variety of Android-based learning apps with multimedia-based content that students can use to learn both inside and outside the classroom. In addition, Android-based educational apps are now moving towards Augmented Reality (AR) technology, which enhances the student learning experience even more.⁴

The ability of prospective teachers to develop and utilize technology-based learning media is one of the indicators of their readiness to face the demands of 21st-century education. The concept of Technological Pedagogical Content Knowledge (TPACK) emphasizes the importance of integration between mastery of materials, pedagogy, and technology in the learning process. The use of AR can be one of the real implementations of TPACK because it allows teachers to package learning materials more interestingly and contextually.⁵

Several studies conducted on prospective teacher students show that the use of AR provides a positive response to the learning process. This technology is considered to improve concept understanding, support visualization of materials, and provide a more enjoyable learning experience. In addition, prospective teachers also view AR as a potential

² Mena, J., Estrada-Molina, O., & Pérez-Calvo, E. (2023). Teachers' Professional Training through Augmented Reality: A Literature Review. *Education Sciences*, 13(5), 517. <https://doi.org/10.3390/educsci13050517>

³ Koumpouros, Y. (2024). Revealing the true potential and prospects of augmented reality in education. *Smart Learning Environments*, 11(1), 2. <https://doi.org/10.1186/s40561-023-00288-0>

⁴ Anastasha, D. A., & Hesti, N. (n.d.). PENGEMBANGAN MEDIA PEMBELAJARAN MENGGUNAKAN AUGMENTED REALITY ASSEMBLER EDU PADA MATERI EKOSISTEM SISWA KELAS V SD.

⁵ Li, G., Zhang, J., Wang, P., Yin, X., & Luo, H. (2024a). *Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023*. INPLASY - International Platform of Registered Systematic Review and Meta-analysis Protocols. <https://doi.org/10.37766/inplasy2024.3.0062>

medium to be applied in classroom learning activities because it can attract students' attention and increase active participation during the learning process.⁶

However, the implementation of Augmented Reality in education still faces various challenges, such as limited technology skills, lack of training, and lack of AR-based media development that suits learning needs. The results of the analysis of teacher professional education students show that there are still many prospective teachers who have difficulty using and developing AR-based learning media. This condition shows the need for a more in-depth study of the use of technology as an innovative learning tool for prospective teachers.⁷

RESEARCH METHOD

The research method used in this literature review was the Literature Review (LR) method, which collects and evaluates research results related to the topic being studied. The purpose of the Literature Review method is to identify, review, and draw conclusions based on all research findings related to the topic being studied.⁸ The Literature Review (LR) steps used in this study are as follows:

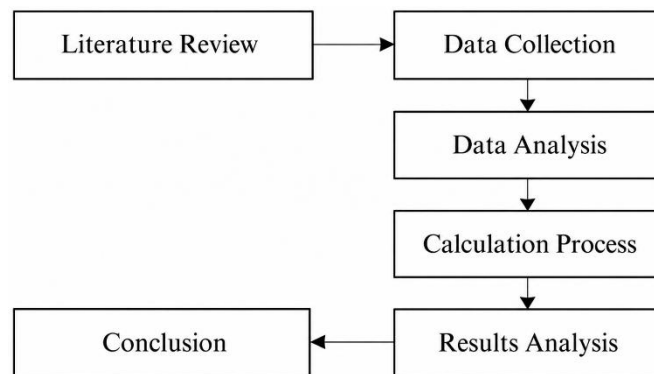


Figure 1. Method Diagram for Literature Review Research

The research stages are carried out systematically through the following steps:

1. Literature identification: searches are conducted through databases such as Google Scholar, ResearchGate, ScienceDirect, and DOAJ using the keywords "Augmented Mathematics word learning, "PGMI". Reality key", and Source selection: each article found is evaluated for its relevance to the topic and inclusion criteria.
2. Thematic classification: literature that passed the selection was categorized based on three main themes, namely spatial visualization, learning motivation, and learning effectiveness.
3. Comparative analysis: the results of each study are compared to find patterns, similarities, and differences in the application of AR.
4. Thematic synthesis and conclusion drawn: all data are compiled into main findings that illustrate the impact and implications of the application of AR in the context of mathematics learning at PGMI.

⁶ Rachim, M. R., Salim, A., & Qomario, Q. (2024). Pemanfaatan Augmented Reality Sebagai Media Pembelajaran Terhadap Keaktifan Belajar Siswa Dalam Pendidikan Modern. *Jurnal Riset dan Inovasi Pembelajaran*, 4(1), 594–605. <https://doi.org/10.51574/jrip.v4i1.140>

⁷ Oktaviani, P., Talentiano, R., Theo, Y. A., & Indrapangastuti, D. (2023). Studi Literatur Pemanfaatan Augmented Reality Sebagai Media Pembelajaran di Sekolah Dasar. *Social, Humanities, and Educational Studies (SHES): Conference Series*, 6(1), 588. <https://doi.org/10.20961/shes.v6i1.71182>

⁸ Li, G., Zhang, J., Wang, P., Yin, X., & Luo, H. (2024b). *Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023*. INPLASY - International Platform of Registered Systematic Review and Meta-analysis Protocols. <https://doi.org/10.37766/inplasy2024.3.0062>

RESULTS AND DISCUSSION

Results

The use of Augmented Reality (AR) as a learning medium can affect students' activity, interest, and motivation to learn; in addition, AR is considered to offer opportunities for use in learning activities, but some challenges need to be considered. This is in line with previous research.

1. Enhancing Student Motivation with the Use of Augmented Reality for Interactive Learning in Engineering Education. The results of the analysis showed that students were satisfied with the use of AR for interactive learning, with high average scores for the motivational factors of the learners, namely attention, relevance, confidence, and satisfaction.⁹
2. Systematic Literature Review: Augmented Reality Trends 2019- 2023 and Opportunities for Its Future Application. The results of the analysis show that education and industry have adopted augmented reality (AR) in the last 5 years. The future of AR application in education faces challenges, including limited institutional support for teacher knowledge development in AR and the readiness of the technology itself.¹⁰
3. Unlocking the Comprehensive Potential: Evaluation A of Augmented Reality and Virtual Reality in Education. The findings show AR and VR technologies have the potential to improve student learning and engagement. Research and teacher training are needed to support the integration of this technology in education.¹¹
4. A Review on Augmented Reality Authoring Toolkits for Education. Research supports the development of AR maker devices for educational purposes, but teachers need more experience in using them.¹²
5. Literature Study on the Utilization of the Assemblr Edu Application as a Mathematics Learning Media for Junior High School/Mts, using AR to motivate students to learn through meaningful interactive displays and facilitate the understanding of mathematics concepts.¹³

Based on the five articles above, reviewed from Afifah's research, Afifah et al. explained that the development of digital teaching materials for computer assembly with Augmented Reality (AR) received a score of 86.3% and was suitable for increasing activeness in learning. In Kaur et al.'s research, the use of Augmented Reality (AR) for learning received a high average score for students' motivational factors, relevance, namely attention, confidence, and satisfaction. In line with Lin H-CK et al., they said that the use of Augmented

⁹ Azizah, A., Afifi, E. H. N., & Nisa, D. C. (2024a). Hubungan Minat Mahasiswa Pendidikan Guru Madrasah Ibtidaiyah (PGMI) terhadap Penggunaan Teknologi Augmented Reality (AR) Sebagai Media Pembelajaran dalam Pemahaman Konsep IPA Mahasiswa. *SEARCH: Science Education Research Journal*, 3(1), 55–64. <https://doi.org/10.47945/search.v3i1.1468>

¹⁰ Li, G., Zhang, J., Wang, P., Yin, X., & Luo, H. (2024c). *Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023*. INPLASY - International Platform of Registered Systematic Review and Meta-analysis Protocols. <https://doi.org/10.37766/inplasy2024.3.0062>

¹¹ Azizah, A., Afifi, E. H. N., & Nisa, D. C. (2024b). Hubungan Minat Mahasiswa Pendidikan Guru Madrasah Ibtidaiyah (PGMI) terhadap Penggunaan Teknologi Augmented Reality (AR) Sebagai Media Pembelajaran dalam Pemahaman Konsep IPA Mahasiswa. *SEARCH: Science Education Research Journal*, 3(1), 55–64. <https://doi.org/10.47945/search.v3i1.1468>

¹² Afifah, B., Widiyaningtyas, T., & Pujiyanto, U. (2019). Pengembangan bahan ajar perakitan komputer bermuatan augmented reality untuk menumbuhkan keaktifan belajar siswa. *TEKNO*, 29(2), 97. <https://doi.org/10.17977/um034v29i2p97-115>

¹³ Dengel, A., Iqbal, M. Z., Grafe, S., & Mangina, E. (2022). A Review on Augmented Reality Authoring Toolkits for Education. *Frontiers in Virtual Reality*, 3, 798032. <https://doi.org/10.3389/frvir.2022.798032>

Reality (AR) in health board games increases students' motivation to learn, so that the integration of AR and games allows students to feel the context of the learning field and strengthen the relationship with real-life scenarios.¹⁴

Based on the analysis of various studies, AR is widely applied to science learning, MTK, Basic Education, Teacher Education, and STEM-based learning. This technology allows users to interact with three-dimensional virtual objects projected into the real environment, so learning becomes more concrete and easier to understand. Research conducted by Mena shows that AR contributes positively to the development of prospective teachers' professional competencies through a more interactive and contextual learning experience. The results of the study also show that the use of AR can increase students' learning motivation. AR media provides an engaging visual experience that can reduce boredom during the learning process.

Several studies report increased students' active participation in the learning process when using AR-based media compared to conventional media. In addition, the use of AR has been proven to support the development of Technological Pedagogical Content Knowledge (TPACK) skills for prospective teachers. Through the use of AR, students not only understand the learning material but also gain experience in integrating technology into learning. In this strategy finding, it shows that AR can be an effective means of preparing prospective teachers to face the demands of 21st-century learning.

Discussion

Augmented Reality as an Innovative Learning Media for PGMI Teacher Candidates

The development of educational technology requires prospective PGMI teachers to be able to utilize innovative learning media. The results of the study show that AR is one of the technologies that can answer these needs because it can combine visual, audio, and interaction elements simultaneously. In learning at Madrasah Ibtidaiyah, many materials are abstract, so they require media that can help the conceptual visualization process. AR allows objects that are difficult to observe directly to be displayed in three-dimensional form, making it easier for students to understand. These findings are in line with research by Li et al., who stated that AR can improve learning effectiveness through the visualization of more real concepts and immersive learning experiences. Thus, prospective PGMI teachers need to be equipped with the ability to design and implement AR-based media as part of their professional competence.

The Influence of Augmented Reality on Learning Motivation and Engagement

One of the main findings of the literature review on increased motivation is the involvement of students in learning using AR. Conventional learning media are often less able to attract students' attention because they rely only on two-dimensional text or images. On the other hand, AR allows students to interact directly with virtual objects so that the learning process becomes more interesting. For prospective PGMI teachers, using AR is important because Madrasah Ibtidaiyah students are at a developmental stage and really like visual and exploratory activities. Therefore, the use of AR can help teachers create a more enjoyable learning atmosphere, increase learning focus, and encourage active student participation during the learning process.

¹⁴ Lin, H.-C. K., Lin, Y.-H., Wang, T.-H., Su, L.-K., & Huang, Y.-M. (2021). Effects of Incorporating Augmented Reality into a Board Game for High School Students' Learning Motivation and Acceptance in Health Education. *Sustainability*, 13(6), 3333. <https://doi.org/10.3390/su13063333>

The Role of Augmented Reality in the Development of TPACK Competency of Prospective Teachers

TPACK competencies are one of the main competencies that teachers must have in the digital era. The results of the study show that the use of AR can help prospective teachers integrate material, pedagogical, and technological knowledge. PGMI students who are used to using AR in the learning process have a greater opportunity to develop creativity in designing learning media that suit students' characteristics. Research conducted by Nurmatin found that the use of AR has a positive relationship with improving the technological competence of elementary school teachers. This shows that the application of AR in the education of prospective teachers not only serves as a learning medium, but also as a means of strengthening professional competencies needed in the future.

Challenges of Implementing Augmented Reality in PGMI Education

Despite having various advantages, the implementation of AR in the education of prospective PGMI teachers still faces several challenges. The results of the study show that limitations in technological devices, internet access, users' technical capabilities, and the cost of developing AR applications are the main obstacles to its implementation. In addition, not all educational institutions have adequate facilities to support the optimal use of AR technology.

Implications of the Utilization of Augmented Reality for PGMI Teacher Education

Based on the results of the study, the use of AR has significant implications for improving the quality of education of prospective PGMI teachers. The use of AR can help students understand learning concepts more deeply, increase creativity in developing learning media, and strengthen their readiness to face digital education challenges. Thus, the integration of AR in PGMI's teacher education program needs to continue to be developed through institutional policies, strengthening students' digital competencies, and further research that examines the effectiveness of AR implementation in various Ibtidaiyah learning courses.¹⁵

Based on various sources, Augmented Reality (AR) is a new technology that can help improve the quality of learning, especially for prospective students of Madrasah Ibtidaiyah or PGMI teachers. This AR technology can display virtual objects in the real world. So the learning atmosphere becomes more lively, exciting, and in accordance with daily life. Because of these advantages, AR is very suitable for use as a learning medium. AR can help students understand difficult and abstract material by displaying it as 3-dimensional images.¹⁶

Research has also found that using AR can make students more enthusiastic and active in learning. With AR, their attention, curiosity, confidence, and learning satisfaction increase because they can interact directly with the material. For prospective MI teachers, the experience of using AR while studying is also important so that they can make learning in elementary school more creative and suitable for children who like to learn through pictures and exploration.

Various studies have found that Augmented Reality is a new learning medium that can improve learning. AR can also increase the enthusiasm for learning, material understanding, and technological capabilities of prospective MI teachers. However, for AR to be truly useful,

¹⁵ Kaur, D. P., Mantri, A., & Horan, B. (2020). Enhancing Student Motivation with use of Augmented Reality for Interactive Learning in Engineering Education. *Procedia Computer Science*, 172, 881–885. <https://doi.org/10.1016/j.procs.2020.05.127>

¹⁶ Nazilah, S., & Ramdhan, F. S. (n.d.). *Augmented Reality Sebagai Media Pembelajaran Untuk Pengenalan Landmark Negara-Negara ASEAN Berbasis Android Dengan Menggunakan Metode Marker Based Tracking*.

there need to be complete facilities, continuous teacher training, and policy support from the campus. If all of this is met, AR can be an effective solution to produce teachers who are professional, creative, and ready to face technological developments and educational needs in today's digital age.

CONCLUSION

Research in the context of Madrasah shows that Augmented Reality (AR) is an innovative learning medium that can help prospective teachers of Madrasah Ibtidaiyah Teacher Education (PGMI) in the digital era. Research from 2021–2025 found that the use of AR can improve the quality of learning by making materials more interactive, visual, and contextual. This technology enhances the learning experience of students and prospective teachers by turning abstract concepts into more concrete ones. In addition, the results of the study show that the use of AR increases student motivation to learn, student engagement, and learning outcomes. For prospective PGMI teachers, using AR not only helps them learn but also helps them develop digital skills and integrate technology into the learning process. Pedagogical content knowledge (TPACK) and technology capabilities are important competencies for teachers in the 21st century. However, the implementation of reality-based learning (AR) in the education of prospective teachers still faces several challenges. These include limitations in technological devices, internet access, users' technical skills, and application development costs. Universities must provide support by providing adequate facilities and infrastructure, educational technology training, and integration of reality-based learning into the curriculum of PGMI study programs.

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