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Enhancing Geometry Learning Outcomes: The Role of Augmented Reality Media in Mathematics Education

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Abstrak

Perkembangan teknologi digital mendorong pemanfaatan teknologi pembelajaran untuk mengatasi kesulitan peserta didik dalam memahami konsep abstrak matematika, khususnya geometri. Salah satu teknologi yang berpotensi mendukung pembelajaran tersebut adalah Augmented Reality (AR) karena kemampuannya dalam memvisualisasikan objek tiga dimensi secara interaktif. Penelitian ini bertujuan untuk mengkaji efektivitas media AR dalam meningkatkan hasil belajar matematika serta mengidentifikasi faktor pendukung dan hambatan implementasinya pada pembelajaran geometri di Sekolah Menengah Pertama. Penelitian ini menggunakan metode Systematic Literature Review (SLR) dengan protokol PRISMA terhadap publikasi tahun 2020–2025 yang bersumber dari basis data Scopus, Google Scholar, dan ERIC. Sebanyak 10 artikel yang memenuhi kriteria inklusi dianalisis secara sistematis. Hasil kajian menunjukkan bahwa integrasi AR dalam pembelajaran geometri mampu meningkatkan hasil belajar, pemahaman konseptual, kemampuan spasial, serta keterlibatan dan motivasi peserta didik. Efektivitas AR didukung oleh visualisasi tiga dimensi interaktif dan kesesuaiannya dengan pendekatan pembelajaran berpusat pada siswa. Namun, penerapannya masih menghadapi kendala berupa keterbatasan infrastruktur, kesiapan guru, dan desain pedagogis. Oleh karena itu, AR berpotensi menjadi inovasi teknologi pembelajaran yang efektif apabila didukung oleh perencanaan instruksional yang matang.

Kata Kunci: *Augmented Reality; Pembelajaran Matematika; Geometri; Bangun Ruang Tiga Dimensi; Hasil Belajar.*

Abstract

The advancement of digital technology drives the integration of technology in mathematics education to overcome students' difficulties in understanding abstract concepts, particularly in geometry. One technology with significant potential to support such learning is Augmented Reality (AR), which enables the interactive visualization of three-dimensional objects. This study aims to systematically review the effectiveness of Augmented Reality media in improving mathematics learning outcomes and to identify the supporting factors and barriers to its implementation in geometry learning for Junior High School students.

The research method employed is a Systematic Literature Review (SLR) following the PRISMA protocol. Literature searches were conducted across the Scopus, Google Scholar, and ERIC databases for publications between 2020 and 2025, resulting in 10 articles that met the inclusion criteria. The synthesis results indicate that the use of AR media consistently enhances mathematics learning outcomes, conceptual understanding, spatial abilities, as well as student engagement and motivation. The effectiveness of AR is supported by its interactive three-dimensional visualization, ease of use, positive student responses, and integration with student-centered learning models. However, the implementation of AR still faces barriers such as infrastructure limitations, teacher readiness, and the potential for student distraction if not pedagogically well-designed. Thus, Augmented Reality media holds substantial potential as an innovative learning tool in geometry education, particularly for three-dimensional shapes, provided it is supported by adequate instructional planning and implementation readiness.

Keywords: *Augmented Reality; Mathematics Learning; Geometry; Three-Dimensional Shapes; Learning Outcomes.*

INTRODUCTION

The rapid advancement of technology in the digital era has brought significant impacts to various aspects of life, including education. The integration of technology into learning has become an integral component of efforts to enhance instructional quality. One rapidly evolving technology increasingly utilized in educational contexts is Augmented Reality (AR). Augmented Reality is a technology that superimposes two- or three-dimensional virtual objects onto the real-world environment in real-time, enabling direct interaction between users and virtual objects (Koparan et al., 2023). The use of AR in learning provides a more contextual and interactive experience and has the potential to deepen students' conceptual understanding (Sari et al., 2022).

In mathematics education, particularly in geometry, students often struggle to grasp concepts due to their abstract nature and the high demand for spatial reasoning skills (Rasna, 2025). One geometric topic that students find complex is curved three-dimensional shapes, including cylinders, cones, and spheres. Student difficulties commonly relate to understanding the concepts of volume, surface area, and the representation of three-dimensional objects. This situation contributes to low student learning outcomes in this topic (Lis Sugianto et al., 2025). Therefore, learning media that can facilitate more concrete, interactive experiences and support students' knowledge construction processes are needed.

The utilization of Augmented Reality media in mathematics learning is considered a potential solution to address these challenges (Panji et al., 2025). Through AR, geometric objects can be visualized as three-dimensional models that can be rotated and viewed from various viewpoints, thereby helping students understand the spatial relationships among the elements of a solid figure (Pramuditya et al., 2022). Direct interaction with virtual objects also encourages students to be more active in the learning process and to construct conceptual understanding independently. Several studies indicate that the use of AR in geometry learning positively impacts conceptual understanding, spatial ability, motivation, and student engagement.

Various empirical studies report that AR-based learning can significantly improve students' mathematics learning outcomes compared to conventional instruction. Research by Arpin et al. (2025) showed that students who learned with AR media achieved higher learning outcomes than those who did not. Similar findings were reported by Marian et al. (2025), who found that integrating AR into junior high school geometry learning, even in contexts with limited infrastructure, significantly enhanced students' conceptual understanding. These results reinforce the potential of AR as an effective instructional media for teaching geometry.

Despite this, research findings on the application of Augmented Reality in mathematics learning remain fragmented across studies with diverse contexts, research designs, educational levels, and learning outcome indicators. While some studies emphasize improvements in learning outcomes, others focus on conceptual understanding, spatial ability, or student motivation, indicating the absence of a comprehensive mapping of AR's effectiveness in geometry learning, particularly for curved three-dimensional shapes. In response to this gap, this study adopts a Systematic Literature Review (SLR) approach to synthesize prior research in order to evaluate the effectiveness of Augmented Reality media, as well as the supporting factors and barriers to its implementation in mathematics learning, specifically geometry. This review is expected to provide a comprehensive overview of AR's contributions to geometry learning and to serve as a basis for recommendations regarding the future development and implementation of Augmented Reality–based learning media. The study is guided by two research questions addressing the extent to which AR media improves geometry learning outcomes and identifying the key factors that support or hinder its effective implementation in mathematics education.

METHOD

This study uses the Systematic Literature Review (SLR) method. An SLR is a research approach that systematically, transparently, and structurally summarizes, evaluates, and synthesizes findings from previous studies on a specific topic (Snyder, 2019). This method was selected to thoroughly map and analyze the effectiveness of Augmented Reality (AR) media in mathematics instruction, particularly for curved three-dimensional solids. The literature search strategy follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, ensuring the process of identification, selection, and data analysis conforms to international standards.

The research stages follow the literature review guidelines by Gundogan et al. (2020), which include six phases: identification, selection, eligibility (quality assessment), data extraction, data synthesis, and reporting.

The first phase, identification, involves searching for scholarly articles relevant to using Augmented Reality media in mathematics education for curved three-dimensional solids. The search was conducted across several academic databases, including Scopus, Google Scholar, and ERIC, using the Publish or Perish software. The literature search used combinations of keywords and Boolean operators (AND, OR), such as "Augmented Reality" AND "Mathematics Learning", "Augmented Reality" AND "Geometry", "Augmented Reality" AND "Curved Surface Solids", along with other relevant keyword variations.

The next phase is selection, which involves filtering articles based on predefined inclusion and exclusion criteria. These criteria ensure that the selected articles align with the study's focus and objectives. The inclusion and exclusion criteria for this research are detailed in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Empirical research articles	Conceptual articles, opinions, or non-systematic reviews
Examine the use of Augmented Reality media	Do not utilize Augmented Reality technology
Geometry topic, specifically three-dimensional solids	Topics outside three-dimensional geometry
Articles in Indonesian or English	Articles in languages other than Indonesian or English
Published between 2020 and 2025	Published before 2020
Research subjects are Junior High School (JHS) students	Research subjects other than JHS students (e.g., primary, high school, university students, teachers)
Full text is available	Full text is not available

Articles that pass the selection stage then proceed to the eligibility assessment stage. At this stage, each article is reviewed in-depth to ensure its methodological rigor and relevance to the research focus. Quality assessment is conducted by considering the alignment of the research objectives, research design, data collection and analysis methods, and the contribution of the findings to understanding the effectiveness of Augmented Reality media in improving mathematics learning outcomes for curved three-dimensional solids.

The next stage is data extraction, which focuses on gathering essential information from each selected article. The extracted data include: author(s) and publication year; educational level; research design; learner characteristics; type and form of Augmented Reality media used; specific curved-solids topics covered; and research findings related to improving mathematics learning outcomes.

Subsequently, the research enters the data synthesis stage, a process of integrating the extracted data to identify patterns, trends, and relationships among the research findings. Synthesis is conducted using thematic analysis, grouping results by AR implementation characteristics and learning outcome indicators. This approach provides a comprehensive overview of the effectiveness of utilizing Augmented Reality media in mathematics learning for curved three-dimensional solids.

The final stage is reporting, which involves presenting the entire research process systematically. This includes the literature search strategy, article selection process, quality assessment, data extraction, and synthesis of findings. The research results are reported in accordance with the PRISMA flow diagram to ensure transparency and traceability of the research process and to facilitate replication in future studies. Thus, this SLR is expected to provide a comprehensive mapping of the effectiveness of Augmented Reality media in mathematics learning, specifically for curved three-dimensional solids.

RESULT

This study followed the 6-stage literature review methodology based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Gundogan et al., 2020). The first stage involved organizing and preparing data for analysis. Data were retrieved from databases such as Google Scholar using the Publish or Perish software with search terms aligned to the research variables, yielding an initial pool of 200 articles.

In the second stage, the researcher screened and examined all retrieved articles. Of the 200 articles, 73 were deemed irrelevant, leaving 127 for further assessment. Of the 127 articles, 19 were excluded due to content mismatches, leaving 108. Subsequently, 52 articles were selected for inclusion, while 56 were excluded for specific reasons, yielding a total of 52 eligible articles for the review.

During the third stage, the researcher categorized articles thematically by research topic. After a thorough reading and analysis, 32 articles were excluded for the following reasons: 10 presented non-aligned theoretical frameworks, 19 contained insufficient empirical results, and 9 presented irrelevant data. Consequently, 20 articles were included in the final synthesis. The search and selection process is summarized in the PRISMA flow diagram.

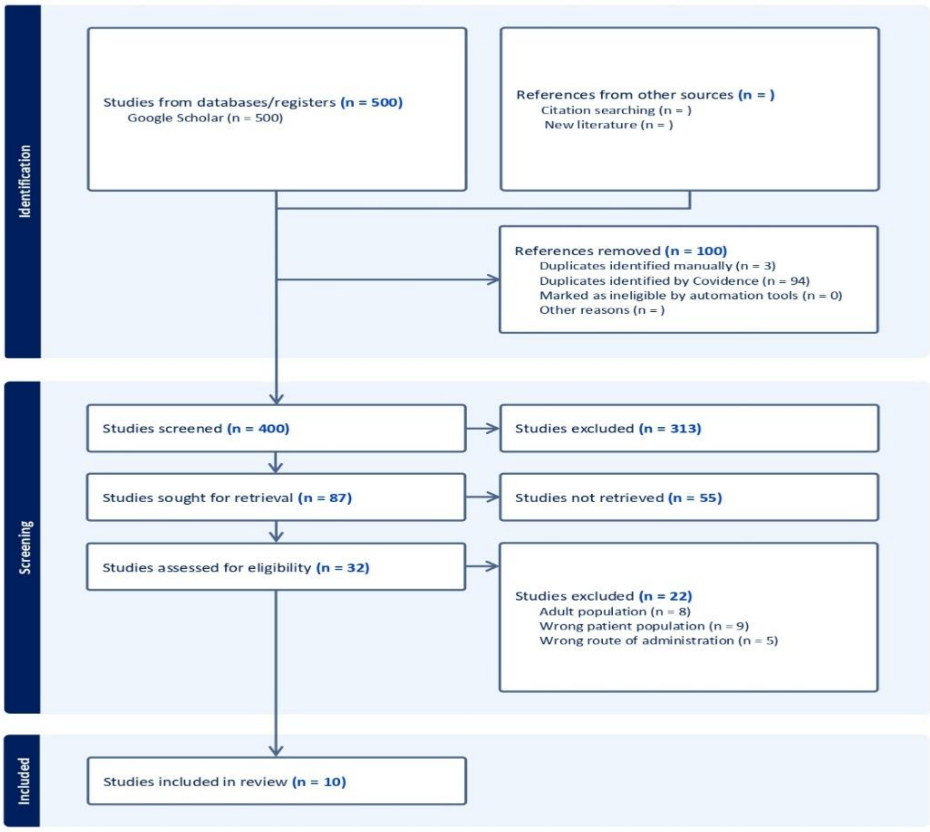

Figure 1. Prisma Flowchart

The fourth and fifth stages encompassed thematic description and synthesis regarding the use of Augmented Reality (AR) in mathematics education, specifically in geometry, along with patterns of its implementation across diverse learning contexts. The analysis at this stage focused on evaluating the effectiveness of AR in enhancing learning outcomes among junior high school students, as reported in previous studies.

The sixth and final stage involved interpretation and concluding, integrating the synthesized research findings to construct a comprehensive understanding of the contribution of AR-based media to improving mathematics learning outcomes, particularly in the area of curved-surface three-dimensional shapes. These findings are discussed in detail in the subsequent discussion section.

Table 2. Summary of Research Findings on the Utilization of Augmented Reality Media

No	Author(s) & Year	AR Media	Main Findings
1	Zekeik et al., 2025	GeoFormeAR	AR improves students’ conceptual understanding and learning outcomes.
2	Sudirman et al., 2025	Digital AR Module	The use of AR modules significantly enhances students’ understanding of 3D geometry and student engagement.
3	Pujiastuti & Haryadi, 2024	AR Application	AR-based learning is effective in improving geometric thinking skills and students’ learning outcomes (high N-Gain in the experimental class).
4	Maulida et al., 2024	AR in the Experiential Learning Model	AR-based learning is more effective than conventional learning in improving students’ mathematical abilities and self-regulated learning.
5	Del Cerro Velázquez & Méndez, 2021	GeoGebra AR	The use of GeoGebra AR significantly improves mathematics learning outcomes and students' spatial abilities compared to conventional instruction.
6	Rohendi et al., 2025	Geometry AR Application	AR increases student interactivity (average 71.9%) and receives very positive responses (81.7% satisfaction), while helping to concretize 3D geometric concepts.
7	Panji et al., 2025	Android-Based AR for Solid Geometry	Improves spatial ability (+27.07 points) and motivation (Cohen’s d = 1.45).
8	Rahman & Meryansumayeka, 2025	AR Solid Geometry Application (Android)	AR-assisted numeracy learning results in moderate levels of students’ critical thinking skills (mean score 66.62), with the highest achievement in interpretation indicators.
9	Kristiana et al., 2025	Android-Based AR (Unity & Vuforia)	AR-based geometry learning significantly improves students' mathematical creative thinking skills (fluency, flexibility, originality, elaboration) and conceptual understanding.
10	Mailizar & Johar, 2021	GeoGebra Augmented Reality	Junior high school students will accept GeoGebra AR; perceived usefulness and perceived ease of use significantly influence intention to use AR in geometry learning.

DISCUSSION

Based on a synthesis of 10 studies summarized in Table 2, the use of Augmented Reality (AR) media in mathematics learning consistently improves students' learning outcomes, particularly in geometry. These findings affirm that AR serves as an instructional media that transforms the abstract nature of mathematical concepts into more concrete and comprehensible representations for learners. Overall, the majority of the reviewed studies report that the use of AR has a positive impact on students' conceptual understanding and academic achievement. Studies by Zekeik et al. (2025), Pujiastuti and Haryadi (2024), and Del Cerro Velázquez and Méndez (2021) reveal that students who learned using AR-based media achieved higher learning outcomes than those taught through conventional approaches. This improvement is reflected in higher post-test scores and N-Gain values ranging from moderate to high in the experimental groups, indicating that AR functions not only as a visualization tool but also as a facilitator of deeper knowledge construction.

Beyond cognitive learning outcomes, the application of AR has also been shown to be effective in developing students' geometric thinking and spatial abilities. Studies by Panji et al. (2025) and Del Cerro Velázquez and Méndez (2021) indicate that interactive three-dimensional object visualization through AR significantly enhances students' spatial skills. The ability to rotate, zoom, and observe geometric solids from multiple perspectives helps learners build more accurate mental representations, thereby facilitating a better understanding of spatial concepts. Another prominent finding concerns the contribution of AR to students' engagement, motivation, and interactivity in learning. Rohendi et al. (2025) report that the use of AR-based geometry applications increases student interactivity to a high level and receives positive responses from the majority of learners. Similarly, Panji et al. (2025) demonstrate that AR exerts a significant effect on students' learning motivation, as indicated by a high effect size. These results suggest that AR can create more engaging learning experiences and encourage active student participation in mathematics instruction.

Furthermore, the integration of AR with specific instructional models yields significant effects on the Development of students' mathematical abilities. Maulida et al. (2024) show that implementing AR within an Experiential Learning model not only improves mathematical competence but also enhances students' self-regulated learning. This finding implies that the effectiveness of AR can be further optimized when combined with pedagogical approaches that position students as active agents in the learning process. In addition to cognitive and affective aspects, several studies highlight AR's influence on higher-order thinking skills, such as critical and creative thinking. Rahman and Meryansumayeka (2025) find that AR-assisted numeracy learning yields moderate levels of students' critical thinking abilities, with the highest achievement observed in the interpretation indicator. Meanwhile, Kristiana et al. (2025) report a significant improvement in students' mathematical creative thinking skills, encompassing fluency, flexibility, originality, and elaboration. These findings indicate that AR holds strong potential to support the Development of 21st-century skills in mathematics education.

From a technology acceptance perspective, the study by Mailizar and Johar (2021) shows that AR media, particularly GeoGebra AR, is well accepted by junior high school students. Perceived usefulness and perceived ease of use significantly influence students' intentions to use AR in geometry learning. This evidence reinforces the argument that the successful implementation of AR is determined not only by its effectiveness in enhancing learning outcomes but also by students' readiness and positive attitudes toward technology use. Overall, the findings of this review demonstrate that the use of Augmented Reality media in mathematics education makes a substantial contribution to improving learning outcomes, conceptual understanding, spatial abilities, and student engagement and motivation. Therefore, AR can be regarded as a promising instructional media for broader implementation, particularly in geometry topics that require strong visualization and spatial understanding.

The Effectiveness of Augmented Reality Media in Improving Mathematics Learning Outcomes in Geometry

Based on the synthesis of findings from previous studies, Augmented Reality (AR) media has been proven effective in improving mathematics learning outcomes in geometry. Nearly all of the analyzed studies report significant improvements in students' learning achievement following the implementation of AR in instructional activities. These improvements are reflected in higher posttest scores, N Gain values in the moderate to high categories, and statistically significant differences between experimental groups and control groups employing conventional teaching methods. The effectiveness of AR in enhancing learning outcomes is closely related to its ability to visualize abstract geometric objects in concrete and interactive three dimensional forms. Research findings indicate that students who learn through AR based media more easily understand geometric concepts, such as relationships among elements of solid figures, three dimensional representations, and concepts of area and volume. The ability to manipulate virtual objects, including rotating and observing geometric solids from multiple perspectives, helps students develop deeper conceptual understanding compared to the use of two dimensional media.

Moreover, the effectiveness of AR is also evident in the improvement of students' geometric thinking and spatial abilities, which are key competencies in geometry learning. Several studies report that AR contributes positively to the development of students' spatial skills, which in turn leads to overall improvements in learning outcomes. Thus, AR not only enhances basic cognitive learning outcomes but also supports the development of higher order thinking skills that are highly relevant to geometry instruction. Considering these findings, it can be concluded that Augmented Reality media demonstrates strong and consistent effectiveness in improving mathematics learning outcomes in geometry. Nevertheless, the level of effectiveness may vary depending on media design, the instructional approach employed, and learner characteristics.

Supporting Factors and Barriers in the Implementation of Augmented Reality Media in Geometry Learning

The synthesis of previous research indicates that several supporting factors contribute to the successful implementation of Augmented Reality media in geometry instruction. The most significant factor is AR's ability to provide interactive, contextualized three-dimensional visualizations. Such visualizations facilitate students' understanding of abstract geometric concepts, thereby increasing engagement, motivation, and learning focus during instruction. Another important supporting factor is students' positive responses and acceptance of AR technology. Several studies report that students perceive AR as an attractive, user-friendly, and helpful learning media. Perceived usefulness and perceived ease of use have been shown to significantly influence students' willingness to adopt AR in learning activities, highlighting the importance of technology acceptance in ensuring the sustainability of AR integration in the classroom.

In addition, the integration of AR with appropriate instructional models, such as Experiential Learning, Problem-Based Learning, or contextual approaches, provides significant support. AR, when combined with pedagogical strategies that position students as active learners, tends to have a more positive impact on learning outcomes and mathematical thinking skills. On the other hand, the reviewed studies also identify several barriers to the implementation of Augmented Reality media. Common challenges relate to limitations in infrastructure and supporting devices, including insufficient hardware availability, low device specifications, and limited internet access in specific school contexts. Furthermore, teachers' readiness to integrate AR into mathematics instruction presents another challenge, particularly regarding technological proficiency and the design of learning activities aligned with instructional objectives.

Another identified barrier is the potential for student distraction when AR use is not pedagogically structured. Without clear instructional guidance, AR risks being used merely as a visual tool without producing significant effects on conceptual understanding and learning outcomes. Therefore, the teacher's role in managing instruction and guiding student activities is crucial to maximizing the benefits of AR. Overall, the implementation of Augmented Reality media in geometry learning holds substantial potential to enhance the quality of mathematics education. However, its effectiveness is highly dependent on the balance between supporting factors and efforts to address existing barriers. With careful planning, adequate infrastructure support, and appropriate pedagogical integration, AR media can be optimized as an innovative and effective instructional tool.

CONCLUSION

Based on the results of the Systematic Literature Review (SLR), it can be concluded that Augmented Reality (AR) media is effective in improving junior high school students' mathematics learning outcomes in geometry, including solid geometry topics that require strong visualization and spatial thinking skills. The majority of the reviewed studies report significant improvements in learning outcomes, conceptual understanding, spatial ability, as well as student engagement and learning motivation following the implementation of AR in instructional activities. AR's capability to visualize three-dimensional objects interactively enables students to make abstract geometric concepts more concrete and easier to comprehend. Interactive media design, ease of use, positive student responses, and integration with student-centered learning models, such as Experiential Learning and Problem-Based Learning support the successful implementation of AR. Nevertheless, the application of AR also encounters several challenges, including infrastructure limitations, teachers' readiness to integrate technology, and the potential for student distraction when AR use is not pedagogically structured. Therefore, it is recommended that the use of AR in mathematics instruction be carefully planned and systematically integrated with appropriate instructional strategies. Future research should focus more specifically on curved surface solid geometry topics, examine the long term impacts of AR usage, and explore the development of AR media that aligns with the needs and characteristics of junior high school students.

REFERENCES

Arpin, R. M., Ariyanto, F., Fitriani, F., Mustakim, R., Mukarramah, S. K., & Dongka, R. H. (2025). Pengaruh penerapan media pembelajaran berbasis augmented reality terhadap hasil belajar siswa pada materi bangun ruang di SMP Negeri 34 Selayar. *JURNAL PETISI (Pendidikan Teknologi Informasi), 6*(2), 180–188.

Del Cerro Velázquez, F., & Méndez, G. M. (2021). Application in augmented reality for learning mathematical functions: A study for the development of spatial intelligence in secondary education students. *Mathematics, 9*(4), 1–19. https://doi.org/10.3390/math9040369

Gundogan, B., Dowlut, N., Rajmohan, S., Borrelli, M. R., Millip, M., Iosifidis, C., Udeaja, Y. Z., Mathew, G., Fowler, A., & Agha, R. (2020). Assessing the compliance of systematic review articles published in leading dermatology journals with the PRISMA statement guidelines: A systematic review. *JAAD International, 1*(2), 157–174. https://doi.org/10.1016/j.jdin.2020.07.007

Kristiana, A. I., Fatahillah, A., & Alfarisi, R. (2025). Enhancing mathematical creative thinking in ethno-geometry learning using augmented reality technology. *Mathematics Teaching Research Journal, 17*(3), 70–87.

Koparan, T., Dinar, H., Koparan, E. T., & Haldan, Z. S. (2023). Integrating augmented reality into mathematics teaching and learning and examining its effectiveness. *Thinking Skills and Creativity, 47*, Article 101245. https://doi.org/10.1016/j.tsc.2023.101245

Kurniasih, D. D., ZH, M. H. R., Ayunisa, D. A., Maryono, M., Mustofa, K., & Siswanto, S. (2025). Analysis of awareness and confidence in learning outcomes with students' academic motivation: SEM approach. *Jurnal Inovasi Teknologi Pendidikan*, *12*(1), 58-67.

Kuswandi, D., Fadhli, M., Zh, M. H. R., Haditia, M., Sinaga, M. N. A., & Thaariq, Z. Z. A. (2025). Implementation of personalized approach in video editing learning to improve digital competency of 21st century learners. *Cahaya Pendidikan, 11*(1), 56–65.

Koparan, T., Dinar, H., Koparan, E. T., & Haldan, Z. S. (2023). Integrating augmented reality into mathematics teaching and learning and examining its effectiveness. *Thinking Skills and Creativity, 47*, Article 101245. https://doi.org/10.1016/j.tsc.2023.101245

Lis Sugianto, Hikmah, H., Kriswinarso, T. B., Sukmawati, S., & Basir, F. (2025). Pengembangan media pembelajaran dengan teknologi augmented reality pada materi bangun ruang sisi lengkung dan pengaruhnya terhadap hasil belajar matematika siswa. *Venn: Journal of Sustainable Innovation on Education, Mathematics and Natural Sciences, 4*(3), 227–241. https://doi.org/10.53696/venn.v4i3.302

Marian, F., Efendi, D., & Abdillah, K. M. (2025). Integrasi teknologi augmented reality dalam pembelajaran matematika untuk meningkatkan pemahaman geometri siswa. *JIPMat, 10*(2), 255–270. https://doi.org/10.26877/jipmat.v10i2.2510

Maulida, A. S., Wahyudin, Turmudi, & Nurlaelah, E. (2024). The effect of experiential learning and directed instructions assisted by augmented reality on students' self-regulated learning. *Infinity Journal, 13*(2), 553–568. https://doi.org/10.22460/infinity.v13i2.p553-568

Panji, M., Saputra, A., Hidayana, R. A., & Azahra, A. S. (2025). Utilizing augmented reality media to enhance students' motivation and spatial thinking in 3D geometry learning. *International Journal of Ethno-Sciences and Education Research, 5*(3), 94–100.

Pramuditya, S. A., Pitriayana, S., Subroto, T., & Wafiqoh, R. (2022). Implementation of augmented reality-assisted learning media on three-dimensional shapes. *Jurnal Elemen, 8*(2), 480–493. https://doi.org/10.29408/jel.v8i2.5238

Pujiastuti, H., & Haryadi, R. (2024). The effectiveness of using augmented reality on the geometry thinking ability of junior high school students. *Procedia Computer Science, 234*, 1738–1745. https://doi.org/10.1016/j.procs.2024.03.180

Rahman, M. R., & Meryansumayeka. (2025). The critical thinking ability of junior high school students in numeracy learning assisted by augmented reality on the topic of rectangular prisms. *Journal of Honai Math, 8*(2), 241–258. https://doi.org/10.30862/jhm.v8i2.839

Ratu, A., & Talakua, A. C. (2024). Aplikasi media pembelajaran interaktif menggunakan augmented reality pada materi bangun ruang sisi lengkung. *Sudo Jurnal Teknik Informatika, 3*(2), 90–98. https://doi.org/10.56211/sudo.v3i2.529

Razna Helia, S. (2025). Upaya meningkatkan pemahaman konseptual bangun ruang sisi datar melalui integrasi teknologi dalam pembelajaran matematika kelas VIII SMP. Dalam *Prosiding SEMNASMU* (Vol. 1).

Rohendi, D., Ramadhan, M. O., Rahim, S. S. A., & Zulnaidi, H. (2025). Enhancing student's interactivity and responses in learning geometry by using augmented reality. *Eurasia Journal of Mathematics, Science and Technology Education, 21*(1), Article em2559. https://doi.org/10.29333/ejmste/15796

Sari, I. P., Batubara, I. H., Hazidar, A. H., & Basri, M. (2022). Pengenalan bangun ruang menggunakan augmented reality sebagai media pembelajaran. *Hello World Jurnal Ilmu Komputer, 1*(4), 209–215. https://doi.org/10.56211/helloworld.v1i4.142

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Sudirman, S., Rodríguez-Nieto, C. A., Adi, P. D. P., Muslim, A. B., Faizah, S., Susandi, A. D., & Sa'Dijah, C. (2025). Contextualising AR digital module instruction as artifacts in 3D geometry: A didactical tetrahedron action research. *International Journal of Mathematical Education in Science and Technology*, 1–27.

Zekeik, H., Mouali, S., Sefian, M. L., & Khalfouni, M. (2025). Enhancing geometry learning with mobile augmented reality: Evaluating the GeoFormeAR application in middle school education. *International Journal of Interactive Mobile Technologies, 19*(20), 113–131. https://doi.org/10.3991/ijim.v19i20.56381

Zh, M. H. R., Kuswandi, D., & Fadhli, M. (2025). Flipbook vs presentation media: Revisiting empirical studies and literature review in Islamic education. *Dinasti International Journal of Education Management and Social Science, 6*, 1–10.

Zh, M. H. R., Pradana, M. I. Y., Soepriyanto, Y., & Budiman, F. (2025). Comparative analysis of student learning outcomes in Al-Qur'an Hadith lessons based on learning media. *Al-Afkar: Journal for Islamic Studies, 8*(1), 241–250.

Zh, M. H. R., Putra, M. F. B., Kuswandi, D., Wedi, A., & Ardiansyah, A. (2024). Developing Wordwall evaluations in blended Islamic education using the Smith and Ragan model. *Al-Aulia: Jurnal Pendidikan dan Ilmu-Ilmu Keislaman, 10*(1), 89–104.

Zh, M. H. R., Sani, N. L., Kuswandi, D., & Fadhli, M. (2024). Needs analysis of development FBO media as a support for blended learning in Al-Qur'an Hadits lesson. *Jurnal Pendidikan Agama Islam Al-Thariqah, 9*(1), 16–32.

Zh, M. H. R., Thaariq, Z. Z. A., & Ardiansyah, A. (2024). Mobile learning: Future learning technologies for Islamic formal education (A literature study). Dalam *Proceedings of the International Conference on Education* (Vol. 2, No. 1, pp. 370–377).

Zulkifli, Z., Rahmawati, R., & Hidayat, A. (2023). Digital learning media integration in Islamic education: Opportunities and challenges in blended learning environments. *Journal of Islamic Education Studies, 5*(2), 145–158.