

Research Article

Development of Interactive Learning Media Based on Augmented Reality Using Delightex Edu

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ABSTRACT

The development of digital technology has brought major changes to the world of education. Learning does not only focus on delivering material but also requires innovation in learning media that can create interactive learning experiences. The use of Augmented Reality (AR) in education can increase concept visualization and student involvement. AR media helps students understand abstract concepts through interactive simulations and visualizations. This research aims to develop Augmented Reality-based interactive learning media assisted by Delightex Edu on sequences and series that are valid, practical, and effective. The research was conducted at SMAN 6 Lhokseumawe. This research uses Research and Development (R&D) research with the Borg and Gall development model, which has been modified into eight stages. The material expert validation obtained 90.25%, in the very valid category, while the media expert validation obtained 89.8%, also in the very valid category. Apart from that, the practicality test results obtained a percentage of 90.6% in the very practical category. Students stated that the media was easy to use, interesting, and helped them understand the learning material. The results of the effectiveness test show that students' learning completion reached 86.7% in the very effective category. Thus, Augmented Reality-based learning media assisted by Delightex Edu was declared suitable for use because it met the criteria of being valid, practical, and effective.

Keywords: Learning media; Augmented reality; Delightex edu; Development; Mathematics

1. INTRODUCTION

The development of digital technology in the 21st century has brought significant changes to the field of education. Learning is no longer focused solely on the conventional delivery of content but also requires innovative instructional media that can create interactive, engaging, and meaningful learning experiences (Septikasari et al., 2025). Technological advancements encourage teachers to utilize digital technology as a supporting tool in the learning process to better align with the characteristics and needs of today's students (Suparyadi et al., 2025). Therefore, the integration of technology into education has become an urgent necessity. The demand for technology-based learning media continues to increase alongside the implementation of educational approaches that emphasize critical thinking, creativity, communication, collaboration, and digital literacy skills (Perdana et al., 2025; Baharuddin & Hatta, 2024). According to Sakr and Abdullah (2024), technological advancements that support education, such as Augmented Reality (AR), offer significant opportunities to enhance the quality of learning by creating more engaging and immersive learning experiences. Furthermore, technology-based learning has become an essential requirement in many schools following the emergence of digital learning systems and hybrid learning.

Despite the continuous advancement of educational technology, learning media used in schools still face several limitations. Most teachers predominantly utilize conventional instructional media, including textbooks, whiteboards, worksheets, and PowerPoint presentations. Although these media facilitate the delivery of learning materials, they are often insufficient in fostering active and interactive learning environments (Arsyad, 2013). According to Daryanto (2016), conventional instructional media have limited effectiveness in promoting students' motivation and engagement, particularly in subjects involving abstract concepts such as mathematics.

Mathematics is a lesson that plays an important role in developing logical, systematic, and critical thinking skills. However, mathematics is often perceived as difficult and less engaging by many students because much of its content is abstract in nature (Unaenah et al., 2023). One of the mathematical topics that students often find challenging is sequences and series. This topic requires students to understand numerical patterns, relationships between terms, and the application of formulas in problem-solving. In the learning process, however, students are frequently required to memorize formulas without fully understanding the underlying concepts. This issue occurs because instruction is still largely

dominated by lecture-based methods and repetitive exercises, with limited support from adequate visualizations. The condition indicates the need for learning media that can provide a more interactive, engaging, and contextual learning experience. One technology that can address this need is Augmented Reality (AR). According to Aditia (2024), Augmented Reality is a technology that integrates two-dimensional or three-dimensional virtual objects into the real-world environment in real time, allowing users to simultaneously perceive a combination of the real world and the virtual world.

Augmented Reality (AR) offers several advantages compared to other learning media. AR is capable of displaying more realistic three-dimensional objects, making abstract concepts easier for students to understand because they can interact directly with virtual objects, resulting in a more active and less monotonous learning process (Mahendra et al., 2025). AR can also enhance students' motivation and interest in learning by providing engaging and enjoyable learning experiences (Yusa et al., 2023; Zahara et al., 2025). Furthermore, AR can be accessed through smartphones, making it more practical and convenient to use anytime and anywhere. According to Zhang et al. (2024), using Augmented Reality (AR) in education can enhance concept visualization, student engagement, and provide a more memorable learning experience. Their study indicates that AR is effective in helping students understand abstract concepts through interactive simulations and visualizations. Furthermore, Tuta and Luić (2024) reported that the implementation of AR has a positive impact on students' learning outcomes, as it makes the learning process more engaging and easier to understand.

Another advantage of Augmented Reality (AR) is to create immersive learning experiences. Immersive learning enables students to feel directly involved in the learning process, resulting in a more meaningful understanding of concepts (Damayanti et al., 2025). The use of AR in mathematics education can facilitate the visualization of concepts that are difficult to explain verbally or through two-dimensional images.

In this research, an Augmented Reality (AR)-based learning media was developed using Delightex Edu. Delightex Edu is a digital learning platform that supports the development of Virtual Reality (VR) and Augmented Reality (AR) applications for interactive learning. The platform enables teachers to create three-dimensional objects, simulations, and virtual environments easily without requiring advanced programming skills. Delightex Edu offers various features that support modern learning practices. Teachers can develop interactive learning media through 3D objects, animations, and simulations that can be accessed using smartphones or computers. Furthermore, Delightex Edu promotes exploration-based learning, allowing students to engage actively in the learning process and develop independent learning skills. The use of Delightex Edu in mathematics learning is highly relevant because it helps students understand abstract concepts through concrete visualizations. In the topic of sequences and series, Augmented Reality (AR) can be used to display number patterns in the form of visual objects that move and develop according to specific patterns. These visualizations enable students to better understand the relationships between terms, common differences, common ratios, and the concept of series in a more realistic and meaningful way.

Previous studies have shown that the use of Augmented Reality (AR) in education has a positive impact on students' learning outcomes and motivation. Research by Anisyah et al. (2024) demonstrated that AR-based learning media effectively improve learning outcomes and make the learning process more enjoyable. Similarly, Sakr and Abdullah (2024) found that AR enhances student engagement by providing a more interactive learning experience. Furthermore, a study by Zhang et al. (2024) on the application of AR in STEM education revealed that AR technology has significant potential to support 21st-century learning. The use of AR not only facilitates the visualization of abstract concepts but also promotes students' creativity and exploratory skills. Although various studies have examined the use of Augmented Reality (AR) in education, research on the development of AR-based interactive learning media assisted by Delightex Edu for teaching sequences and series remains limited, and the development of AR learning media using Delightex Edu is still relatively scarce. Most previous studies have primarily focused on the impact of AR implementation on the learning process. Therefore, this study is important to conduct in order to provide an innovative mathematics learning medium that is more engaging and aligned with current educational needs. Furthermore, the developed media not only present three-dimensional objects but also offer an interactive learning experience that can enhance students' understanding and engagement in learning.

This research aims to develop an Augmented Reality (AR)-based interactive learning media assisted using Delightex Edu for the topic of sequences and series that is valid, practical, and effective for implementation in the teaching and learning process. The development of this learning media is expected to provide an innovative solution that aligns with current advancements in educational technology, particularly in mathematics learning on the topic of sequences and series.

2. RESEARCH METHOD

This research uses the term Research and Development (R&D). R&D is a research method used to develop products through a series of systematic development stages, followed by testing to determine the validity, practicality, and effectiveness of the products developed (Sugiyono, 2018). The development model applied in this study refers to the Borg and Gall model, which has been modified into eight stages of research as shown in the following chart:

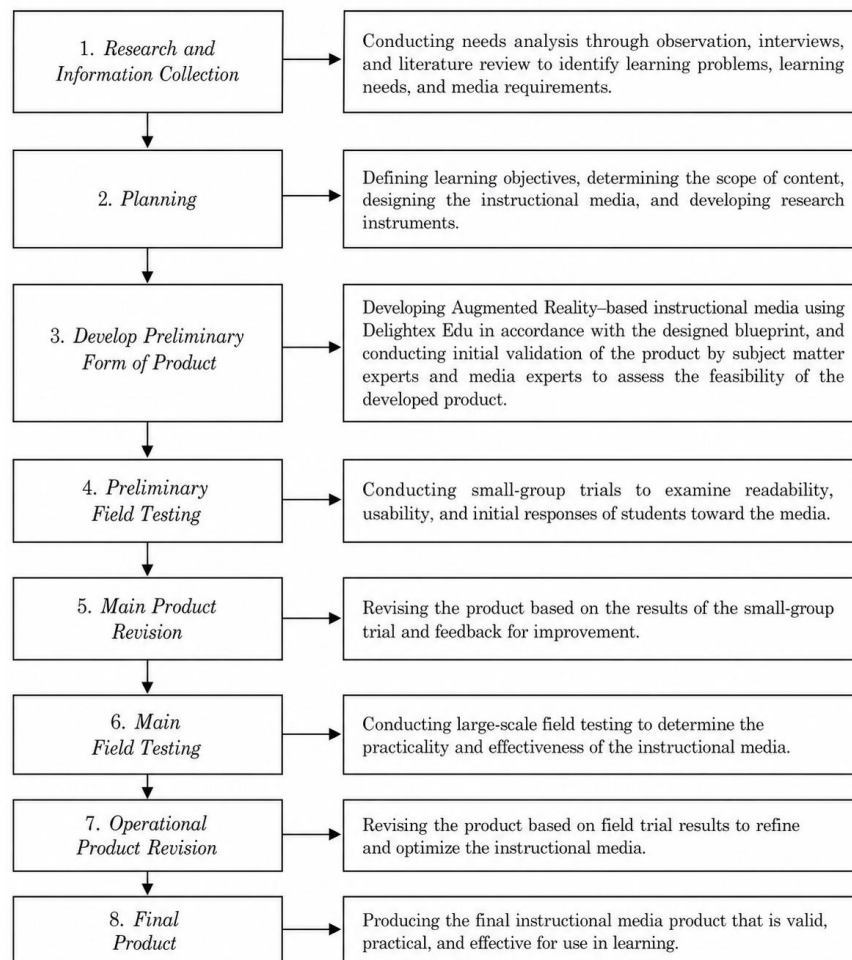


Figure 1. Modified Borg and Gall Model Research Stages Chart

This research was conducted at SMA Negeri 6 Lhokseumawe, located in Baloy-Punteuet Village, Blang Mangat District, Lhokseumawe City, with the subject being a class X student. Observations and interviews were used during the needs analysis stage, while questionnaires were used to assess the validity and practicality of the media. The test is used to measure the level of effectiveness of the developed learning media. Data analysis techniques are carried out descriptively, quantitatively, and qualitatively. Practicality data were collected through a questionnaire of student responses after using the learning media, while effectiveness data were collected through student learning outcome tests. Validity and practicality analysis is carried out by calculating the percentage of empirical scores against the maximum score using the formula:

$$P = \frac{TSe}{TSh} \times 100\%$$

Description:

TSe = the total value of the results of filling out the questionnaire

TSh = the maximum number of results of filling out the questionnaire.

The percentage results are then classified into the categories of very valid, valid, less valid, and invalid, as well as very practical, practical, less practical, and impractical. The following criteria must be met:

Table 1. Criteria for Validity and Practicality

Validity/practicality value (%)	Criteria for Validity
$85 < x \leq 100$	Highly valid/practical (no improvement)
$70 < x \leq 85$	Valid/practical (with minor improvements)
$50 < x \leq 70$	Invalid/impractical (used with major fixes)
$0 \leq x \leq 50$	Invalid/Impractical, or not to be used
Modified from: (Sugiyono, 2018)	

Meanwhile, the effectiveness analysis was carried out based on the percentage of completeness of students' learning outcomes using the formula:

$$E = \frac{\sum \text{students complete}}{\sum \text{All Student}} \times 100\%$$

Learning media is deemed effective if the percentage of students' learning completeness falls into the effective or very effective category, according to the set criteria.

3. RESULTS AND DISCUSSION

3.1 Research Results

This development research resulted in Delightex Edu-assisted Augmented Reality (AR)-based learning media developed using the Borg and Gall model, which was modified into 8 stages of research. The media developed is designed to help students understand learning materials in a more concrete, interactive, and engaging way by visualizing three-dimensional objects using AR technology. Media development is carried out in stages, from needs analysis to the production of a final product that is valid, practical, and effective for learning. The results of the research at each stage are explained as follows.

The initial stage of this study, namely the Research and Information Collecting phase, was conducted through classroom observations, interviews, and a literature review. Classroom observations were conducted to examine the existing learning process and identify instructional conditions. The observation results revealed that the learning activities were predominantly teacher-centered, relying heavily on lecture-based instruction and conventional learning media. Consequently, students tended to play a passive role during the learning process. Interviews with teachers indicated that students frequently struggled to understand abstract concepts due to the limitations of the classroom learning media. Furthermore, the integration of technology-based learning media remained limited, resulting in a learning environment lacking interactive experiences. In addition, a literature review was conducted by examining scholarly journals, books, and previous studies on the development of Augmented Reality (AR)-based learning media. The literature review found that AR-based media can enhance students' motivation, engagement, and learning outcomes by providing realistic, interactive visualizations of learning materials. Based on the results of the needs analysis, an Augmented Reality-based learning medium was developed using Delightex Edu to facilitate students' understanding of learning materials in a more effective, engaging, and meaningful way.

The second stage is planning, which involves determining learning outcomes and objectives, tailoring materials to learning outcomes and student characteristics, designing media displays, and developing research instruments. The media is designed to contain learning materials, three-dimensional (3D) objects, interactive animations, learning videos, and practice questions that are adjusted to the learning indicators. In addition, research instruments were prepared in the form of material expert validation sheets, media expert validation sheets, student response questionnaires, and learning outcome test instruments. All instruments are prepared in accordance with the research objectives and assessment indicators. Subsequently, during the Develop Preliminary Form of Product stage, the initial version of the learning media was developed using the Delightex Edu application, leveraging its Augmented Reality (AR) features, which can be accessed on smartphones. The developed media integrates various multimedia elements, including text, images, audio, animations, and three-dimensional (3D) objects, to create a more engaging and interactive learning experience. The interface was designed to be simple and user-friendly, enabling students to operate the media independently with minimal difficulty. Several screenshots of the developed learning media are presented in the [Figure 2](#).

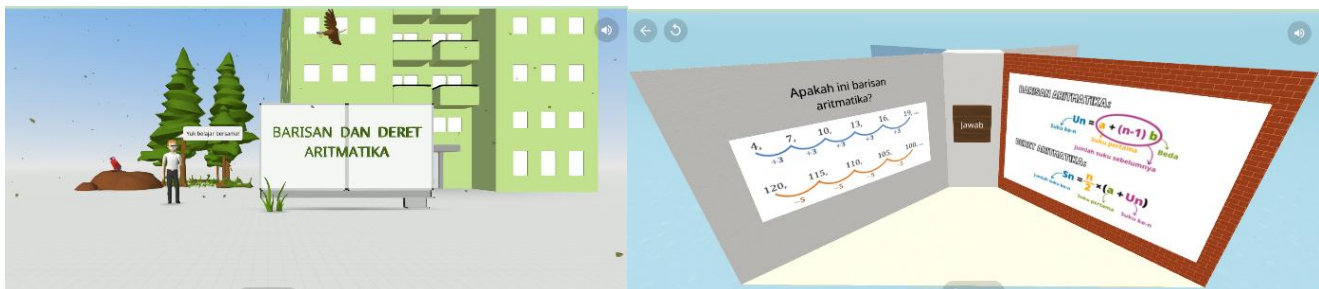


Figure 2. AR-based Learning Media Display Using Delightex Edu

The product is then validated by material and media experts to assess its feasibility. The assessment of material experts includes aspects of material suitability, conceptual accuracy, material completeness, and language. The following are the results of the validation of material experts in detail from each aspect:

Table 2. Material Expert Validation Results

No	Assessment Aspects	Percentage	Criteria
1	Material suitability	92%	Highly valid
2	Concept accuracy	91%	Highly valid
3	Material completeness	91%	Highly valid
4	Language	87%	Highly valid
	Average	90,25%	Highly valid

The results of the validation by material experts showed an average of 90.25% in the very valid category. This shows that the material presented aligns with the learning objectives. The validator also said that the use of Augmented Reality objects helps to present abstract material more concretely. However, there are some suggestions for improvement, such as adding contextual examples and simplifying certain terms to make it easier for students to understand. Meanwhile, the assessment by media experts includes appearance, ease of use, visual quality, interactivity, and media suitability. The following are the results of the validation of media experts in detail:

Table 3. Media Expert Validation Results

No	Assessment Aspect	Percentage	Criteria
1	Media Views	92%	Highly valid
2	Ease of Use	90%	Highly valid
3	Media Interactivity	89%	Highly valid
4	Visual Quality	90%	Highly valid
5	Media Suitability	88%	Highly valid
	Average	89,8%	Highly valid

The results of the validation by media experts also show that AR-based learning media is very valid, with an average percentage of 89.8%, making it suitable for use without major revisions. These results show that the media has an attractive visual appearance, is easy to use, offers a high level of interactivity and visual quality, and provides clear navigation. The media is considered capable of increasing students' interest in learning because it effectively combines visual and technological elements. Revisions made based on validators' suggestions include adjusting the layout of the navigation buttons, improving the size of three-dimensional objects, and improving color composition in both images and text. After validation, the media are tested in small groups (preliminary field testing). A small-group trial was conducted with 10 students to determine the readability, ease of use, and initial responses to the developed learning media. Based on small-group trials, students showed strong enthusiasm for using AR media. As a result of the interview, students stated that the media is more interesting than ordinary learning media because it is able to display objects in a real and interactive way. In addition, students also stated that the media is easy to use and helps them understand the learning material faster. However, there are some suggestions for improvement, such as adding instructions for use and adjusting the text size to make it easier to read.

The next stage in this study is Main Product Revision. The product revision stage is carried out based on the results of small group trials and input from validators. Some of the revisions include: (1) Clarifying the menu and navigation display; (2) Improve the visual quality of three-dimensional objects; (3) Adjust the size of the text to make it easier to read; and (5) Adding material explanations to several parts of the media. The revision was carried out to improve the quality of the media so that it is more optimal for use in the field trial stage. After revision, the next stage is the main field test or large group trial. A large group trial was conducted on 30 students to determine the level of practicality and effectiveness of learning media. The following are the details of the results of filling out the practicality questionnaire:

Table 4. Student Response Results

No	Assessment Aspect	Percentage	Criteria
1	Ease of use	91%	Very practical
2	Media attractiveness	93%	Very practical
3	Clarity of the material	88%	Very practical
4	Interactivity	90%	Very practical
5	Learning motivation	91%	Very practical
	Average	90,6%	Very practical

Based on the results of the student response questionnaire above, a practicality percentage of 90.6% was obtained with the category of very practical. This shows that the media is easy to use, has an appealing appearance, and can increase students' motivation to learn. Meanwhile, the effectiveness of media was obtained through tests of students' learning outcomes after using AR-based learning media. The results of the learning test showed that 26 out of 30 students obtained a score of ≥ 75 , or a learning completeness rate of 86.7%, and were included in the very effective category. Thus, Delightex

Edu's Augmented Reality-based learning media was found to be effective in the learning process.

The seventh stage of this study was Operational Product Revision. This stage was conducted based on the results of the large-group field testing and aimed to refine the instructional media before producing the final product. The field testing findings indicated that no significant issues or critical comments were identified regarding the use of the developed instructional media. Nevertheless, the students provided several suggestions for improvement, which were taken into consideration during the revision process. The revisions focused on enhancing animations, improving the layout of navigation buttons, and optimizing the display of Augmented Reality (AR) objects. These improvements were implemented to enhance visual quality, ensure media stability, and improve user comfort during the learning process. Subsequently, at the Final Product stage, the study produced a finalized Augmented Reality-based instructional medium, supported by Delightex Edu, that had undergone comprehensive validation, revision, and field testing. Based on expert evaluations, student responses, and effectiveness testing, the developed media met the criteria for validity, practicality, and effectiveness. Therefore, it is considered suitable for use as an instructional medium to support a more interactive and meaningful learning experience.

3.2. Discussion

The results of the study show that Delightex Edu's Augmented Reality-based learning media has been successfully developed through the stages of the Borg and Gall model, which have been modified into eight stages, namely research and information collection, planning, developing a preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revision, and final product. Development is carried out systematically, from needs analysis to the production of final products that meet the criteria of validity, practicality, and effectiveness. Through these stages, the resulting products not only focus on technological display but also consider the suitability of the material, students' needs, and the effectiveness of its use in learning. During the needs analysis stage, it was found that students had difficulty understanding abstract material due to limitations in the learning media used. Therefore, AR technology was chosen because it can display three-dimensional objects in real life on a smartphone, helping students understand the concept of learning more easily. The validation results for material experts were 90.25% in the very valid category, while those for media experts were 89.8% in the very valid category. These results show that the developed media have met the criteria for appearance, interactivity, visual quality, and suitability to the learning objectives. In addition, the results of the practicality test showed a 90.6% score in the very practical category. Students stated that the media was easy to use, interesting, and helped them understand the learning material. The high practicality of media is also influenced by the use of smartphones, which are familiar to students.

The results of the effectiveness test showed that the students' learning completeness reached 86,7% with the category of very effective. This shows that AR-based learning media can improve students' understanding of concepts and learning outcomes. The use of three-dimensional object visualization helps students understand material that was previously difficult to understand through verbal explanations alone. Three-dimensional object visualization and interactive animation make it easier for learners to understand concepts that were previously considered difficult and abstract. In addition, the use of AR media increases students' motivation and involvement during the learning process. This is in line with research by Nur et al. (2026), which found that AR-based learning media is effective in increasing students' interest and learning outcomes through interactive and immersive learning experiences. Research by Siti Anisyah et al. (2024) also explains that AR can create more engaging learning and improve student learning outcomes. In addition, Hartono's (2022) research shows that the use of AR applications positively influences students' learning outcomes in physics. Thus, Delightex Edu's Augmented Reality-assisted learning media is declared suitable for use because it meets valid, practical, and effective criteria. This media can be an innovative alternative to support a more engaging, interactive, and meaningful learning process for students.

4. CONCLUSION

Based on the research conducted in developing an Augmented Reality-based interactive learning media assisted by Delightex Edu using the Borg and Gall model modified into eight stages, the product was found to be highly valid based on the validation results from both material experts and media experts. In addition, the practicality test results obtained from students' response questionnaires indicated that the media was categorized as very practical. Students stated that the media was easy to use, engaging, and supported their understanding of the learning materials. The learning achievement test results showed that 26 out of 30 students achieved scores of at least 75, resulting in a learning mastery percentage of 86.7%. Therefore, the Augmented Reality-based learning media assisted by Delightex Edu was considered effective for use in the learning process. These findings indicate that AR-based learning media can improve students' learning outcomes. Thus, the developed learning media are considered valid, practical, and effective, and it supports the mathematics learning process.

REFERENCES

- Anisayah, S., Imlessih, M. M. M., Kusumaningrum, S., Haryati, N. S., & Santoso, J. T. B. (2024). Augmented reality: Interactive and fun learning media to improve student learning outcomes. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, 8(2). <https://doi.org/10.21831/jk.v8i2.70167>
- Aditia, R. (2024). Peran dan Tantangan Teknologi Augmented Reality dalam Meningkatkan Pengalaman Pengguna Media. *Amerta: Jurnal Ilmu Sosial dan Humaniora*, 4(1), 35-43. <https://ejournal.amertamedia.co.id/index.php/amerta/article/view/197>
- Arsyad, A. (2013). *Media pembelajaran* (edisi revisi). Jakarta: Raja Grafindo Persada.
- Baharuddin & Hatta. (2024). Transformasi Manajemen Pendidikan: Integrasi Teknologi dan Inovasi dalam Meningkatkan Efektivitas Pembelajaran. *Jurnal Review Pendidikan dan Pengajaran (JRPP)*, 7(3), 7535–7544. <https://doi.org/10.31004/jrpp.v7i3.29703>
- Damayanti, A., Indrayana, T., Rahmawati, S. L., Puspitasari, A., & Zahroh, U. A. (2025). Implementasi Media Pembelajaran Virtual Reality Games untuk Membangun Motivasi Belajar Siswa Sekolah Dasar. *Jurnal PGSD Indonesia*, 11(2), 65-74. <https://journal.upy.ac.id/index.php/JPI/article/view/9082>
- Daryanto. (2016). *Media pembelajaran: Peranannya sangat penting dalam mencapai tujuan pembelajaran* (Edisi revisi ke-2). Yogyakarta: Gava Media.
- Hartono. (2022). Pengaruh Aplikasi Augmented Reality Terhadap Hasil Belajar Fisika SMA Negeri 1 Karangrayung Tahun Pelajaran 2021/2022. *Jurnal Penelitian Pembelajaran Fisika*, 13(1), 145-154. <https://doi.org/10.26877/jp2f.v13i1.11716>
- Mahendra, D., Subroto, D. E., Barokah, B., Mudoifah, E., & Mudafiah, D. (2025). Penerapan Augmented Reality untuk meningkatkan motivasi belajar peserta didik. *Jurnal Padamu Negeri*. <https://doi.org/10.69714/958k3814>
- Nur, A. M., Andrizal, A., Maksun, H., Sugiarto, T., Wagino, W., & Hidayat, N. (2026). Pengaruh Media Pembelajaran Berbasis Augmented Reality Terhadap Minat dan Hasil Belajar Peserta Didik: Systematic Literature Review. *Jurnal Ilmiah Profesi Pendidikan*, 11(1), 904–919. <https://doi.org/10.29303/jipp.v11i1.4760>
- Perdana, F. F. H., Azhar, R., Musyafa, H. R., Rahayu, G. S. (2025). Penerapan pembelajaran berbasis teknologi dalam mengembangkan keterampilan abad 21. *Sibatik Journal*, 4(11), 3627–3642. <https://doi.org/10.54443/sibatik.v4i11.3593>
- Sabil, M. A. (2023). Kurikulum Merdeka: Tantangan Dan Peluang Di Era Digital. *Pendas: Jurnal Ilmiah Pendidikan Dasar* 8, 10. <https://doi.org/10.23969/jp.v8i3.11520>
- Sakr, A., & Abdullah, T. (2024). Virtual, augmented reality and learning analytics impact on learners and educators: A systematic review. *Education and Information Technologies*, 29, 19913–19962. <https://doi.org/10.1007/s10639-024-12602-5>
- Septikasari, D., Nurlaila, Saleh, F., Inayah, S., Warikar, A., Suwarningsih, T., Muslimin, & Suardi, M. (2025). *Inovasi Pembelajaran Guna Menciptakan Pengalaman Belajar yang Asyik dan Menarik*. Padang : CV Pustaka Inspirasi Minang.
- Sugiyono. (2018). *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Bandung: Alfabeta Bandung.
- Suparyadi, Rafi'i, Ningsih, T. S., Irawan, N., & Sumirat, P. (2025). Digitalisasi media pembelajaran sebagai strategi penguatan komunikasi budaya dan keterampilan komunikasi peserta didik. *Jurnal Pendidikan Indonesia: Teori, Penelitian dan Inovasi*, 5(4), 65–75. <https://doi.org/10.59818/jpi.v5i4.1789>
- Tuta, J., & Luić, L. (2024). D-learning: An experimental approach to determining student learning outcomes using augmented reality (AR) technology. *Education Sciences*, 14(5), 502. <https://doi.org/10.3390/educsci14050502>
- Unaenah, E., Sulaiman, A. M. S., & Wardhana, F. P. (2023). Analisis kesulitan peserta didik dalam memahami konsep matematika. *Seroja: Jurnal Pendidikan*, 2(4). <https://doi.org/10.572349/seroja.v2i4.816>
- Yusa, I. W., Wulandari, A. Y. R., Tamam, B., Rosidi, I., & Setiawan, A. Y. B. (2023). Development of Augmented Reality (AR) learning media to increase student motivation and learning outcomes in science. *Jurnal Inovasi Pendidikan IPA*, 9(2). <https://doi.org/10.21831/jipi.v9i2.52208>
- Zahara, Y., Mahmuzah, R., Sinaga, N. A., Ningtiyas, F. A. (2025). Penerapan Augmented Reality Sebagai Inovasi Media Ajar Untuk Meningkatkan Minat Belajar Siswa. *Jurnal Pendidikan Matematika Malikussaleh (JPMM)*, 5(4), 485-494. <https://doi.org/10.29103/jpmm.v5i4.25056>
- Zhang, Y., Feijoo-Garcia, M. A., Gu, Y., Popescu, V., Benes, B., & Magana, A. J. (2024). Virtual and augmented reality in science, technology, engineering, and mathematics (STEM) education: An umbrella review. *Information*, 15(9), 515. <https://doi.org/10.3390/info15090515>