

Development of Flashcard Media Based on Augmented Reality (AR) on Solar System Material for Grade VI Elementary School

Nurul Fitriyani, Peduk Rintayanti, Moh. Salimi

Universitas Sebelas Maret
nurulfitriyani.spd@student.uns.ac.id

Article History

accepted 1/8/2025

approved 1/9/2025

published 1/10/2025

Abstract

In this digital era, technological developments are rapidly advancing and undoubtedly influencing various aspects of life. One such area is education. Driven by these rapid technological advancements, the education sector is required to adapt to technological progress in order to create a more effective and interactive learning process that engages students and meets the needs of the times. This study aims to conduct a literature review analysis on the use of augmented reality (AR) media. The method used in this study is a Systematic Literature Review of 20 articles, namely 10 national articles and 10 international articles from 2020 to 2025. The articles were selected according to the criteria to be analysed. The results show that augmented reality (AR)-based learning media has consistently proven to be feasible, practical, and effective in various subjects. Augmented reality (AR) can increase motivation, conceptual understanding, critical thinking skills, numeracy literacy, interest in reading, and even student learning outcomes. Validation from subject matter experts, media experts, and users generally shows a rating of good to very feasible, with positive responses from both teachers and students. Thus, AR can be an innovative solution to make learning more interactive, interesting, and meaningful at various levels of education.

Keywords: *Augmented Reality, Flash Card, Solar System, Elementary School*

Abstrak

Di era digital ini, perkembangan di bidang teknologi sangatlah pesat dan tentunya memberikan pengaruh pada aspek kehidupan. Salah satunya adalah pada bidang pendidikan. Dilatar belakangi oleh perkembangan pesat dari teknologi tersebut sehingga dunia pendidikan dituntut dapat beradaptasi dengan kemajuan teknologi agar dapat menciptakan proses pembelajaran yang lebih efektif, interaktif, menarik siswa untuk aktif, dan sesuai dengan kebutuhan zaman. Penelitian ini bertujuan untuk melakukan analisis kajian literatur tentang penggunaan media berbasis *augmented reality (AR)*. Metode yang digunakan dalam penelitian ini adalah metode *Systematic Literature Review* pada 20 artikel yaitu 10 artikel nasional dan 10 artikel internasional dengan rentang tahun 2020-2025. Artikel yang diambil dan diseleksi sesuai dengan kriteria yang akan dianalisis. Hasil penelitian menunjukkan bahwa media pembelajaran berbasis *augmented reality (AR)* secara konsisten terbukti layak, praktis, dan efektif dalam berbagai mata pelajaran. *Augmented reality (AR)* mampu meningkatkan motivasi, pemahaman konsep, keterampilan berpikir kritis, literasi numerasi, minat membaca, hingga hasil belajar peserta didik. Validasi dari ahli materi, media, dan pengguna umumnya menunjukkan kategori baik hingga sangat layak, dengan respon positif dari guru maupun siswa. Jadi, AR dapat menjadi solusi inovatif untuk menjadikan pembelajaran lebih interaktif, menarik, dan bermakna di berbagai jenjang pendidikan.

Kata kunci: *Augmented Reality, Flash Card, Tata Surya, Sekolah Dasar*



INTRODUCTION

Basic education is an important foundation in shaping the cognitive, affective, and psychomotor abilities of students and is one of the factors supporting the progress of the nation. According to the 2003 National Education System Law, education is a conscious and planned effort to create an environment and learning process that enables students to actively develop their potential. One of its objectives is to master the skills needed for oneself, society, the nation, and the state. In achieving this objective, the success of the learning process is greatly influenced by various factors, including the role of teachers, students, the availability of educational facilities and infrastructure, and a supportive learning environment.

In the digital age, technological integration has become a necessity in learning. Generation Alpha demands a new approach because they have grown up surrounded by technology. Teachers need to choose appropriate models, methods, and media, one of which is augmented reality (AR). AR provides interactive, enjoyable, and immersive learning that can increase motivation, activity, and learning outcomes (Verdiatmoko, 2025) and supports the development of curiosity, critical thinking, and understanding of scientific concepts that are close to everyday life (Parisu, 2025). In primary school science education, particularly in abstract topics such as the Solar System, AR helps bridge the gap in direct experience and facilitates the understanding of scientific concepts.

One form of media that can be combined with augmented reality (AR) technology is flashcards. According to Akbar (2022), flashcards are learning aids in the form of cards that usually contain simple and concise information and are often used to aid memory or learning basic concepts. By combining flashcards with augmented reality (AR) technology, the information on the cards can not only be read but also visualised in the form of 3D animations. This visualisation can strengthen students' understanding of abstract concepts in Solar System material. The use of augmented reality (AR)-based flashcards has the advantage of being attractive and easy to use (Yasin, et al., 2023). This is in line with Piaget's constructivism theory, which emphasises the importance of direct learning experiences, as well as Vygotsky's theory of the zone of proximal development (ZPD), where AR can serve as visual scaffolding to bridge abstract concepts. Furthermore, according to Mayer's multimedia theory, the integration of text and 3D visuals in AR strengthens students' understanding.

According to Khosiyono (2022), augmented reality (AR)-based learning media is also in line with the technology-enhanced learning (TEL) approach, which places technology as a tool to improve the quality of the learning process and outcomes. In the context of science learning, augmented reality (AR)-based visualisation has been proven to increase students' motivation, interest, and understanding of scientific phenomena that cannot be observed directly. Although the potential of augmented reality (AR) technology in education has begun to be recognised, its use in primary education in Indonesia is still relatively low. This is due to several factors, including limited access to digital devices and a lack of training for teachers.

The use of augmented reality (AR) allows students to see and interact with virtual objects that appear to be in the real world. These realistic forms can increase student motivation and learning outcomes. According to research conducted by Danti (2023), augmented reality (AR) can have an impact on student learning outcomes. Augmented reality (AR) media can provide opportunities to hone students' abilities, such as critical thinking and imagination, and provide stimuli that can stimulate improved learning outcomes. Based on the results of the study, it was concluded that there was a

significant effect of the use of Augmented Reality (AR) learning media in science subjects on the learning outcomes of third-grade students at MIN 2 Madiun City.

Although the potential of augmented reality (AR) technology in education has begun to be recognised, its utilisation at the primary education level in Indonesia is still relatively low due to a lack of infrastructure, insufficient training for teachers, and the perception that creating or using augmented reality media tends to be time-consuming. This literature review provides an understanding and new insights into the development of augmented reality (AR)-based media, the ease of its development and long-term use, and the ease with which augmented reality (AR) media can be used anywhere and anytime.

METHODS

The method used in this research is a literature review or systematic literature review (SLR). According to Petticrew, et al. (2008) systematic literature review is a form of study that aims to identify, evaluate, and synthesise relevant research on a particular topic with evidence that has been scientifically tested. The process of searching for articles on Google scholar with criteria: 1) keywords flashcard media development and augmented reality, 2) articles published between 2020-2025, 3) derived from 10 National articles and 10 International Articles from previous research that help in understanding relevant topics in different studies.

The steps of systematic literature review (SLR) developed by Petticrew, et al. (2008) are 1) formulating research questions or hypotheses clearly and relevantly, 2) identifying the type of research, 3) conducting a search for relevant articles, 4) selecting search results according to criteria, 5) critically evaluating the selected articles, 6) synthesising the results of different studies, and 7) publishing the results of the review. To produce a comprehensive and relevant review, these steps must be carried out systematically, transparently, and accountably.

Table 1.1 Database Search Keywords

Database	Keywords	Number of Articles
Google scholar	pengembangan media <i>flashcard</i> berbasis <i>augmented reality</i>	1.260
number		1.260

Article searches using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart were conducted in four stages, namely identification, screening, eligibility, and data inclusion. These stages are outlined in Figure 1 below:

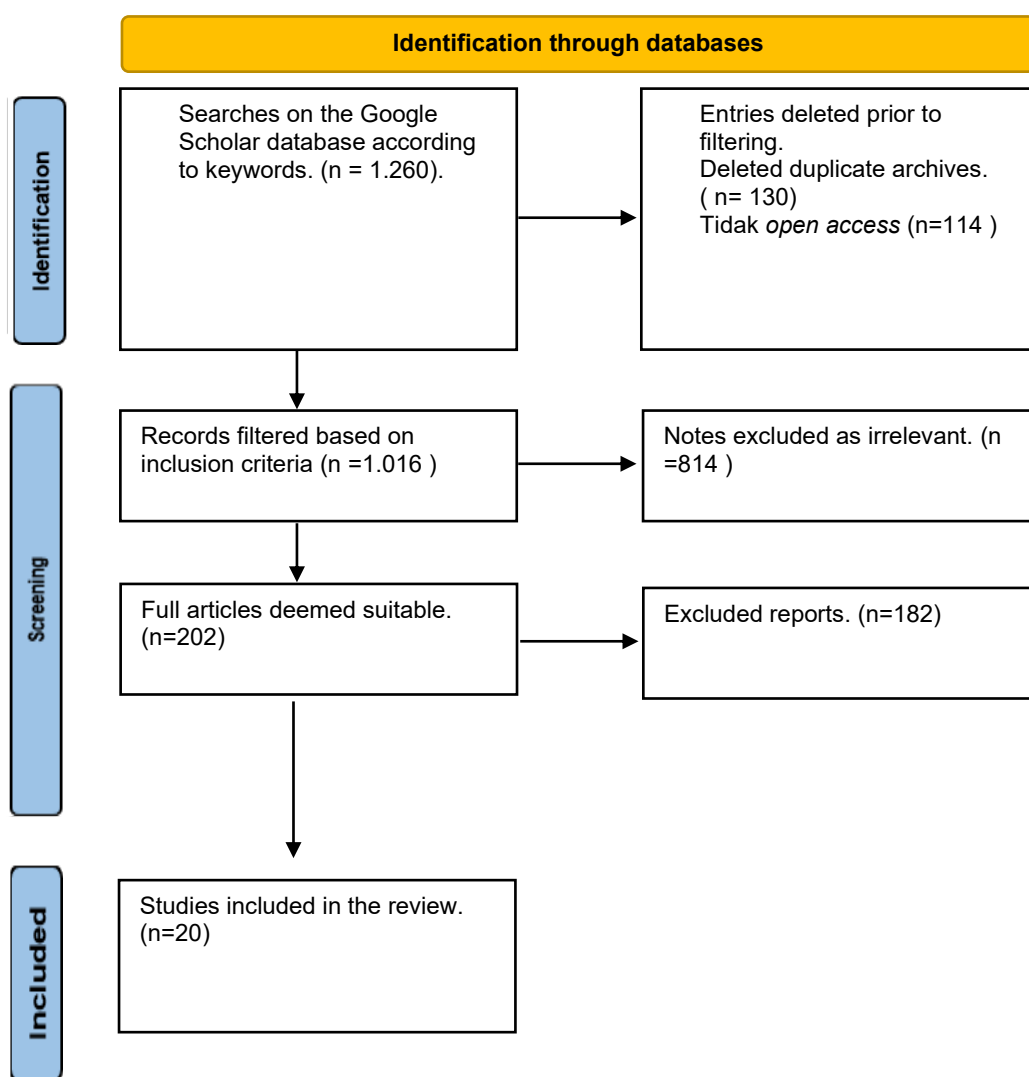


Figure 1. PRISMA Diagram

RESULTS AND DISCUSSION

Learning media essentially serves as an intermediary between teachers and students to make the learning process more effective. Gagne in Sadiman (2007) emphasises that media is not merely a tool, but part of the learning environment that can stimulate students to actively participate. From this definition, it is clear that the role of media is not only technical (hardware and software), but also pedagogical in building learning experiences.

Flashcards, as a conventional medium, have proven to be effective in sharpening memory due to their simple, visual presentation and direct association between symbols or images and the concepts being studied. However, this medium is still limited in terms of interactivity and deep student engagement.

In contrast, Augmented Reality (AR) enables the integration of the real world with virtual objects (2D/3D) in real-time and interactively. According to Azuma in Sari (2023), the strength of AR lies in its ability to provide a more immersive and contextual learning experience. When compared to flashcards, AR not only displays information but also allows students to interact directly with the material in more depth.

From a learning media perspective, AR falls into the category of audio-visual aids (AVA) because it relies on the senses of sight and hearing to reinforce understanding.

However, the added value of AR compared to traditional AVA media lies in its interactivity, realism, and emotional engagement of students. This is in line with the goals of modern education, which emphasises meaningful, active, and contextual learning.

The results of the analysis of the literature review, both national and international, agree that augmented reality (AR) media is valid, practical, and effective for use in learning. National articles emphasise media development and user response, while international articles highlight the effects of experiments on learning outcomes, motivation, participation, and literacy. This is relevant to Piaget's theory, which explains that primary school children are in the concrete operational stage of development, making augmented reality particularly suitable for helping students understand the material. This is in line with Vygotsky's constructivism theory and Mayer's multimedia theory because augmented reality (AR) can function as digital scaffolding that helps students understand material that is initially difficult to understand on their own, with the support of interactive visualisation. Augmented reality (AR) media combines text, audio, and images or animations to support multimedia learning in accordance with Mayer's principles. The results of the literature review also assist teachers in utilising augmented reality (AR)-based flashcards as a concrete bridge to the abstract, digital assistance through group discussions, and interactive multimedia that combines text, audio, and visuals, making science learning in primary schools easier to understand, more interesting, and meaningful. However, the implementation of augmented reality (AR) is more effective overseas because it is supported by infrastructure, curriculum, teachers, and students who are ready. In Indonesia, implementation is still low due to technical and pedagogical obstacles, such as teacher training and systems, policies, and costs.

Based on a literature review or systematic literature review sourced from 10 national journals and 10 international journals covering the period from 2020 to 2025, the results are sufficient to explain the expected objectives. The following are the results of a search of several relevant articles related to augmented reality (AR) based learning media:

Table 1. Relevant National Articles

No	Article	Reference
1	Qorimah, E. N., Laksono, W. C., Hidayati, Y. M., & Desstya, A. (2022). The need for Augmented Reality (AR) Based Learning Media Development on Food Chain Material. <i>Journal of Pedagogy and Learning</i> , 5(1), 57-63.	https://ejournal.undiksha.ac.id/index.php/JP2/article/view/46290
2	Panduwinata, L. F., Wulandari, R. N. A., & Zanky, M. N. (2021). Development of augmented reality (AR) based learning media on archive storage procedures material. <i>Lectura: Journal of Education</i> , 12(1), 15-28.	https://journal.unilak.ac.id/index.php/lectura/article/view/5958
3	Listiawan, T., & Antoni, A. (2021). Development of augmented reality (AR) based mathematics learning media on geometry transformation material. <i>JP2M (Journal of</i>	https://jurnal.stkippgritulungagung.ac.id/index.php/jp2m/article/view/2099/0

	Mathematics Education and Learning), 7(1), 43-52.	
4	Prabowo, E., & Wakhudin, W. (2024). Development of Augmented Reality (AR) Media to Increase Student Learning Motivation in IPAS Class 4 SD Negeri 3 Linggasari. Indonesian Journal of Education and Learning (JPPI), 4(2), 591-604.	https://www.jurnal.bimaberilmu.com/index.php/jppi/article/view/552
5	Wibowo, V. R., Putri, K. E., & Mukmin, B. A. (2022). Development of augmented reality-based learning media on animal classification material for grade V elementary school. PTK: Journal of Classroom Action, 3(1), 58-69.	https://jurnal.ciptamediaharmoni.id/index.php/ptk/article/view/119
6	Elvina, T., Miranda, D., & Lukmanulhakim, L. (2024). Development of Augmented Reality Based Thematic Flashcards for 5-6 Years Old Children. Journal of Education, 2(1), 57-61.	https://edukhasi.org/index.php/edu/article/view/256
7	Juliana, L. N. (2024). The Development Of Augmented Reality-Based Flashcard Media In Indonesia Language Learning Class V In Basic Schools (Doctoral dissertation, UIN RADEN INTAN LAMPUNG).	https://repository.radenintan.ac.id/34655/
8	Nina, Q. A. Y., Fatih, M., & Alfi, C. (2023). Development of Augmented Reality-Based Flashcard Media on Force Materials to Improve Critical Thinking Ability of Grade IV Students. JIIP-Scientific Journal of Education Sciences, 6(11), 8558-8564.	https://www.jiip.stkipyapisdompu.ac.id/jiip/index.php/JIIP/article/view/2597
9	Khasanah, S. U. (2025). Development of AR-based Flashcards Mathematics Learning Media (Augmented Reality) on Fraction Materials. Integrative Perspectives of Social and Science Journal, 2(2 March), 1528-1536.	https://ipssj.com/index.php/ojs/article/view/195
10	Aini, L. N., & Guntur Nurcahyanto, S. T. (2025). Development of Augmented Reality (AR)-based E-Flashcard Media on Biology Learning Materials of Class XI Defence System (Doctoral dissertation, Universitas Muhammadiyah Surakarta).	https://eprints.ums.ac.id/134674/

Based on the results of the literature review conducted on relevant national articles, the following are as follows:

1. Based on literature 1:

Based on the results of research conducted by Qorimah, et al. (2022) in the form of a needs analysis of augmented reality media development, it states that teachers and students want to use augmented reality (AR) media as a solution in dealing with the food chain learning process because food chain material has 12.5% concrete and 87.5% abstract concepts so that media development is needed to support the cultivation of concepts and understanding of students, especially in food chain material.

2. Based on literature 2:

Based on research by Panduwinata, et al. (2021), it was found that the development of augmented reality (AR) media can hone students' knowledge in understanding archive storage procedures and students are easier to practice the archive storage system.

3. Based on literature 3:

Based on research by Listiawan, et al. (2021), the research results show that augmented reality-based mathematics learning media on Geometric Transformation material is declared feasible based on the assessment of several parties, namely: 1) The assessment of the media expert obtained a total score of 57 or 71.25%, which was included in the "Worthy" category, 2) The assessment of the first material expert obtained a score of 50 or 62.5%, also in the "Feasible" category, and 3) The second material expert gave a score of 73 which when percented reached 73.75%, still in the "Feasible" category. Meanwhile, the overall questionnaire results from students showed a positive response with a percentage of 85.46% and included the "Very Appropriate" category. From the individual aspect, students' responses obtained a score of 71.15% which is classified in the "Appropriate" category.

4. Based on literature 4:

Based on research by Prabowo, et al. (2024), it was found that the use of augmented reality media in IPAS learning is feasible and effective enough to increase student learning motivation. This is proven by the results of validation assessments from media, material, and language experts and getting 'very valid' criteria with a percentage of 66.92% so that it is feasible to be used in learning and increasing student learning motivation.

5. Based on literature 5:

Based on research conducted by Wibowo, et al. (2022) stated that the augmented reality-based media developed showed very good results, with a score of 84.54%. Validation from material experts showed a high level of validity with a score of 86.5%. Students' response to the media reached a score of 95%, while the teacher's response obtained 92%, indicating that this media is classified as very practical. In addition, the posttest results showed a classical achievement of 87.5%, fulfilling the effectiveness criteria.

6. Based on literature 6:

Based on research by Elvina, et al. (2024) concluded that thematic flashcard media supported by augmented reality technology is classified as very feasible and practical or effective to be used as a learning tool for children aged 5-6 years. This flashcard utilises the Assemblr Edu application to bring virtual elements into the real world, so that the learning process about the stages of butterfly and grasshopper metamorphosis becomes more interesting and interactive. Augmented reality technology allows learners to witness and interact directly with 3D objects that appear real in front of them.

7. Based on literature 7:

Based on research by Juliana, et al. (2024) obtained research results in the form of learning media feasibility with a percentage of 85% and very feasible criteria, material feasibility with a percentage of 89%. Then, small-scale responses from students 83.3% and large-scale 85% with very feasible criteria so that it can be concluded that the product in the form of augmented reality-based flashcards developed can be used and support the learning process.

8. Based on literature 8:

Based on research conducted by Nina, et al. (2023) stated that the results of the use of augmented reality-based flashcard media development in learning force material proved to be able to improve the critical thinking skills of fourth grade students at SDN Sawentar 02 Kanigoro, Blitar Regency. Proven by the results of media and material expert validation of 90%, linguists 87.5% and teacher user expert results of 100%.

9. Based on literature 9:

Based on research by Khasanah, et al. (2025) obtained the results of the feasibility test of AR-based flashcard media by validation results from media experts and material experts which reached an average percentage of 92% with the category "Very Feasible". The practicality test also produced a positive response, with an average questionnaire score from teachers of 94% and students of 92%, both of which were included in the "Very Feasible" category. Therefore, the use of AR flashcards is proven to be effective and practical in improving learners' understanding of fraction materials at the elementary school level.

10. Based on literature 10:

Based on research by Aini, et al. (2025) explained that validation by material experts reached a percentage of 90%, while validation from media experts was 68.4%. The small-scale trial resulted in a score of 87.6%, with a learner response of 85.3% and a teacher response of 95%. This learning media can be accessed through the website using a smartphone or laptop device, and is proven to be able to increase students' motivation, involvement, and understanding of the material studied.

Table 1. Relevant International Articles

No	Article	Reference
1	Hamzah, M. L., Rizal, F., & Simatupang, W. (2021). Development of Augmented Reality Application for Learning Computer Network Device. <i>International Journal of Interactive Mobile Technologies</i> , 15(12).	https://www.researchgate.net/profile/Refdinal-Refdinal-3/publication/352522735_Development_of_Augmented_Reality_Application_for_Learning_Computer_Network_Device/links/61e6b78fc5e3103375a35b2c/Development-of-Augmented-Reality-Application-for-Learning-Computer-Network-Device.pdf
2	Priyanto, P., & Sumarwan, S. (2024). Development of augmented reality learning media in chemistry subject high school. <i>International Journal of Artificial Intelligence Research</i> , 7(2), 123-131.	https://ijair.id/index.php/ijair/article/view/912
3	Isma, H. I., Haris, A., & Ramadhan, I. (2024). Development of Physics Learning Media Based on Augmented Reality. <i>International</i>	https://www.iipce.org/index.php/IJPCE/article/view/362

	<i>Journal of Physics and Chemistry Education</i> , 16(1), 1-8.	
4	Muskhir, M., Luthfi, A., Sidiq, H., & Fadillah, R. (2024). Development of Augmented Reality Based Interactive Learning Media on Electric Motor Installation Subjects. <i>JOIV: International Journal on Informatics Visualization</i> , 8(4), 2097-2103.	https://joiv.org/index.php/joiv/article/view/2256
5	Nafian, M. I. (2024). Development of Augmented Reality Media to Grow Numerical Literacy of Elementary School Students. <i>International Journal of Educatio Elementaria and Psychologia</i> , 1(3), 124-135.	https://www.journal.ypidathu.or.id/index.php/ijEEP/article/view/947
6	Listiani, K. K., & Paramartha, W. E. (2025). Augmented Reality Based Flashcard Media to Improve Student Learning Outcomes on the Topic Water Cycle V Grade Elementary School. <i>International Journal of Elementary Education</i> , 9(1), 160-169.	https://ejournal.undiksha.ac.id/index.php/IJEE/article/view/94634
7	Ruswanti, T., Jannah, M., Fitri, R., Kristanto, A., Dewi, U., & Lasarus, Y. M. (2025). Effect of Augmented Reality Flash Card Media on Reading Interest and Storytelling Ability in Children Aged 5-6 Years. <i>International Journal of Emerging Research and Review</i> , 3(2), 000096-000096.	https://ieeexplore.ieee.org/abstract/document/10761444
8	Hasibuan, S., & Chairad, M. (2023). The Development of Augmented Reality (AR) in Anatomy Course. <i>International Journal of Education in Mathematics, Science and Technology</i> , 11(3), 744-754.	https://eric.ed.gov/?id=EJ1386690
9	Tsai, C. C. (2020). The effects of augmented reality to motivation and performance in EFL vocabulary learning. <i>International Journal of Instruction</i> , 13(4), 987-1000.	https://eric.ed.gov/?id=EJ1270818
10	Sökmen, Y., Sarikaya, İ., & Nalçacı, A. (2024). The effect of augmented reality technology on primary school students' achievement, attitudes towards the course, attitudes towards technology, and participation in classroom activities. <i>International Journal of</i>	https://www.tandfonline.com/doi/abs/10.1080/10447318.2023.2204270

	<i>Human-Computer Interaction</i> , 40(15), 3936-3951.	
--	--	--

Based on the results of the literature review conducted on relevant international articles, it is as follows:

1. Based on literature 1:

Based on research by Hamzah, et al. (2021) states that the use of augmented reality-based learning media in the introduction of computer network devices is able to integrate virtual elements into the real environment, and change the display of two-dimensional images into three-dimensional visualisation. This makes the learning process more varied and not boring, and encourages students to be more active in exploring, such as getting to know the shape and visualisation of computer network device names that resemble the original along with information related to each device. Based on the results of the evaluation of the level of practicality using the System Usability Scale (SUS) method for 31 respondents, it was concluded that this AR application received a positive response and was well received by students, with a SUS score of 78.5.

2. Based on literature 2:

Based on research by Priyanto, et al. (2024) showed that AR learning media for class X chemistry was successfully developed with covalent bonding material and molecular shapes. Testing showed high feasibility, with a score of 89.58% in the media aspect, 91.25% in the material aspect, and 80.20% in the prospective user response. This media received a positive response from students and teachers as users because of the clear visualisation that is easy to understand, appropriate examples, and attractive appearance.

3. Based on literature 3:

Based on research by Isma, et al. (2024) explained that data analysis was carried out using the Gregory method. The results showed that the internal consistency coefficient value reached 1 or 100%, while the responses from physics teachers and students were in the range of 80% to 100%. These findings indicate that the use of augmented reality media in physics learning is feasible.

4. Based on literature 4:

Based on research by Muskhir, et al. (2024) shows that the results of research on the development of augmented reality learning media for electric motor installation subjects are declared valid and practical. Validation involved two media validators and two material validators. The validation results showed a value of 0.58 in media validation and 0.62 in material validation using the validity category ≥ 0.4 . The practicality test obtained a score of 86.63%, including in the very practical category.

5. Based on literature 5:

Based on research by Nafian, et al. (2024) explains that augmented reality media that has been developed to foster numeracy literacy in elementary school students shows a very good level of validity, namely obtaining an assessment of 92% from material experts and 88% from media experts. In addition, there was a significant increase in students' numeracy literacy, indicated by an increase in the percentage of completeness from 6.15% in the pre-test to 79.8% in the post-test. With an N-Gain score of 0.52, this media was proven effective and worthy of being utilised as a supporting learning resource.

6. Based on literature 6:

Based on the research of Listiani, et al. (2025) showed that the assessment of the material experts in this study showed a score of 4.87. The assessment of learning media experts reached 4.91, which indicates that the media has very good

qualifications. The practicality of the media was evaluated through responses from practitioners and 10 grade V students. The response from practitioners reached 91% and from students was 95.2%, both of which were classified as very good. The augmented reality-based flashcard media developed was declared: (1) valid in terms of content, design, and learning media, (2) practical according to the perspectives of practitioners and learners, and (3) effective in improving student learning outcomes on grade V water cycle material, as evidenced by the results of the t test so that it can be concluded that this augmented reality-based flashcard media is proven to be valid, practical, and effective in supporting the improvement of student learning outcomes.

7. Based on literature 7:

Based on the research of Ruswanti, et al. (2025) shows that the study has a significance level with a p value of less than 0.001, which means there is a difference in the gain score between the experimental group and the control group. This shows that because there is a difference between the control group and the experimental group, there is an effect of augmented reality flashcard media on reading interest and storytelling ability of children aged 5-6 years.

8. Based on literature 8:

Based on the research of Hasibuan, et al. (2023) shows the results of validation from media experts with a score of 79.05% in the 'good' category. Validation results from material experts with a score of 87.67% in the 'very good' category. In a limited trial involving ten students, a result of 81.6% was obtained. In the large group test with 30 students, the result was 88.8%. Learners' responses showed a high level of satisfaction with the Augmented Reality (AR) media developed, with the assessment being in the 'very interesting' category. This research is still limited to the product revision stage, so it is recommended that further research consider the mass production stage. The novelty of this research lies in the use of Augmented Reality (AR) based learning media in learning anatomy courses.

9. Based on literature 9:

Based on the research of Tsai, et al. (2025) stated that the research explained that learners who learned by using Augmented Reality (AR) method showed higher motivation towards the learning material and better achievement compared to students who learned through traditional lecture method. The qualitative results of the study showed various opportunities as well as challenges in the use of AR as well as the lecture method in learning English vocabulary. The findings are expected to contribute positively to the development of effective English teaching strategies for EFL students and teachers at the elementary school level in Taiwan.

10. Based on literature 10:

Based on the research of Sökmen, et al. (2024) explains that the study aims to examine the effect of Augmented Reality (AR) technology on learning achievement, attitudes towards learning and technology, and participation of primary school students in the classroom. AR learning materials were developed by grade 4 teachers according to the curriculum. Using a quasi-experimental design and cluster random sampling, learners from 11 schools were divided into experimental and control groups. Results showed that learners who learnt with AR showed more positive achievement, participation and attitude than the control group. In addition, there was a positive relationship between achievement, attitude, and participation in the experimental group.

CONCLUSIONS

Based on the synthesis of national and international literature reviews, it can be concluded that the use of augmented reality (AR) media has been proven effective in

increasing student motivation while also helping them understand concepts that tend to be abstract and difficult to explain using conventional media alone. Augmented reality (AR) can provide a more interactive and contextual learning experience that attracts interest and improves learning outcomes, whether for early childhood, primary school, or secondary school students. Almost all studies show that expert validation and student and teacher responses are very positive, with validity, practicality, and effectiveness rated as good to very good. However, the implementation of augmented reality (AR) in Indonesia still faces a number of obstacles, particularly related to limitations in digital devices, school infrastructure, and teacher readiness to optimally utilise AR-based learning technology.

Based on the results of the study, there are several important recommendations, namely: 1) teachers need special training on the use of augmented reality (AR) so that they can integrate it appropriately into learning in accordance with Piaget's constructivism theory, Vygotsky's theory, and Mayer's multimedia theory. 2) The availability of devices and digital infrastructure support is a necessary step for the implementation of augmented reality (AR) in various schools. 3) The integration of augmented reality (AR) in learning needs to be directed towards supporting a student-centred learning approach, so that students are not only motivated but also more active in building understanding and critical thinking skills. 4) Further context-based research is needed to ensure that the development of AR media is increasingly tailored to the needs and characteristics of students in Indonesia.

LITERATURE

- Aini, L. N., & Guntur Nurcahyanto, S. T. (2025). *Pengembangan Media E-Flashcard Berbasis Augmented Reality (AR) Pada Pembelajaran Biologi Materi Sistem Pencernaan Kelas XI* (Doctoral dissertation, Universitas Muhammadiyah Surakarta).
- Anitah, S. 2008. *Media Pembelajaran*. Surakarta: UNS Press.
- Armia, A., & Ardian, Z. (2021). Perancangan Augmented Reality Sebagai Media Promosi Gedung Kampus Universitas Ubudiyah Indonesia. *Journal Of Informatics And Computer Science*, 7(1), 10-16.
- Elvina, T., Miranda, D., & Lukmanulhakim, L. (2024). Pengembangan Flashcard Tematik Berbasis Augmented Reality Anak Usia 5-6 Tahun. *Jurnal Edukasi*, 2(1), 57-61.
- Hamzah, M. L., Rizal, F., & Simatupang, W. (2021). Development of Augmented Reality Application for Learning Computer Network Device. *International Journal of Interactive Mobile Technologies*, 15(12).
- Hasibuan, S., & Chairad, M. (2023). The Development of Augmented Reality (AR) in Anatomy Course. *International Journal of Education in Mathematics, Science and Technology*, 11(3), 744-754.
- Isma, H. I., Haris, A., & Ramadhan, I. (2024). Development of Physics Learning Media Based on Augmented Reality. *International Journal of Physics and Chemistry Education*, 16(1), 1-8.
- Juliana, L. N. (2024). *Pengembangan Media Flashcard Berbasis Augmented Reality Pada Pembelajaran Bahasa Indonesia Kelas V Di Sekolah Dasar/SD* (Doctoral Dissertation, Uin Raden Intan Lampung).
- Khasanah, S. U. (2025). Pengembangan Media Pembelajaran Matematika Flashcards Berbasis AR (Augmented Reality) pada Materi Pecahan. *Integrative Perspectives of Social and Science Journal*, 2(2 Maret), 1528-1536.
- Lestari, A. I., Ndona, Y., & Gultom, I. (2024). Pengembangan Sosial Emosional Siswa SD dengan Perspektif Konstruktivisme Sosial Oleh Lev Vygotsky. *JlIP-Jurnal Ilmiah Ilmu Pendidikan*, 7(11), 12441-12445.

- Listiani, K. K., & Paramartha, W. E. (2025). Augmented Reality Based Flashcard Media to Improve Student Learning Outcomes on the Topic Water Cycle V Grade Elementary School. *International Journal of Elementary Education*, 9(1), 160-169.
- Listiawan, T., & Antoni, A. (2021). Pengembangan media pembelajaran matematika berbasis augmented reality (AR) pada materi transformasi geometri. *JP2M (Jurnal Pendidikan Dan Pembelajaran Matematika)*, 7(1), 43-52.
- Muskhir, M., Luthfi, A., Sidiq, H., & Fadillah, R. (2024). Development of Augmented Reality Based Interactive Learning Media on Electric Motor Installation Subjects. *JOIV: International Journal on Informatics Visualization*, 8(4), 2097-2103.
- Nafian, M. I. (2024). Development of Augmented Reality Media to Grow Numerical Literacy of Elementary School Students. *International Journal of Education Elementaria and Psychologia*, 1(3), 124-135.
- Nina, Q. A. Y., Fatih, M., & Alfi, C. (2023). Pengembangan Media Flashcard Berbasis Augmented Reality Materi Gaya untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas IV. *JlIP-Jurnal Ilmiah Ilmu Pendidikan*, 6(11), 8558-8564.
- Panduwinata, L. F., Wulandari, R. N. A., & Zanky, M. N. (2021). Pengembangan media pembelajaran berbasis augmented reality (AR) pada materi prosedur penyimpanan arsip. *Lectura: Jurnal Pendidikan*, 12(1), 15-28.
- Prabowo, E., & Wakhudin, W. (2024). Pengembangan Media Augmented Reality (AR) untuk Meningkatkan Motivasi Belajar Siswa pada Mata Pelajaran IPAS Kelas 4 SD Negeri 3 Linggasari. *Jurnal Pendidikan dan Pembelajaran Indonesia (JPPI)*, 4(2), 591-604.
- Priyanto, P., & Sumarwan, S. (2024). Development of augmented reality learning media in chemistry subject high school. *International Journal of Artificial Intelligence Research*, 7(2), 123-131.
- Qorimah, E. N., Laksono, W. C., Hidayati, Y. M., & Desstya, A. (2022). Kebutuhan Pengembangan Media Pembelajaran Berbasis Augmented Reality (AR) pada Materi Rantai Makanan. *Jurnal Pedagogi Dan Pembelajaran*, 5(1), 57-63.
- Ruswanti, T., Jannah, M., Fitri, R., Kristanto, A., Dewi, U., & Lasarus, Y. M. (2025). Effect of Augmented Reality Flash Card Media on Reading Interest and Storytelling Ability in Children Aged 5-6 Years. *International Journal of Emerging Research and Review*, 3(2), 000096-000096.
- Sökmen, Y., Sarıkaya, İ., & Nalçacı, A. (2024). The effect of augmented reality technology on primary school students' achievement, attitudes towards the course, attitudes towards technology, and participation in classroom activities. *International Journal of Human-Computer Interaction*, 40(15), 3936-3951.
- Sugilar, H. (2020, March). Multimedia matematika di era digital. In *Prosiding Seminar Nasional Teknik Elektro UIN Sunan Gunung Djati Bandung* (pp. 442-451).
- Suryana, E., Aprina, M. P., & Harto, K. (2022). Teori Konstruktivistik dan Implikasinya dalam Pembelajaran. *JlIP-Jurnal Ilmiah Ilmu Pendidikan*, 5(7), 2070-2080.
- Tsai, C. C. (2020). The effects of augmented reality to motivation and performance in EFL vocabulary learning. *International Journal of Instruction*, 13(4), 987-1000.
- Wibowo, V. R., Putri, K. E., & Mukmin, B. A. (2022). Pengembangan media pembelajaran berbasis augmented reality pada materi penggolongan hewan kelas V sekolah dasar. *PTK: Jurnal Tindakan Kelas*, 3(1), 58-69.