

Use Of Augmented Reality as an Alternative Media for Learning Mathematics: A Systematic Literature Review

Dina Prasetyowati¹, Wardono^{2*}, Scolastika Mariani³, Nuriana Rachmani Dewi⁴

Mathematics Education, Universitas Negeri Semarang
Gunung Pati, Semarang, Central Java, Indonesia

¹dinaprasyowati@students.unnes.ac.id; ^{2*}wardono@mail.unnes.ac.id;

³mariani.mat@mail.unnes.ac.id; ⁴nurianaramadan@mail.unnes.ac.id

Article received: 13-05-2025, revision: 22-06-2025, published: 30-07-2025

Abstrak

Teknologi Augmented Reality (AR) kini menjadi tren yang berkembang di bidang pendidikan. Augmented Reality mempunyai kemampuan untuk menggabungkan dunia digital dan dunia nyata yang kemudian mengarah pada munculnya kemungkinan-kemungkinan baru dalam meningkatkan kualitas kegiatan belajar mengajar. Studi ini bertujuan untuk memahami seberapa efektif penggunaan Augmented Reality sebagai media alternatif dalam pembelajaran matematika di lembaga pendidikan. Studi ini menerapkan metode Systematic Literature Review (SLR) dengan mengumpulkan artikel-artikel dari berbagai jurnal internasional maupun nasional menggunakan kata kunci yang sudah ditetapkan. Terdapat 231 artikel yang ditemukan pada tahap awal pencarian dengan total 23 artikel yang memenuhi kriteria inklusi dan eksklusi. Hasilnya pemanfaatan AR dalam pendidikan matematika telah diterapkan dan diterapkan sebagai media pendukung pembelajaran interaktif di berbagai tingkatan mulai dari sekolah dasar hingga perguruan tinggi. Temuan dari ulasan ini mendukung literatur mengenai pemanfaatan Augmented Reality sebagai media alternatif dalam pembelajaran matematika.

Kata Kunci: Augmented Reality; Media Pembelajaran; Systematic Literature Review.

Abstract

Augmented Reality (AR) technology has become an emerging trend in the field of education. AR is capable of integrating digital elements with the real environment, thereby creating new opportunities to enhance the quality of teaching and learning processes. This study aims to understand how effective the use of Augmented Reality as an alternative media in mathematics learning in educational institutions is. This study applies the Systematic Literature Review (SLR) method by collecting articles from various international and national journals using predetermined keywords. There were 231 articles found in the initial stage of the search with a total of 23 articles meeting the inclusion and exclusion criteria. The results show that AR has been applied and implemented in mathematics education as a supporting media for interactive learning at various levels, from elementary school to university. The findings of this review support the literature on the use of Augmented Reality as an alternative medium in mathematics learning.

Keywords: Augmented Reality; Learning Media; Systematic Literature Review.

I. INTRODUCTION

Mathematics is one of the fields of study taught at all levels of education. Mathematics contains objects as a means of scientific thinking in meeting practical needs and solving problems in everyday life. Mathematics has a role in the development of technology and science, so that mathematics is often referred to as the science that underlies the development of technology and science in the world (Nurlaela & Imami, 2022). Students are intended to develop into rational, accurate, meticulous, critical, creative, innovative, imaginative, and decisive human beings through mathematical education. Making significant decisions, resolving issues, and creating plans are just a few of the everyday circumstances in which this capacity for logical thought would be quite helpful, with the certain hope that mathematics education will become a very important aspect of education for the advancement of science in Indonesia (Hasibuan, 2018; Dewi & Sari, 2025).

Nowadays, technological developments are progressing increasingly rapidly. Technological developments make it easier for humans to obtain information quickly and accurately (Mulyadi & Afriansyah, 2022). Technological developments continue to be updated to make daily activities easier (Rahayu, Aima, & Juwita, 2023). Palanci & Turan (2021) say that all types of technology that have developed today cannot be separated from the science of mathematics in them. In mathematics learning, technology is expected to support effective learning and improve the quality of learning. This development also plays a role in the

development of learning media. From the words media and learning, Saputri (2020) said that learning media is a container for material messages that want to be conveyed in learning activities. The goal to be achieved is that the creative learning process will increase the possibility for students to learn more and improve skills in accordance with the learning objectives. Learning media will become more interesting for students even though it does not reduce the meaning of the material (Nuraeni, Nurjanah, & Siregar, 2024). One of the technological developments in mathematics learning media is Augmented Reality (AR).

By displaying three-dimensional (3D) objects in the real world through camera media so that the camera appears as though the 3D objects exist in the real world, augmented reality (AR) technology makes it possible to combine the real and virtual (digital) worlds (Saputro et al., 2024; Safrida, Suwito, & Ambarwati, 2025). AR also makes it possible to display illustrations that are challenging to realize concretely (Sungkono, Apiati, & Santika, 2022; Sudirman, Luritawaty, & Bonyah, 2024). The technology that can integrate three-dimensional (3D) virtual things into a three-dimensional actual world and display them in real time is known as augmented reality, according to Rozi et al. (2021). Numerous scholars are interested in augmented reality (AR). utilized as a substitute to get around the difficulty of mathematical content and integrated with other learning philosophies. The use of 3D constructions in geometry and mathematics at the high school and university levels is covered by Kaufmann et

al. (2000). Velázquez and Méndez (2021) address the use of AR in algebra, whereas Dinayusadewi and Agustika (2020) apply AR to geometry lessons for elementary school.

AR is frequently used as the preferred interactive technology in a variety of educational and learning environments, it has grown quickly (Nurbekova & Baigusheva, 2020; Rahman, 2025). AR simplifies difficult knowledge and increases flexibility in the teaching and learning process (Hamzah et al., 2021). AR has been investigated in several academic disciplines beyond mathematics, such as physics, biology, and chemistry, in addition to its application in mathematics education (Wong et al., 2021). The flexibility of AR technology to be utilized anywhere and on a variety of devices, including computers, tablets, gadgets, and laptops, is one of the key elements driving its development.

By gathering articles from numerous national and international publications using predefined keywords, this study employs the Systematic Literature Review (SLR) method. The aim of this research is to determine the extent to which Augmented Reality is used as an alternative mathematics learning media in educational institutions.

II. METHOD

This research uses the Systematic Literature Review (SLR) method. SLR is a form of secondary study which uses a well-defined methodology which aims to identify, analyze and interpret the results of studies in previous research to answer research questions that have been set (Wohlin et al, 2020). SLR is a method for

obtaining answers related to research questions by conducting a literature review of previous research that is relevant to the topic being discussed. This study uses the SLR guidelines proposed by Kitchenham and Charters (2010) in Software Engineering. According to this guideline, SLR consists of three main phases, namely planning, conducting and reporting.

In this research, researchers used data sourced from Scopus, Eric and Google Scholar with the keywords Augmented Reality in Mathematics Education. Taking into consideration the selection of articles is the year of publication of articles published in the last 6 years, namely from 2018 to 2023. Research questions are created according to the needs of the selected research topic by compiling relevant research questions. The research questions (RQ) in this study are as follows.

RQ1: How is the development of Augmented Reality as a mathematics learning media based on year distribution?

RQ2: Where are the locations that use Augmented Reality as a mathematics learning media?

RQ3: What are the outcomes of Augmented Reality media in mathematics learning?

RQ4: Any mathematics subject matter that uses Augmented Reality?

RQ5: What levels of education use Augmented Reality as a media for learning mathematics?

RQ6: What are the aims and benefits of using Augmented Reality as a mathematics learning media?

In searching for articles to answer predetermined research questions,

researchers used the keywords "augmented reality in mathematics education" in the Scopus, Eric and Google Scholar databases. Researchers applied several inclusion and exclusion criteria to select articles to use. These criteria are explained in Table 1.

Table 1.
Inclusion and Exclusion Criteria

| Inclusion | Exclusion |
|--|---|
| Articles published range from 2018 – 2023 | Articles published before 2018 |
| The article used discusses the use of Augmented Reality as a learning medium | Articles that do not discuss Augmented Reality as a learning medium |
| Specifics related to mathematics education | Apart from mathematics education |
| Indexed journal | Non-indexed journal, book review |
| Articles written in English | Articles written in other than English |
| Open access article | Articles are limited to abstracts only and are paid |

As stated in the methodology section, the papers chosen for this SLR came from the databases Scopus, ERIC, and Google Scholar. This database was selected because it satisfies predefined criteria and protocol requirements. 634 articles from the three databases were found during the article selection process using the given keywords. Then, based on the relevance of the title, there are 231 articles from the three data bases, namely Scopus (79), Eric (99), Google Scholar (53). After carefully reviewing the title, keywords, abstract, content and inclusion and exclusion criteria, the article was excluded because it did not have a study focus on "mathematics education". Finally, a total of 23 scientific articles were analyzed, namely Scopus (12), Eric (7), Google Scholar (4).

III. RESULT AND DISCUSSION

To obtain the data required to address this research issue, all 23 articles were analyzed. The research questions were then used to group the into six categories. Table 2 lists the eligible papers that were used in this investigation.

Table 2.
List of Articles that Meet the Criteria

| Code | Title |
|------|---|
| R1 | Effect of Augmented Reality and Simulation on the Achievement of Mathematics and Visual Thinking Among Students |
| R2 | Application In Augmented Reality for Learning Mathematical Functions: A Study for the Development Of Spatial Intelligence In Secondary Education Students |
| R3 | Ethnomathematics Augmented Reality: Android-Based Learning Multimedia to Improve Creative Thinking Skills on Geometry |
| R4 | The Elements of Computational Thinking in Learning Geometry by Using Augmented Reality Application |
| R5 | Heuristic Evaluation on Affective 4-Dimensional Augmented Reality Mathematics for Children with Low Vision |
| R6 | The Effect of Augmented Reality in Improving Visual Thinking in Mathematics of 10th-Grade Students in Jordan |
| R7 | Augmented Reality as A Didactic Resource for Teaching Mathematics |
| R8 | Using Augmented Reality to Enhance Students' Representational Fluency: The Case of Linear Functions |
| R9 | Efficacy of Educational Platforms in Developing the Skills of Employing Augmented Reality in Teaching Mathematics |
| R10 | Probability Learning in Mathematics Using Augmented Reality: Impact on Student's Learning Gains And Attitudes |
| R11 | Augmented Reality in Lower Secondary Education: A Teacher Professional Development Program in Cyprus and Greece |
| R12 | The Effect of Using Augmented Reality Module in Learning Geometry on Mathematics Performance among Primary Students |
| R13 | Effectiveness of the Augmented Reality on |

| Code | Title |
|------|---|
| | Improving the Visual Thinking in Mathematics and Academic Motivation for Middle School Students |
| R14 | Enhancing Mathematical Literacy Ability through Guided Inquiry Learning with Augmented Reality |
| R15 | On the Potential of Augmented Reality for Mathematics Teaching with the Application cleARmaths |
| R16 | Does Teaching Geometry with Augmented Reality Affect the Technology Acceptance of Elementary School Mathematics Teacher Candidates? |
| R17 | On Augmented Reality for the Learning of 3D-Geometric Contents: A Preliminary Exploratory Study with 6-Grade Primary Students |
| R18 | Examining Students' Intention to Use Augmented Reality in a Project-Based Geometry Learning Environment |
| R19 | An Augmented Reality Learning Toolkit for Fostering Spatial Ability in Mathematics Lesson: Design and Development |
| R20 | How to improve critical thinking skills and spatial reasoning with augmented reality in mathematics learning? |
| R21 | Development of Augmented Reality Application as a Mathematics Learning Media in Elementary School Geometry Materials |
| R22 | Mathematics Learning Based on Augmented Reality: A Relevant Mathematics Teaching Content and Enhanced Student Abilities |
| R23 | Comparative Evaluation of Virtual and Augmented Reality for Teaching Mathematics in Primary Education |

RQ1: How is the development of Augmented Reality as a mathematics learning media based on year distribution?

The first Research Questions in this research relate to the development of Augmented Reality as a learning medium based on year distribution. Knowing the year of deployment will provide an overview of the progress of AR studies that have been carried out and predict what is still needed and will be researched further.

If presented in graphical form, the distribution of research analyzed based on year of publication can be seen in Figure 1 below.

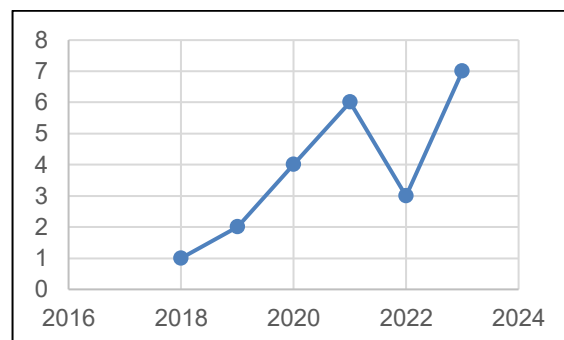


Figure 1. Distribution of research based on year of publication

It is evident from the graph in Figure 1 that there was a rise in augmented reality research between 2018 and 2021. After that, it fell in 2022 before rising once more in 2023. Research on the use of augmented reality in mathematics education is viewed as a novel approach compared to other studies that have been conducted in the past. Researchers are becoming more interested in adopting augmented reality as a teaching tool for mathematics, according to the article [R17]. According to the research findings in article [R4], augmented reality is a new and quickly evolving educational technology, and it's likely that more research will be done in the years to come to support this emerging technology.

It is anticipated that augmented reality will grow in popularity and development throughout society, including in educational settings (Martín Gutiérrez et al., 2017). Some AR-based non-educational applications have gained popularity, like the game Pokémon GO, which appeals to both adults and kids. According to article

[R14], there has been a rise in the use of augmented reality (AR) in mathematics education in 2021, which may be connected to the COVID-19 pandemic's effects. Society has undergone a significant, abrupt, and drastic digital transition as a result of the COVID-19 epidemic. A digital revolution in educational technology was compelled by the pandemic. Due to the pandemic's effects, 2020 marks the start of widespread transmigration in all spheres of life, including schooling.

RQ2: Where are the locations that use Augmented Reality as a mathematics learning media?

Augmented Reality has been used in the education sector in various countries around the world. However, there are several countries that are not as fast as other countries in using Augmented Reality. The list of research locations for Augmented Reality as a learning medium in the field of technology along with article references can be presented in the form of a percentage graph in Figure 2.

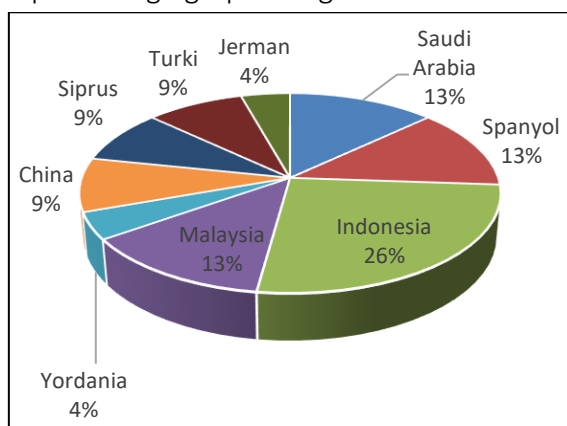


Figure 2. Percentage Distribution of Augmented Reality Research by Country

From this picture, it can be seen that Indonesia's percentage is the largest. The use of Augmented Reality as a medium in

education has attracted the attention of many countries, including Indonesia. The use of Augmented Reality reflects innovation in education. Countries in the world are often interested in adopting the latest technology to improve the quality of education and prepare the younger generation to face future challenges.

RQ3: What are the outcomes of Augmented Reality media in mathematics learning?

The application of Augmented Reality in mathematics learning can provide outcomes in the form of various media that support understanding of mathematical concepts. Based on the literature review carried out, several forms of Augmented Reality output that can be used in mathematics learning can be seen in Table 3.

Table 3. Output of Augmented Reality Media Forms

| Output | Article Reference |
|---|--|
| Augmented Reality Form Visualization Module | R1, R12, R14 |
| Game Applications | R7 |
| Augmented Reality Identification | R2, R11, R13, R16, R21 |
| Markers use Augmented Reality | R3, R4, R5, R6, R8, R9, R10, R15, R17, R18, R19, R20, R22, R23 |

Based on table 3 above, it is found that there is only one Augmented Reality output in the form of a game application in the article [R7]. In this article [R7] explains a game application designed using Augmented Reality technology to teach mathematical concepts in a fun and interactive way. Students can engage in games that involve solving mathematical problems or exploring concepts virtually.

The output in the form of markers using Augmented Reality is the most output. The research results [R22] say that Augmented Reality markers allow students to interact directly with virtual objects or mathematical information that appears when the marker is identified. This makes mathematics learning more interactive and visualizes mathematical concepts in a real way. This statement is also in line with what was conveyed by [R8] that by utilizing Augmented Reality markers in mathematics learning, teachers can create innovative learning experiences and increase students' understanding of mathematical concepts in an interesting and relevant way.

RQ4: Any mathematics subject matter that uses Augmented Reality?

There are many mathematics lessons that can be enhanced by using Augmented Reality to provide a more interactive and visual learning experience. Based on a literature review, mathematics lessons using Augmented Reality were found to be widely used in geometry and elementary school mathematics. This is because geometric concepts are often abstract and difficult to understand through two-dimensional representations. By using Augmented Reality, students can see and understand these concepts in a three-dimensional context, making them more real and relatable to the world around them. Integrating augmented reality technology in mathematics learning can make the material more interesting and can help students understand concepts in a more visual and interactive way. Students and teachers can utilize mobile devices to

learn and teach mathematics in a new way thanks to the augmented reality gadget created in research [R19]. The use of augmented reality technology in mathematics instruction at different educational levels is suggested by the paper [R13]. Additionally, they advise integrating this technology into geometry in particular and mathematics in general. The usage of augmented reality-based geometry mathematics learning materials in elementary schools was shown to be feasible [R21].

Using Augmented Reality in mathematics learning may require hardware such as a tablet or smartphone that is compatible with Augmented Reality technology. In addition, researchers must ensure that the use of this technology truly supports mathematics learning objectives and is not just an entertainment element. Overall, the integration of augmented reality in geometry material can increase the attractiveness and effectiveness of learning, helping students build a deeper understanding of geometric concepts which are often abstract.

RQ5: What levels of education use Augmented Reality as a media for learning mathematics?

From elementary school through university, augmented reality has been used as a medium to assist interactive learning in mathematics education. Table 4 shows the distribution of Augmented Reality research by educational attainment.

Table 4.
Use of Augmented Reality Media Based on
Education Level

| Educational level | Article Reference | Number of Articles |
|--------------------|---|--------------------|
| Elementary school | R5, R9, R12, R16, R17, R21, R23 | 7 |
| Junior high school | R1, R2, R3, R8, R10, R11, R13, R14, R18 | 9 |
| Senior High School | R4, R6, R20 | 3 |
| College | R7, R15, R19 | 3 |
| Not mentioned | R22 | 1 |

Based on table 4 above, it can be seen that the highest level of education in research that uses augmented reality as a learning medium is in junior high school. This is because students at the junior high school level tend to be more responsive to interesting and interactive learning experiences. The use of augmented reality can increase student engagement by providing visual elements and direct experience in understanding mathematical concepts. The results of research [R8] show that students are satisfied with augmented reality-based media, which helps improve their understanding of real-life, symbolic, and graphic representations and relationships. Mathematics material in junior high school often involves more abstract and complex concepts compared to lower levels of education. The use of augmented reality can help students visualize and understand these concepts in a more real and concrete way. The use of augmented reality in middle school can help create innovative learning environments, facilitate understanding of more complex mathematical concepts, and increase student engagement. This is in accordance with the characteristics of

students at this stage of development, where they are in a transition period towards more abstract and conceptual learning.

RQ6: What are the aims and benefits of using Augmented Reality as a mathematics learning media?

The use of augmented reality as a learning medium has quite varied goals and benefits. Based on the review of articles that have been carried out, the main purpose of using augmented reality media is to help students understand abstract mathematical concepts by presenting more concrete visual representations. This is in line with the results of research [R13] which states that augmented reality technology can improve visual thinking in mathematics and academic motivation among secondary school students in Saudi Arabia. In the article [R21] says that augmented reality can be used to support cooperation between students in solving mathematical problems or collaborative projects. Learners can interact with augmented reality objects together, facilitating discussion and team learning. The use of augmented reality can expand the scope of mathematics learning [R8] by bringing mathematical concepts into real life. This helps students to relate mathematical concepts to real-world situations. Augmented reality can be used to create situations where students have to solve mathematical problems in a more in-depth and relevant context [R17]. It helps develop students' problem solving skills.

Regarding technology readiness, article [R22] states that the use of augmented reality can help students become more

familiar with modern technology, equipping them with digital skills that are important in the current era. Augmented reality learning can visualize abstract concepts for understanding and the structure of an object model, making augmented reality a more effective medium in accordance with the objectives of the learning media [R19]. The use of augmented reality in mathematics learning aims to make learning more effective, fun, and help students build a solid understanding of mathematics. These benefits show the potential of augmented reality as an innovative learning tool at various levels of education.

IV. CONCLUSION

In this study, every research question was evaluated. It is anticipated that augmented reality will grow in popularity and development throughout society, notably in educational settings. Many nations, including Indonesia, are interested in using augmented reality as a teaching tool. Elementary school geometry and math curricula frequently make use of augmented reality. From elementary school to university, augmented reality (AR) has been used in mathematics education as a supporting medium for interactive learning. According to the analysis's findings, junior high school kids make up the largest sample in the review of the chosen articles, with elementary school children coming in second.

Students can immediately use Augmented Reality for engaging and authentic learning materials. In addition, because Augmented Reality integrates the

virtual and real worlds, it can enhance students' enthusiasm in studying. Because augmented reality is interactive, kids can experience situations directly and realistically and can see the outcomes of the lessons that teachers have taught them.

The results of this review have filled and strengthened the literature regarding the use of Augmented Reality as an alternative mathematics learning media. Although this research has several limitations due to the review and article selection process. For further research, it is possible to expand the scope of discussion regarding barriers to the use of Augmented Reality in the field of education and not limit the search for articles based on the year of publication for review so that the discussion of articles can be more complex. According to the systematic study's findings, if you know precisely which aspects of augmented reality are appropriate for teaching mathematics, you may create and apply it in pedagogical practice. Additionally, researchers advise that studies on augmented reality concentrate on examining the wide range of applications and long-term effects of the creation and use of augmented reality on learning mathematics.

REFERENCES

- Ahmad, F. A. R. O. B. (2021). The effect of augmented reality in improving visual thinking in mathematics of 10th-grade students in Jordan. *International Journal of Advanced Computer Science and Applications*, 12(5).

- Aldalalah, O., Ababneh, Z., Bawaneh, A., & Alzubi, W. (2019). Effect of augmented reality and simulation on the achievement of mathematics and visual thinking among students. *International Journal of Emerging Technologies in Learning (IJET)*, 14(18), 164-185. <https://doi.org/10.3991/ijet.v14i18.10748>
- Alibraheim, E. A., Hassan, H. F., & Soliman, M. W. (2023). Efficacy of educational platforms in developing the skills of employing augmented reality in teaching mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(11), em2348. <https://doi.org/10.29333/ejste/13669>
- Anggraini, S., Setyaningrum, W., & Retnawati, H. (2020, July). How to improve critical thinking skills and spatial reasoning with augmented reality in mathematics learning? In *Journal of Physics: Conference Series* (Vol. 1581, No. 1, p. 012066). IOP Publishing. doi:10.1088/1742-6596/1581/1/012066
- Cahyono, A. N., Sukestiyarno, Y. L., Asikin, M., Miftahudin, Ahsan, M. G. K., & Ludwig, M. (2020). Learning mathematical modelling with augmented reality mobile math trails program: How can it work? *Journal on Mathematics Education*, 11(2), 181–192. <https://doi.org/10.22342/jme.11.2.10729.181-192>
- Cai, S., Liu, E., Shen, Y., Liu, C., Li, S., & Shen, Y. (2020). Probability learning in mathematics using augmented reality: impact on student's learning gains and attitudes. *Interactive Learning Environments*, 28(5), 560-573. <https://doi.org/10.1080/10494820.2019.1696839>
- Del Cerro Velázquez, F., & Morales Méndez, G. (2021). Application in augmented reality for learning mathematical functions: A study for the development of spatial intelligence in secondary education students. *Mathematics*, 9(4), 369. <https://doi.org/10.3390/math9040369>
- Demitriadou, E., Stavroulia, K. E., & Lanitis, A. (2020). Comparative evaluation of virtual and augmented reality for teaching mathematics in primary education. *Education and information technologies*, 25, 381-401. <https://doi.org/10.1007/s10639-019-09973-5>
- Dinayusadewi, N. P., & Agustika, G. N. S. (2020). Development Of Augmented Reality Application as a Mathematics Learning Media in Elementary School Geometry Materials. *Journal of Education Technology*, 4(2), 204. <https://doi.org/10.23887/jet.v4i2.25372>
- Dewi, E. A., & Sari, R. M. M. (2025). Analisis Konseptual dan Historis Geometri Euclid dalam Elemen: Relevansi dan Pengaruhnya pada Matematika Modern. *Radian Journal: Research and Review in Mathematics Education*, 4(2), 87–96. <https://doi.org/10.35706/radian.v4i2.13172>
- Elsayed, S. A., & Al-Najrani, H. I. (2021). Effectiveness of the augmented reality on improving the visual thinking in mathematics and academic motivation

- for middle school students. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(8), em1991. <https://doi.org/10.29333/ejmste/11069>
- Fernández-Enríquez, R., & Delgado-Martín, L. (2020). Augmented reality as a didactic resource for teaching mathematics. *Applied Sciences*, 10(7), 2560. doi:10.3390/app10072560
- Flores-Bascuñana, M., Diago, P. D., Villena-Taranilla, R., & Yáñez, D. F. (2019). On augmented reality for the learning of 3D-geometric contents: A preliminary exploratory study with 6-grade primary students. *Education Sciences*, 10(1), 4. <https://doi.org/10.3390/educsci10010004>
- Hamzah, M. L., Ambiyar, Rizal, F., Simatupang, W., Irfan, D., & Refdinal. (2021). Development of augmented reality application for learning computer network device. *International Journal of Interactive Mobile Technologies*, 15(12), 47–64. <https://doi.org/10.3991/ijim.v15i12.21993>
- Hanid, M. F. A., Said, M. N. H. M., Yahaya, N., & Abdullah, Z. (2022). The Elements of Computational Thinking in Learning Geometry by Using Augmented Reality Application. *International Journal of Interactive Mobile Technologies*, 16(2). <https://doi.org/10.3991/ijim.v16i02.27295>
- Hasibuan, E. K. (2018). Analisis Kesulitan Belajar Matematika Siswa pada Pokok Bahasan Bangun Ruang Sisi Datar di SMP Negeri 12 Bandung. *Axiom: Jurnal Pendidikan Dan Matematika*, 7(1).
- Johar, R. (2021). Examining Students' Intention to Use Augmented Reality in a Project-Based Geometry Learning Environment. *International Journal of Instruction*, 14(2), 773–790. <https://doi.org/10.29333/iji.2021.14243a>
- Kaufmann, H., Schmalstieg, D., & Wagner, M. (2000). Construct3D: a virtual reality application for mathematics and geometry education. *Education and Information Technologies*, 5(4), 263–276. <https://doi.org/10.1023/A:1012049406877>
- Kitchenham, B., Pretorius, R., Budgen, D., Brereton, O. P., Turner, M., Niazi, M., & Linkman, S. (2010). Systematic literature reviews in software engineering a tertiary study. *Information and software technology*, 52(8), 792-805.
- Lasica, I. E., Meletiou-Mavrotheris, M., & Katzis, K. (2020). Augmented reality in lower secondary education: A teacher professional development program in Cyprus and Greece. *Education Sciences*, 10(4), 121. <https://doi.org/10.3390/educsci10040121>
- Li, S., Shen, Y., Jiao, X., & Cai, S. (2022). Using augmented reality to enhance students' representational fluency: The case of linear functions. *Mathematics*, 10(10), 1718. <https://doi.org/10.3390/math10101718>
- Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual technologies trends in education. *Eurasia Journal of*

- Mathematics, Science and Technology Education*, 13(2), 469–486.
<https://doi.org/10.12973/eurasia.2017.00626a>
- Mulyadi, R., & Afriansyah, E. A. (2022). Pengaruh literasi digital terhadap kemandirian belajar matematika siswa. *Math Didactic: Jurnal Pendidikan Matematika*, 8(2), 183-191.
- Nadzri, A. Y. N. M., Ayub, A. F. M., & Zulkifli, N. N. (2023). The Effect of Using Augmented Reality Module in Learning Geometry on Mathematics Performance among Primary Students. *environment*, 3, 4.
<https://doi.org/10.18178/ijiet.2023.13.9.1952>
- Nuraeni, R., Nurjanah, & Siregar, H. M. (2024). Eksplorasi Pembelajaran Kalkulus Integral dengan Menggunakan Teknologi. *Plusminus: Jurnal Pendidikan Matematika*, 4(1), 83–94.
<https://doi.org/10.31980/plusminus.v4i1.1526>
- Nurbekova, Z., & Baigusheva, B. (2020). On the issue of compliance with didactic principles in learning using augmented reality. *International Journal of Emerging Technologies in Learning*, 15(15), 121–132.
<https://doi.org/10.3991/ijet.v15i15.14399>
- Nurlaela, E., & Imami, A. I. (2022). Peningkatan Kemampuan Literasi Matematika Siswa Melalui Penerapan Model Pembelajaran Problem Based Learning Di Kelas VII SMPIT Insan Harapan. *Jurnal Ilmiah Dikdaya*, 12(1), 33–38.
<https://doi.org/10.33087/dikdaya.v12i1>
- Nurulnadwan Aziz*, Siti Zulaiha Ahmad, Sariya Binsaleh, and Wan Wan Rahzihan Zulnasyreeq Wan a Rahman. (2023). Heuristic Evaluation on Affective 4-Dimensional Augmented Reality Mathematics for Children with Low Vision. *International Journal of Information and Education Technology* vol. 13, no. 2, pp. 313-319, 2023.
<https://doi.org/10.18178/ijiet.2023.13.2.1809>
- Önal, N., İbili, E., & Çaliskan, E. (2017). Does Teaching Geometry with Augmented Reality Affect the Technology Acceptance of Elementary School Mathematics Teacher Candidates? *Online Submission*, 8(19), 151-163.
- Ozcakir, B., & Cakiroglu, E. (2021). An Augmented Reality Learning Toolkit for Fostering Spatial Ability in Mathematics Lesson: Design and Development. *European Journal of Science and Mathematics Education*, 9(4), 145-167.
<https://doi.org/10.30935/scimath/11204>
- Palancı, A., & Turan, Z. (2021). How Does the Use of the Augmented Reality Technology in Mathematics Education Affect Learning Processes? A Systematic Review. *Uluslararası Eğitim Programları ve Öğretim Çalışmaları Dergisi*, 11(1), 89-110.
- Pujiastuti, H., & Haryadi, R. (2023). Enhancing Mathematical Literacy Ability through Guided Inquiry Learning with Augmented Reality. *Journal of Education and e-Learning Research*, 10(1), 43-50.

- <https://doi.org/10.20448/jeelr.v10i1.4338>
- Rahayu, M., Aima, Z., & Juwita, R. (2023). Validitas E-Modul Berbasis Android Menggunakan Sigil Software pada Materi Peluang. *Plusminus: Jurnal Pendidikan Matematika*, 3(2), 265–276.
<https://doi.org/10.31980/plusminus.v3i2.1342>
- Rahman, H. N., & Setyaningrum, W. (2022, December). Mathematics learning based on augmented reality: A relevant mathematics teaching content and enhanced student abilities. In *AIP Conference Proceedings* (Vol. 2575, No. 1). AIP Publishing.
<https://doi.org/10.1063/5.0108248>
- Rahman, M. S. (2025). Eksplorasi Hubungan Augmented Reality Dan Kecemasan Terhadap Penerapan Kecakapan Matematis Pada Pembelajaran Geometri. *Radian Journal: Research and Review in Mathematics Education*, 4(2), 59–70.
<https://doi.org/10.35706/radian.v4i2.13169>
- Ramadhani, R., Juandi, D., & Nurlaelah, E. (2021). A meta-analysis on the effect of inquiry learning model on students' mathematical problem-solving skills. *Indonesian Journal of Science and Mathematics Education*, 4(3), 302-312.
- Rino, R., Ariyadi, W., Tri, R., Ahmad, A. A., Astri, W. A., & Khasanah, N. H. (2023). Ethnomathematics augmented reality: Android-based learning multimedia to improve creative thinking skills on geometry. *International Journal of Information and Education Technology*, 13(4), 731-737.
<https://doi.org/10.18178/ijiet.2023.13.4.1860>
- Rozi, F., Kurniawan, R. R., & Sukmana, F. (2021). Pengembangan Media Pembelajaran Pengenalan Bangun Ruang Berbasis Augmented Reality Pada Mata Pelajaran Matematika. *JUPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika)*, 6(2), 436–447.
<https://doi.org/10.29100/jipi.v6i2.2180>
- Safrida, L., Suwito, A., & Ambarwati, R. (2025). Augmented Reality in Case Method Learning to Improve Geometry Skills. *Mosharafa: Jurnal Pendidikan Matematika*, 14(2), 559–570.
<https://doi.org/10.31980/mosharafa.v14i2.3064>
- Saputri, R. R., & Qohar, A. (2020, October). Development of comic-based mathematics learning media on social arithmetic topic. In *Journal of Physics: Conference Series* (Vol. 1657, No. 1, p. 012082). IOP Publishing.
- Saputro, T. V. D., Purnasari, P. D., Lumbantobing, W. L., & Sadewo, Y. D. (2024). Augmented Reality for Mathematics Learning: Could We Implement It in Elementary School? *Mosharafa: Jurnal Pendidikan Matematika*, 13(1), 163–174.
<https://doi.org/10.31980/mosharafa.v13i1.1984>
- Schutera, S., Schnierle, M., Wu, M., Pertz, T., Seybold, J., Bauer, P., ... & Krause, M. J. (2021). On the potential of augmented reality for mathematics

teaching with the application cleARmaths. *Education Sciences*, 11(8), 368. <https://doi.org/10.3390/educsci11080368>

Sudirman, S., Luritawaty, I. P., & Bonyah, E. (2024). Conceptual Knowledge through Instruction Interactive Teaching Materials Integrated Augmented Reality. *Mosharafa: Jurnal Pendidikan Matematika*, 13(2), 273–290. <https://doi.org/10.31980/mosharafa.v13i2.1957>

Sungkono, S., Apiati, V., & Santika, S. (2022). Media Pembelajaran Berbasis Teknologi Augmented Reality. *Mosharafa: Jurnal Pendidikan Matematika*, 11(3), 459–470. <https://doi.org/10.31980/mosharafa.v11i3.737>

Velázquez, F. D. C., & 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>

Wohlin, C., Mendes, E., Felizardo, K. R., & Kalinowski, M. (2020). Guidelines for the search strategy to update systematic literature reviews in software engineering. *Information and software technology*, 127, 106366.

Wong, C. H. S., Tsang, K. C. K., & Chiu, W.-K. (2021). Using augmented reality as a powerful and innovative technology to increase enthusiasm and enhance student learning in higher education chemistry courses. *Journal of Chemical Education*, 98(11), 3476–3485.

<https://doi.org/10.1021/acs.jchemed.0c01029>

AUTHOR'S BIOGRAPHY

Dina Prasetyowati, S.Pd., M.Pd.



Born in Jember, December 30, 1984. He earned a bachelor's degree in Mathematics Education from Semarang State University and a master's degree in Mathematics Education from Semarang State University. He is currently a lecturer in the Mathematics Education study program at PGRI Semarang University.

Prof. Dr. Dr. Wardono, M.Si.



Professor in the Department of Mathematics, Faculty of Mathematics and Natural Sciences, UNNES, who is known as an expert in developing mathematics learning to improve students' mathematical literacy, with a focus on making mathematics easy, fun, and meaningful, and actively fostering competitions such as OSN and PPG.

Dr. Scolastika Mariani, M.Si.



Lecturer at Semarang State University majoring in Mathematics (FMIPA), with a specialization in Applied Statistics, and actively teaches and guides students at various levels of education

Dr. Nuriana Rachmani Dewi, M.Pd.



Lecturer at Semarang State University majoring in Mathematics (FMIPA), with a specialization in the field of Learning Education, and actively teaches and guides students at various levels of education