

## Advancing Science Learning Outcomes with Quiver AR and Problem Based Learning

Nadiya Solastika Andhini, Sri Yamtinah, Joko Daryanto

Universitas Sebelas Maret  
jengtina@staff.uns.ac.id

---

### Article History

accepted 1/2/2026

approved 1/3/2026

published 31/3/2026

---

### Abstract

*The rapid development of educational technology highlights the need for innovative learning approaches that can enhance students learning outcomes and support sustainable education in elementary schools. This study aims to examine how the integration of Quiver Augmented Reality (AR) and Problem Based Learning (PBL) contributes to improving learning outcomes and higher-order thinking skills in elementary education. This research employed a Systematic Literature Review (SLR) method by analyzing peer-reviewed journal articles published between 2021 until 2025 obtained from databases such as Scopus, Spinger Nature, ScienceDirect, Google Scholar, etc. The selected studies were reviewed using predefined inclusion and exclusion criteria and synthesized to identify research trends, instructional impacts, and implementation challenges. The findings indicate that the integration of Quiver AR and PBL consistently enhances students' learning outcomes, particularly in science subjects, by improving conceptual understanding, learning engagement, and motivation. Additionally, most studies report positive effects on students critical thinking and problem solving skills due to the interactive and student centered nature of AR supported PBL environments. However, several challenges were identified, including limited teacher readiness, technical constraints, and the need for appropriate instructional design. Quiver AR integrated with Problem-Based Learning represents a promising educational technology innovation that supports effective, engaging, and sustainable learning in elementary education.*

**Keywords:** *Augmented Reality, Elementary School, Educational Technology, Learning Outcomes, Problem Based Learning*

### Abstrak

Perkembangan teknologi pendidikan yang pesat menegaskan pentingnya pendekatan pembelajaran inovatif yang mampu meningkatkan hasil belajar peserta didik serta mendukung pendidikan berkelanjutan di Sekolah Dasar. Penelitian ini bertujuan untuk mengkaji bagaimana integrasi Quiver Augmented Reality (AR) dan Problem Based Learning (PBL) berkontribusi dalam meningkatkan hasil belajar dan keterampilan berpikir tingkat tinggi pada pendidikan dasar. Penelitian ini menggunakan metode Systematic Literature Review (SLR) dengan menganalisis artikel jurnal bereputasi yang dipublikasikan pada rentang tahun 2016 hingga 2025 yang diperoleh dari basis data seperti Scopus, Springer Nature, ScienceDirect, Google Scholar, dan sumber lainnya. Artikel yang terpilih ditelaah menggunakan kriteria inklusi dan eksklusi yang telah ditetapkan, kemudian disintesis untuk mengidentifikasi tren penelitian, dampak pembelajaran, serta tantangan implementasi. Hasil kajian menunjukkan bahwa integrasi Quiver AR dan PBL secara konsisten mampu meningkatkan hasil belajar peserta didik, khususnya pada mata pelajaran IPA, melalui peningkatan pemahaman konsep, keterlibatan belajar, dan motivasi. Selain itu, sebagian besar penelitian melaporkan adanya pengaruh positif terhadap kemampuan berpikir kritis dan keterampilan pemecahan masalah peserta didik karena karakteristik lingkungan pembelajaran PBL berbantuan AR yang interaktif dan berpusat pada peserta didik. Namun demikian, ditemukan beberapa tantangan, antara lain keterbatasan kesiapan guru, kendala teknis, serta perlunya desain pembelajaran yang tepat. Integrasi Quiver AR dengan Problem Based Learning merupakan inovasi teknologi pendidikan yang menjanjikan dalam mendukung pembelajaran yang efektif, menarik, dan berkelanjutan di Sekolah Dasar.

**Kata kunci:** *Augmented Reality, Hasil Belajar, Problem Based Learning, Sekolah Dasar, Teknologi Pendidikan*

---



## INTRODUCTION

Education currently plays a crucial role in building a nation, as it is the primary foundation for advancing the nation (Dewi et al., 2024). Implementing an educational system requires the use of sound learning methods and media. The increasingly dynamic developments of this era have transformed the education system to adapt to the current globalization (Utomo & Agustina, 2022). Education is a process of sharing or acquiring knowledge between individuals (Sukma et al., 2022). Education is a conscious and planned effort used to prepare students through the learning process, in which educators play a role in teaching (Ariyani & Kristin, 2021). The success of the learning process is known when there is individual change for the better (Arzeti & Ismiyanti, 2025). The learning process can run smoothly if it includes learning models and media that can create competent and independent individuals.

Learning activities will be more meaningful if students are directly involved in solving the problems they face. By involving students in the problem-solving process, it is hoped that they will be able to understand subjects, especially science, more comprehensively and deeply (Wakhid et al., 2022). Therefore, educators need to create a learning environment that supports students' active involvement in the problem-solving process. One way to do this is by implementing an appropriate learning model. There are many different learning models, one of which is *the Problem-Based Learning* (PBL) model. The PBL learning model is a problem-based model, so learning activities are directed towards solving problems. This problem-based model makes educators facilitators of teaching and learning activities that focus on student activity. Learning will be more meaningful when the learning process involves active participation of students, both individually and in groups, so they have more real-life experiences (Djonomiarjo, 2021). This is in line with research (Elsa Yuliana et al., 2023) which states that problem-based learning uses problems to teach students to develop knowledge, skills, and self-confidence.

Learning media currently comes in a variety of forms, one of which is digital learning media. The use of learning media is expected to assist and facilitate students' learning process, leading to successful learning outcomes (Yeni et al., 2023). The essence of learning media is a means of conveying information from educators to students. The primary function of learning media is to create a learning environment for students, enabling them to receive knowledge accurately and in-depth, as well as developing cognitive capacity and shaping their personalities (Saleh et al., 2023). Good learning media is media that can help students understand the material presented.

use of technology simplifies the delivery of learning materials. Technology-based learning will certainly attract students' attention and increase their focus on learning. Digital learning certainly requires tools to convey messages or support the teaching and learning process. Learning media becomes a tool to convey messages or support learning (Luthfi et al., 2023). Media becomes a learning delivery process that is useful for achieving learning outcomes and experiences and has an influence on students' learning experiences (Sitepu, 2022). In this regard, educators have a crucial role in implementing digital learning media to be able to create quality learning activities that meet the characteristics of 21st-century students who tend to require interactive digital-based learning media (Rahma et al., 2023). Learning media that have a digital or technological touch play a crucial role in the teaching and learning process because learning activities will be more enjoyable, less boring, and can facilitate students' understanding of the material in a real way.

The digital media used in this study is Quiver AR. Augmented Reality (AR) technology is able to combine digital media with the real world in real-time and create interactive and immersive learning experiences (Aziz et al., 2025). One example is AR-based media that is relevant for Metamorphosis science learning. This educational

application is a web that is able to transform two-dimensional images that have been colored into three-dimensional objects that can move through mobile devices or cellphones (Sapitri et al., 2023) . Quiver AR not only displays a unique visual experience, but also involves auditory and kinesthetic aspects that can make students more active. In line with the research of Lee et al. (2024) that AR technology has great potential to increase active student engagement because it provides a more meaningful learning experience. This Quiver AR media has novelty in the study because it is related to the PBL model that can train problem solving with AR technology that can provide visual, auditory, and kinesthetic experiences simultaneously. This combination has rarely been studied in depth in the literature on science learning in elementary schools.

The selection of the PBL model and Quiver AR media is based on the fact that the use of technology can facilitate teachers in visualizing material that students have previously only been able to imagine. Thus, technology can help students see the metamorphosis process that has previously only been imagined. Furthermore, science subjects certainly require direct experience or direct practice to see concrete results. Currently, science material is one of the important materials in the elementary school curriculum. However, many students still experience difficulty in understanding science material because it requires quite high critical thinking skills (Rambe et al., 2024) . This creates a clear gap between the demands of the curriculum and students' actual abilities. Some students still experience significant obstacles in understanding science concepts that require high critical thinking skills. This gap is clearly visible in abstract materials such as metamorphosis, where students are often only asked to imagine the process without adequate visualization. Reliance on teacher explanations alone without direct experience leads to students' understanding being less critical. Science learning in elementary schools should be student-centered *and* educators should encourage students to develop independently through experiments in learning.

The learning process, accompanied by the use of appropriate learning methods and media, is expected to improve critical thinking skills and student learning outcomes. This is urgent because the need for technology is increasingly pressing. Current learning requires technological literacy. Integrating technology can bridge students' cognitive difficulties before these barriers to understanding become permanent and reduce their learning motivation. This aligns with one of the goals of education, which is to develop students' critical thinking skills. Critical thinking skills are the ability to analyze, evaluate, and combine logically and rationally problems (Untari et al., 2018) . Students with high critical thinking skills will also influence learning outcomes. The selection of appropriate learning methods and media also influences student learning outcomes. Learning outcomes are crucial to achieving learning objectives, which are seen from the influencing factors, including learning methods and media (Nyoman Dewi Astiti et al., 2021) .

Learning outcomes are the results achieved by students after receiving instruction for a certain period of time (Yandi et al., 2023) . Learning outcomes are a reflection of learning efforts; if students' learning efforts are good, the learning outcomes they obtain will also be better. Learning outcomes are certain competencies or abilities, whether cognitive, affective, or psychomotor, achieved or mastered by students after receiving the learning process (Indah & Anisatul, 2021) . Learning outcomes serve as a reference in assessing the success of learning experienced by students. Learning outcomes obtained by students can be in the form of several abilities, namely aspects of knowledge, aspects of attitudes, and aspects of skills possessed by students after receiving learning materials (Rahman, 2021) . The influence of increased learning outcomes is also partly due to the teacher's strategy in teaching and the selection of appropriate methods and media.

Based on the identification of problems and urgency that have been described, this study aims to analyze and describe in depth the effectiveness of the integration of the Problem Based Learning (PBL) model assisted by Quiver AR media in transforming the quality of science learning in Elementary Schools. This study examines how the synergy between the PBL approach and Augmented Reality technology can stimulate students' critical thinking skills in solving authentic problems, while measuring its impact on improving learning outcomes that include the cognitive, affective, and psychomotor domains. Through this systematic literature review, it is hoped that innovative integration patterns can be found that are able to visualize abstract concepts into concrete, interactive, and student-centered learning experiences, thereby providing theoretical and practical contributions to the development of science learning strategies that are more effective and adaptive to the needs of the 21st century.

### **METHOD**

This study used the Systematic Literature Review (SLR) method. This method identifies, examines, evaluates, and interprets all research obtained. Researchers reviewed various articles according to the research questions (Alifah et al., 2023). The analysis stages were carried out in a structured and systematic manner in each process by following various predetermined stages (Triandini et al., 2019). After that, researchers conducted an in-depth review of the analyzed articles. Data collection and analysis techniques need to be carefully considered to obtain accurate and reliable research results. This Systematic Literature Review (SLR) study has five stages: 1) formulating the research questions, 2) describing and searching for relevant articles, 3) classifying and evaluating the collected articles, 4) extracting and processing data, 5) interpreting the article findings and providing conclusions (Fitriani & Putra, 2022; Nurfadilah et al., 2022).

Researchers need to determine the theme to be studied. Researchers chose the theme "Quiver AR media and the PBL model" as the topic to be discussed in the research. Literature study data collection was carried out by searching for articles in Google Scholar, Scopus, and other literature sources. Researchers limited the years from 2016-2026. After that, selecting articles by selecting the content of articles relevant to the research. The selected articles contained more than 30 articles sourced from Google Scholar and Scopus. Articles were selected by researchers through in-depth and systematic analysis. The analysis technique was carried out by extracting important information from each literature, which included key findings regarding the advantages and disadvantages of the PBL model, the effectiveness of Quiver AR media, and factors that influence student learning outcomes. The extracted data were then processed, compared, and synthesized to obtain a comprehensive picture of the contribution of PBL and Quiver AR integration to the quality of learning in Elementary Schools. The final results of this analysis were then narrated to provide accurate and reliable conclusions.

### **RESULTS AND DISCUSSION**

#### **PBL Learning Model**

The Problem Based Learning (PBL) learning model is an approach that teaches students about authentic problems with the aim of constructing knowledge independently, developing inquiry and higher-order thinking skills, and developing independence and self-confidence (Musyadad, 2022). The PBL learning model is a form of learning based on the constructivism paradigm, where the learning orientation is student-centered learning. (Mayasari et al., 2022). The main focus of this PBL model is on presenting real problems to students, then students are asked to find solutions to the problems themselves through research and investigation based on theories, concepts and principles learned from the knowledge they have acquired. The PBL

model teaches students to exchange ideas with other friends, listen to opinions, reflect on their own ideas, and ultimately find the right solution to the problem at hand (Yu & Zuhana, 2023) . The application of the PBL model involves students in the challenge of learning to face problems and solve them in the real world.

The primary foundation of PBL is the existence of a problem. In the PBL model, students are invited to analyze the problem and then consider various analytical solutions to the problem. Therefore, the PBL model positions students as the primary subjects in learning activities and in achieving learning outcomes. Students are encouraged to think independently, develop self-confidence, and produce results in ongoing activities (Aprina et al., 2024) . Thus, the PBL model is able to create a learning environment that supports students in achieving critical thinking skills and science learning outcomes. According to Rusman (2021) , the main characteristics of the PBL learning model are: 1) the beginning of learning is in the form of a problem, 2) the problems discussed are in the unstructured real world, 3) problems require multiple perspectives, 3) students are given challenges from problems to find out knowledge, attitudes, and competencies that require learning identification, 5) the main thing is self-directed learning, 6) the sources of knowledge utilized can be diverse, 7) learning is collaborative, communicative, and cooperative, 8) the development of inquiry and problem solving have an important role in knowledge in finding solutions to problems, 9) the openness of the PBL process in the form of synthesis and integration of the learning process, 10) involves evaluation and review of student experiences and the learning process.

The PBL learning model is based on the theoretical framework of constructivism, social learning, situated cognition , and the quality of practice of various learning theories (Muhartini et al., 2023) . In this PBL model, educators have a role in presenting problems, asking questions, and facilitating inquiry and dialogue. This problem-based learning will not run optimally if educators do not create a learning environment that allows for an open exchange of ideas or concepts. This PBL learning model has five main stages that begin with a problem and end with the presentation and analysis of solutions to the problem. The characteristics of the problems used are real-world environmental conditions, problems that can be solved, interdisciplinary, objective, oriented towards completing tasks, and require complex knowledge.

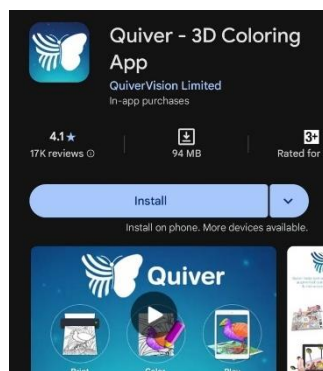
This PBL learning model certainly has advantages and disadvantages in the implementation process. According to Dulyapit et al. (2023) the advantages of using the PBL model include 1) being able to improve student learning outcomes, 2) students will be accustomed to solving problems in everyday life, 3) improving critical thinking skills, initiative, creativity, and innovation, 4) improving knowledge and skills in group work. Meanwhile, the disadvantages of the PBL model are: 1) students' self-confidence will decrease when they are not willing to try, 2) difficulty in finding solutions to problems, 3) requiring a lot of time to find the right answer. These disadvantages can be anticipated by educators if they are able to condition learning activities well.

### **Quiver AR Learning Media**

Quiver AR Media is a technology-based learning media that uses Augmented Reality. Augmented Reality (AR) is a technology that combines two-dimensional or three-dimensional virtual objects with a real three-dimensional environment and then projects them through these virtual objects in real time (Sari et al., 2022) . The main focus of Augmented Reality (AR) is on technological reality because it is closer to the real world. Augmented Reality (AR) allows users to interact in real-time with the system. The development of Augmented Reality (AR) is very fast so it can be applied in various fields including education, one of which is science learning.

Quiver media is considered augmented reality because, in its application, students scan a pre-made image, and the colored image appears in real time . Quiver is an app

available on the Play Store for Android and iOS. Below is a screenshot of the Quiver app.



Gambar 1.1 Aplikasi Quiver

According to Aziz et al. (2025), Quiver media can increase students' enthusiasm for learning and create a more enjoyable and less boring learning atmosphere. This is in line with research by Lee et al. (2024) that AR technology can participate in the development of in-depth learning and improve student competency. This is reinforced by Rahayu et al. (2021) who stated that interactive media is very effective in improving conceptual understanding because students will more easily grasp material in visual and narrative forms. Another study by Niningsih et al. (2025) showed that Augmented Reality is effective for use in learning. This can be concluded that AR media has high flexibility for use in various learning needs, both regular and inclusive.

The use of Quiver AR media certainly has advantages and obstacles, especially those experienced by educators. The advantage felt by educators when using Quiver media as an interactive learning medium is that students become more focused and orderly in completing the assigned tasks. However, the obstacle experienced in utilizing the Quiver AR application is still difficulty in directing the camera to detect the results of the images that have been worked on. Therefore, many students are impatient to see the results of their work, so that the focus of educators is hampered (Fatmawati et al., 2019). This obstacle can be overcome by using a cellphone with a camera that supports good scanning or can also be scanned images must be clearer to get maximum results.

### Learning Outcomes

Learning outcomes are useful for measuring students' abilities related to their understanding of the material being taught. Learning outcomes are the results achieved by students after learning activities in a specified subject and within a specified time (Rahmawati, 2020). Learning outcomes are the achievements of students after carrying out learning and have achieved changes in the students themselves (Wijayanti & Sri Adi, 2021). Student learning outcomes are efforts to achieve academic achievements through exams or assignments, active participation in questions and answers that can support the acquisition of these learning outcomes (Dhaki, 2020).

Achieving good learning outcomes can be determined by the learning models and media used by educators. Educators and educational practitioners need to improve student learning outcomes because they can be useful in facing problems or life challenges in the future (Aini et al., 2023). There are two factors that influence student learning outcomes, including internal factors and external factors. Internal factors that influence student learning outcomes include attitude, intelligence, habits, interest, talent, and motivation. External factors that influence are family, community, and school (Astiti et al., 2021). The choice of learning models and media is also a determining factor in the success of improving student learning outcomes.

Good learning outcomes can be determined by quality learning models and media (Marini et al., 2022) . Learning outcomes are the abilities a person acquires from learning activities. The quality of learning can be measured through student learning outcomes. Educators can determine whether students have understood and mastered the material. Therefore, the use of technology such as Augmented Reality is expected to be able to change student learning outcomes for the better, thereby enhancing the learning experience and improving the quality of learning (Lestari et al., 2019; Naik et al., 2020) .

In line with research by Haryana et al. (2022) , learning outcomes are the cognitive achievements and performance abilities of each individual after receiving material in the learning process. Learning outcomes are measured to determine the extent to which students understand the material, remember information, and demonstrate increased abilities after using learning media. According to another study by Wittmann et al. (2025) , learning outcomes can improve when the use of learning media is appropriate. Differences in the characteristics of the learning environment also affect student learning outcomes. When learning is made more flexible and creates a pleasant atmosphere, student learning outcomes will improve. The opinion of Paul et al. (2025) states that learning outcomes are things that describe the knowledge, skills, and competencies obtained by students after receiving learning materials.

Based on this statement, it can be concluded that learning outcomes are measured by students after going through a learning process that includes cognitive, psychomotor, and affective aspects. Learning outcomes are expected to be able to change student behavior to have a better understanding related to the material being taught. Learning outcomes aim to determine the level of achievement of student competencies. In addition, learning outcomes function to determine student abilities and involve the extent to which students have understood the material. If students experience difficulties with certain material, of course, educators must provide more extra explanations of the material, so that all students have the same understanding of the material.

### CONCLUSION

The integration of Quiver Augmented Reality (AR) learning media has been proven to significantly transform the quality of science learning in elementary schools by presenting abstract concept visualizations that are more concrete and interactive. The use of this technology can create a more meaningful and student-centered learning experience because it presents three-dimensional objects in real time that simultaneously involve visual, auditory, and kinesthetic aspects. This directly addresses the need for innovative media that can bridge students' difficulties in observing natural processes and phenomena in real time.

The application of the Problem-Based Learning (PBL) model in synergy with these media has been proven to effectively improve learning outcomes and higher-order thinking skills in elementary education. Through an orientation towards solving real-world problems, this model encourages students to actively engage in investigations, discussions, and reflections that have a positive impact on the cognitive, affective, and psychomotor domains. Thus, the combination of the PBL model and Quiver AR is a strategic innovation to improve students' conceptual understanding and critical thinking skills in facing the challenges of science learning.

The implications of this research indicate that the success of 21st-century learning relies heavily on the collaboration between appropriate instructional strategies and the use of cutting-edge technology. However, several limitations exist in its implementation, such as technical constraints on devices, obstacles in the image scanning process, and limited teacher readiness in mastering digital technology. As a recommendation, continuous efforts are needed to improve teacher competency in

mastering innovative technology and systematic learning planning. It is also recommended that future researchers conduct empirical studies directly in the classroom to explore the potential of AR media in other subjects.

### REFERENCE

- Aini, N. N., Milatul, A., Rofi', S. B., & M. Anas, T. (2023). Efektivitas Penggunaan Media Pembelajaran Virtual Reality terhadap Hasil Belajar Siswa pada Pembelajaran IPA di SD. *Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar*, 6(2), 267. <https://doi.org/10.33603/caruban.v6i2.8611>
- Al, E. Y. et. (2023). 3 1, 2,3. 08:1730–40.
- Alifah, H. N., Virgianti, U., Imam, M., Sarin, Z., Studi, P., Guru, P., Dasar, S., & Kudus, U. M. (2023). Systematic Literature Review: Pengaruh Media Pembelajaran Digital pada Pembelajaran Tematik Terhadap Hasil Belajar Siswa SD. *Jurnal Ilmiah Dan Karya Mahasiswa*, 1(3), 103–115.
- Aprina, E. A., Erna, F., & Andi, S. (2024). Penerapan Model Problem Based Learning dalam Mengembangkan Keterampilan Berpikir Kritis Pada Mata Pelajaran IPA. *Indonesian Research Journal on Education*, 4(3), 981–990. <https://doi.org/10.31004/irje.v4i3.832>
- Ariyani, B., & Kristin, F. (2021). Model Pembelajaran Problem Based Learning untuk Meningkatkan Hasil Belajar IPS Siswa SD. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 5(3), 353–361.
- Arzeti, E. F., & Ismiyanti, Y. (2025). Pengaruh Model PBL Terhadap Kemampuan Berpikir Kritis Matematika Siswa SD Berbantuan Media Roda Putar Bangun Datar. *Integrative Perspectives of Social and Science Journal*, 2(1), 842.
- Astiti, N. D, Luh Putu, P. M., & I Made, S. (2021). Faktor Yang Mempengaruhi Hasil Belajar. *Jurnal Mimbar Ilmu*, 26(2), 193–203. <https://ejournal.undiksha.ac.id/index.php/MI>
- Astiti, Nyoman Dewi, Luh Putu, P. M., & I Made, S. (2021). Faktor Yang Mempengaruhi Hasil Belajar. *Jurnal Mimbar Ilmu*, 26(2), 193–203. <https://ejournal.undiksha.ac.id/index.php/MI>
- Aziz, A., Herry, W. S., Widyawati, Yuliana, N., M. Agus, S. N., & Febri, I. (2025). Quiver Sebagai Media Pengajaran Alfabet pada Sekolah Dasar: Studi Deskriptif. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, 3(4), 5562–5567. <https://doi.org/10.31004/jerkin.v3i4.1445>
- Dewi, R. A. M., Desi, N. A., & Ririn, S. (2024). Pengaruh Model Pembelajaran Problem Based Learning Berbantuan Media Komik Digital Terhadap Kemampuan Berpikir Kritis Siswa Pada Materi Fotosintesis Kelas IV SD Negeri. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran*, 5(1), 841–850. <https://doi.org/10.62775/edukasia.v5i1.867>
- Dhaki, A. S. (2020). Peningkatan Hasil Belajar Siswa. *Jurnal Pendidikan Indonesia*, 1(03), 283–294.
- Djonomiarjo, T. (2021). Pengaruh Model Problem Based Learning Terhadap Hasil Belajar. *Jurnal Ilmu Pendidikan Nonformal Aksar*, 5(1), 39–46. <http://ejournal.pps.ung.ac.id/index.php/AKSARA/index>
- Dulyapit, A., Yayat, S., & Fanny, S. (2023). Application of the Problem Based Learning (PBL) Model to Improve Student Learning Outcomes in Class V at UPTD SD Negeri Tapos 5, Depok City. *Journal of Insan Mulia Education*, 1(1), 31–37.
- Fatmawati, N., Kisno, Devi, N., & Ardiyansyah. (2019). Pemanfaatan Aplikasi Quiver-3D Coloring Berbasis Augmented Reality dalam Pengembangan Kognitif Anak Usia Dini. *Prosiding Seminar Nasional Guruan Lampung, November*.
- Fitriani, D., & Putra, A. (2022). Systematic Literature Review (SLR): Eksplorasi Etnomatematika pada Makanan Tradisional. *Journal of Mathematics Education And Learning*, 2(1), 18. <https://doi.org/10.19184/jomeal.v2i1.29093>
- Haryana, M. R. A., Sony, W., Didi, A., & Ertambang, N. (2022). Virtual Reality Learning Media with Innovative Learning Materials to Enhance Individual Learning Outcomes

- Based on Cognitive Load Theory. *The International Journal of Management Education*, 20(3). 10.1016/j.ijme.2022.100657
- Indah, R. P., & Anisatul, F. (2021). Pengaruh Kemandirian Belajar Terhadap Hasil Belajar Siswa. *Madrosatuna: Jurnal Pendidikan Guru Madrasah Ibtidaiyah*, 8(1), 41–47. <https://doi.org/10.47971/mjpgmi.v2i1.63>
- Lee, S., Kim, H., & Park, J. (2024). The Impact of Augmented Reality on Creativity and Learning Engagement in Elementary Education. *International Journal of Emerging Technologies in Learning*, 19(3), 45–58. <https://doi.org/10.3991/ijet.v19i03.12345>
- Lestari, I., Maksum, A., & Kustandi, C. (2019). Mobile Learning Design Models for State University of Jakarta, Indonesia. *International Journal of Interactive Mobile Technologies*, 13(09), 152–171. <https://doi.org/10.3991/ijim.v13i09.10987>
- Luthfi, T., Shalimar, A., Zidan, A. F., Syifa, M. P., Sofyan, I., & Nadia, T. A. S. (2023). Media Pembelajaran Digital sebagai Penunjang Mata Pelajaran IPA di Sekolah Dasar. *Indonesian Journal of Teaching and Learning (INTEL)*, 2(4), 484–492. <https://doi.org/10.56855/intel.v2i4.374>
- Marini, A., Syifa, N., Tunjungsari, S., Desy, S., Ika, L., Yustia, S., Ajat, S., & Rossi, I. (2022). Mobile Augmented Reality Learning Media with Metaverse to Improve Student Learning Outcomes in Science Class. *IJIM: International Journal of Interactive Mobile Technologies*, 16(07), 99–115.
- Mayasari, A., Opan, & Juliawati, E. (2022). Implementasi Model Problem Based Learning (PBL) dalam Meningkatkan Keaktifan Pembelajaran. *Jurnal Tahsinia*, 3(2), 167–175. <https://doi.org/10.57171/jt.v3i2.335>
- Muhartini, Amril, M., & Abu, B. (2023). Pembelajaran Kontekstual dan Pembelajaran Problem Based Learning. *Pembelajaran Kontekstual Dan Pembelajaran Problem Based Learning*, 1(1), 66–77.
- Musyadad, V. F. (2022). Supervisi Akademik untuk Meningkatkan Motivasi Kerja Guru dalam Membuat Perangkat Pembelajaran. *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, 5(6), 1936–1941.
- Naik, G., Chitre, C., Bhalla, M., & Rajan, J. (2020). Impact of Use of Technology on Student Learning Outcomes: Evidence From a Large-Scale Experiment in India. *World Development*, 127, 1–28. <https://doi.org/10.1016/j.worlddev.2019.104736>
- Niningsih, Salam, A., & Ramadhan, S. (2025). Penerapan Media Pembelajaran Pengenalan Hewan Berbasis Augmented Reality untuk Anak Usia Dini di TKN 26 Lelamase. 2(1). <https://doi.org/10.61798/galon.v2i1.275>
- Nurfadilah, A., Hakim, A. R., & Nurrohidah, R. (2022). Systematic Literature Review: Pembelajaran Matematika pada Materi Luas dan Keliling Segitiga. *Polinomial: Jurnal Pendidikan Matematika*, 1(1), 1–13.
- Paul, A. K., Das, D., Chatterjee, K., & Dey, P. (2025). Automated Learning Outcome Extraction Systems. *Lecture Notes in Networks and Systems*. 10.1007/978-981-96-6534-1\_20
- Rahayu, D., Utami, F., Nur, I., Laili, N., Yuniati, R., & Mulia, S. (2021). My Alphabet Application: Alphabet Introduction Learning Media for 1st-grade Elementary School using Augmented Reality Technology. *Jurnal UPI: Journal of Software Engineering, Information & Communication Technology (SEICT)*.
- Rahma, F. A., Harjono, H. S., & Sulistyono, U. (2023). Problematika Pemanfaatan Media Pembelajaran Berbasis Digital. *Jurnal Basicedu*, 7(1), 603–6011. <https://doi.org/10.31004/basicedu.v7i1.4653>
- Rahman, S. (2021). Pentingnya Motivasi Belajar dalam Meningkatkan Hasil Belajar. 289–302.
- Rahmawati, M. S. (2020). Meningkatkan Hasil Belajar Matematika Materi Pokok Bilangan pada Peserta Didik MI Negeri Karang Poh Pulosari Pematang Melalui Strategi Think Talk Write (TTW). *Indonesian Journal of Educationalist*, 1(2), 199–210.
- Rambe, Y., Khaeruddin, & Ma'ruf. (2024). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kritis dan Hasil Belajar IPA pada Siswa Sekolah Dasar. 4(1), 341–355. <https://doi.org/https://doi.org/10.51574/jrip.v4i1.1372>

- Rusman. (2021). *Model-Model Pembelajaran*. Jakarta: PT. Raja grafindo Persada.
- Saleh, M. S., Syahrudin, Muh. Syahrul, S., Azis, I., & Sahabuddin. (2023). Media Pembelajaran. In *Eureka Media Aksara* (pp. 6–7). Purbalingga: Eureka Media Aksara. <https://repository.penerbiteureka.com/publications/563021/media-pembelajaran>
- Sapitri, M. W., Indihadi, D., & Rahman, T. (2023). Pengembangan Media Pembelajaran Alphabet Match dalam Mengenalkan Huruf Pada Anak Usia Dini. *Jurnal PAUD AGAPEDIA*, 7(1). <https://doi.org/10.17509/jpa.v7i1.59930>
- Sari, I. P., Ismail, H. B., Al Hamidy, H., & Mhd, B. (2022). Pengenalan Bangun Ruang Menggunakan Augmented Reality sebagai Media Pembelajaran. *Hello World Jurnal Ilmu Komputer*, 1(4), 209–215. [https://jurnal.ilmubersama.com/index.php/hello\\_world/article/view/142](https://jurnal.ilmubersama.com/index.php/hello_world/article/view/142)
- Sitepu, E. N. (2022). Media Pembelajaran Digital. *Prosiding Seminar Pendidikan Dasa*, 242–248. doi: 10.34007/ppd.v1i1.19
- Sukma, R. R., Ismiyanti, Y., & Ulia, N. (2022). Pengaruh Blended Learning dengan model Flipped Classroom Berbantuan Video terhadap Hasil Belajar Kognitif Kompetensi IPA Kelas V. *Jurnal Ilmiah Pendidikan Dasar*, 9(2), 142. <https://doi.org/10.30659/pendas.9.2.142-156>
- Triandini, E., Jayanatha, S., Indrawan, A., Werla Putra, G., & Iswara, B. (2019). Metode Systematic Literature Review untuk Identifikasi Platform dan Metode Pengembangan Sistem Informasi di Indonesia. *Indonesian Journal of Information Systems*, 1(2), 63. <https://doi.org/10.24002/ijis.v1i2.1916>
- Untari, E., Rohmah, N., & Lestari, D. W. (2018). Model Pembelajaran Problem Based Learning (PBL) sebagai Pembiasaan Higher Order Thinking Skills (HOTS) pada Pembelajaran IPA di Sekolah Dasar. *Prosiding SNPS (Seminar Nasional Pendidikan Sains)*, 135–142. <https://jurnal.fkip.uns.ac.id/index.php/snps/article/view/12529>
- Utomo, I. S., & Agustina, T. A. H. (2022). Penerapan Model Pembelajaran Problem Based Learning untuk Meningkatkan Hasil Belajar dan Kemampuan Berpikir Kritis Matematika pada Siswa Kelas IV Sekolah Dasar. *Pinisi Journal Pendidikan Guru Sekolah Dasar*, 2(2), 736. <https://doi.org/10.70713/pjp.v2i2.29692>
- Wakhid, A., Maria, A. A., & Marciana, S. (2022). Peningkatan Keaktifan dan Hasil Belajar IPA dengan Model Pembelajaran Problem Based Learning (PBL) Kelas V SD Negeri Sudimoro 2 Tahun Ajaran 2021/2022. *Teaching: Jurnal Inovasi Keguruan Dan Ilmu Pendidikan*, 2(2), 234–239. <https://www.jurnalp4i.com/index.php/teaching/article/view/1345>
- Wijayanti, N., & Sri Adi, W. (2021). Studi Korelasi Motivasi Belajar terhadap Hasil Belajar Matematika Selama Daring. *Journal of Instructional Mathematics*, 2(1), 1–9. <https://doi.org/10.37640/jim.v2i1.849>
- Wittmann, S., Wulf, T., & Fabian, A. M. (2025). The International Journal of Management Education Conventional Versus Fully Online Flipped Learning Environments: A Comparison of Flexibility, Interaction, Flow Experience, and Student Learning Outcomes. *The International Journal of Management Education*, 24(July 2025).
- Yandi, A., Anya, N. K. P., & Yumna, S. K. P. (2023). Faktor-Faktor Yang Mempengaruhi Hasil Belajar Peserta Didik (Literature Review). *Jurnal Pendidikan Siber Nusantara*, 1(1), 13–24. <https://doi.org/10.38035/jpsn.v1i1.14>
- Yeni, D. F., Desi, R., Muriani, & Desi Armi, E. P. (2023). Pengaruh Penggunaan Media Pembelajaran Digital terhadap Hasil Belajar Siswa. *Edu Journal Innovation in Learning and Education*, 1(2), 93–102. <https://doi.org/10.55352/edu.v1i2.571>
- Yu, L., & Zuhana, M. Z. (2023). The critical thinking-oriented Adaptations of Problem-Based Learning Models: A Systematic Review. *Frontiers in Education*, 8. <https://doi.org/10.3389/feduc.2023.1139987>