JPPIPA 11(12) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Impact of Augmented Reality Media on IPAS Learning Outcomes: A Moderated Analysis of Learning Motivation

Septi Misliza[1*], Anisah[1], Yeni Erita[1], Muhammadi[1]

[1] Basic Education, FIP, Universitas Negeri Padang, Indonesia.

Received: October 21, 2025
Revised: November 20, 2025
Accepted: January 02, 2026
Published: January 03, 2026

Corresponding Author:
Septi Misliza
septimisliza59@gmail.com

DOI: 10.29303/jppipa.v11i12.13533

© 2025 The Authors. This open access article is distributed under a (CC-BY License)

Abstract: Student learning achievement is influenced by the quality of instructional media, yet IPAS learning outcomes in several elementary schools remain low due to limited media variation. This study aimed to analyze the effects of Augmented Reality (AR)–based media, learning motivation, and their interaction on fourth-grade students' IPAS learning outcomes. A quantitative experiment with a 2×2 factorial design was conducted involving 43 students (22 in the experimental group and 21 in the control group). Learning motivation was categorized into high and low levels using a motivation questionnaire administered prior to treatment. Pre-test and post-test instruments were used to measure learning outcomes. Data were analyzed using a two-way ANOVA after meeting normality and homogeneity assumptions, with Mann–Whitney U tests performed only as complementary pairwise comparisons. The results showed a significant main effect of AR-based media on learning outcomes ($p = 0.002$) and a significant main effect of learning motivation, where high-motivation students achieved higher scores than low-motivation students ($p = 0.023$ and $p = 0.027$). However, the interaction between AR media and learning motivation was not significant, indicating that AR media improved outcomes regardless of students' motivation level. In conclusion, AR-based media effectively enhance IPAS learning outcomes, although their impact is not influenced by motivation.

Keywords: Augmented reality; IPAS; Learning motivation; Learning Outcome

Introduction

The Merdeka Curriculum, implemented nationally since 2021, emphasizes learning autonomy and encourages the use of innovative, contextual, and technology-based learning approaches (Alimuddin, 2023). One of its structural changes is the introduction of the IPAS subject, which integrates natural, environmental, and technological literacy to develop students' scientific reasoning (Yansah et al., 2023). Although this curriculum aims to foster more authentic and inquiry-based learning, learning outcomes in IPAS remain below expectations in many elementary schools (Budiono & Hatip, 2023). Preliminary observations and national reports show that Indonesian students still struggle to master scientific concepts and demonstrate low performance on basic science indicators, suggesting a gap between curriculum expectations and learning implementation in the classroom (Maddawin et al., 2024).

The low learning outcomes are closely related to the limited use of effective and interactive learning media (Alawyah et al., 2024). Teachers generally rely on conventional media, which often fail to help students visualize abstract IPAS concepts or connect scientific material to real-life phenomena (Ummah & Mustika, 2024). Interactive media, particularly those integrating visual and experiential elements, have been shown to support deeper conceptual understanding and improve student engagement (Tiarasari, 2021). However, in practice, innovative technologies such as Augmented Reality (AR) are still rarely utilized due to limited facilities, insufficient training, and low teacher confidence in adopting emerging technologies (Istmadelia & Tyas, 2024).

How to Cite:
Misliza, S., Anisah, Erita, Y., & Muhammadi. (2025). The Impact of Augmented Reality Media on IPAS Learning Outcomes: A Moderated Analysis of Learning Motivation. *Jurnal Penelitian Pendidikan IPA*, *11*(12), 814-820. https://doi.org/10.29303/jppipa.v11i12.13533

Augmented Reality offers immersive and interactive visualizations that allow students to observe scientific objects and processes in three-dimensional, real-time formats (Sakr & Abdullah, 2024). Prior studies consistently report that AR enhances student engagement, improves conceptual understanding, and supports meaningful learning in science-related subjects (Anzuye et al., 2025). Despite its potential, the implementation of AR in IPAS learning at the elementary level especially in rural or low-resource contexts remains limited (Pamorti & Suryandari, 2024). This situation indicates the need to investigate whether AR-based media can significantly improve learning outcomes in IPAS (Hafizhah & Setyasto, 2024).

Another important factor influencing learning outcomes is students' learning motivation (Tutupary et al., 2024). Motivation plays a central role in regulating students' attention, persistence, and effort during learning activities (Arifin, 2019). Students with high motivation tend to engage more deeply with learning media and benefit more from technology-based interventions, whereas students with low motivation may show minimal improvement even when exposed to advanced media (Ai, 2025). Although several studies have examined the effectiveness of AR, very few have specifically explored how motivation interacts with AR-based media in influencing learning outcomes, particularly in the context of IPAS learning in elementary schools (Delcheva & Zhelyazkova, 2023).

This gap suggests the need for research examining both the direct effect of AR media and its interaction with students' motivation. Therefore, this study aims to analyze the effect of augmented reality–based learning media and learning motivation—both independently and interactively on students' learning outcomes in IPAS. The findings of this study are expected to contribute to the development of technology-enhanced learning practices in the Merdeka Curriculum era and provide empirical evidence regarding the moderating role of motivation in AR-assisted learning environments.

Method

This study used a 2×2 factorial design in a quasi-experimental framework, because the determination of the experimental and control classes was based on existing classes, thus not allowing for complete randomization (Ibrahim et al., 2018). The factorial design was used to examine: The main effect of learning media (A), A1: Augmented Reality Media and A2: PowerPoint Media. The main effect of learning motivation (B), B1: High Motivation and B2: Low Motivation.

The interaction between media and motivation (A×B). The research design framework can be seen in Table 1.

Table 1. Research Design

	Augmented reality-based media (A_1)	Power point media (A_2)
High (B_1)	A_1B_1	A_1B_2
Low (B_2)	A_2B_1	A_2B_2

The research population consisted of all fourth-grade students from eight elementary schools in Cluster I of Patamuan Subdistrict in the 2025/2026 academic year, totaling 129 students. The sample was determined using purposive sampling. Purposive sampling is a sampling technique based on certain considerations or objectives of the researcher (Etikan et al., 2016). Based on the suitability of the material, learning facility conditions, school accessibility, and class characteristic equality. Based on these criteria, SDN 01 Patamuan was selected as the research location. Class IVA (22 students) was designated as the experimental class, and class IVB (21 students) as the control class.

After measuring learning motivation through questionnaires, students in both classes were grouped into high motivation and low motivation categories using average scores as the basis for classification. This grouping resulted in four factorial cells, namely students in the experimental class with high motivation (A1B1), students in the experimental class with low motivation (A1B2), students in the control class with high motivation (A2B1), and students in the control class with low motivation (A2B2), so that a factorial design could be applied even though the experiment was quasi-experimental. Learning outcome data were obtained through tests after learning using AR media in the experimental class and PowerPoint media in the control class. Before testing the hypothesis, the data were tested for normality and homogeneity. The main analysis used was two-way ANOVA to test the main effect of learning media, the main effect of learning motivation, and the interaction between the two. If significant differences were found, further tests were conducted as needed.

Result and Discussion

Data Normality Test and Data Homogeneity Test

The results of the Shapiro–Wilk normality test on the experimental and control classes showed that all data groups had a significance value of < 0.05, indicating that the data were not normally distributed. However, the results of the homogeneity test showed that most data groups were homogeneous except for the group of students with low motivation. Therefore, the Mann–Whitney nonparametric test was used in the initial

analysis to compare the two groups, while the main analysis was still performed using Two-Way ANOVA according to the 2×2 factorial design.

Table 2. Testing the Normality of Learning Outcomes of Students in the Experimental Class and Control Class

Class	Shapiro-Wilk		
	Statistic	df	Sig.
Experiment	.815	22	.001
Control	.881	21	.015
High Motivation Experimental	.722	11	.001
High Motivation Control	.949	11	.633
Low Motivation Experimental	.871	11	.079
Low Motivation Control	.655	10	.000

Table 3. Testing the Homogeneity of Data in the Experimental Class and Control Class

	Sig.
Data in the Experimental Class and Control Class	.182
Data in High Motivation Experimental Class and High Motivation Control Class	.330
Data in the Low Motivation Experimental Class and the Low Motivation Control Class	.014

The Effect of Augmented Reality Media on Learning Outcomes

Learning outcomes are an important indicator in determining the success of the learning process because they reflect the achievement of objectives and the effectiveness of the strategies, methods, and media used (Sudjana, 2009; Yusa et al., 2023). In the context of IPAS learning, the use of appropriate learning media greatly determines how students understand abstract concepts (Saputra & Suhartini, 2025; Lestari et al., 2025). Augmented Reality (AR)-based media is one innovation that is believed to be able to bridge the gap between abstract information and concrete representations through 3D visualization and interactivity (Prananta et al., 2024; Akçayır & Akçayır, 2017).

The findings of this study indicate that there is a significant difference in learning outcomes between students who learn using AR-based media and students who use PowerPoint. The average learning outcome of the experimental class was 91.4, higher than that of the control class, which was 80.6. These results were confirmed by the Mann–Whitney U test with a Sig. (2-tailed) value = 0.002 < 0.05, which shows that the use of AR media has a significant effect on improving IPAS learning outcomes.

These differences show that AR media does not merely function as a visual aid, but also provides a more interactive and immersive learning experience (Siki & Leba, 2025; Kurniawan et al., 2024). The visualization of 3D objects allows students to see, manipulate, and explore objects directly, thereby facilitating higher cognitive and emotional engagement (Mubayyinah et al., 2024; Pratama et al., 2025). This active and meaningful learning experience supports meaningful learning, where conceptual understanding is not merely rote memorization but is based on a process of internalizing meaning a conclusion supported by multiple empirical studies on AR in science education (Alfarizi et al., 2024; Zhang et al., 2022; Tian & Ironsi, 2025).

Previous studies reinforce these findings. A systematic review on AR-based media found that AR consistently improves elementary school students' understanding of science concepts (Siki & Leba, 2025). Another empirical study combining AR and discovery learning showed significant gains in conceptual understanding and motivation (Fatmawati et al., 2026). Similarly, development of AR media for physics learning demonstrated improved concept comprehension among students (Khoiriyah et al., 2025). Moreover, a study in an IPAS course at the elementary level reported enhanced learning outcomes with AR use.

Overall, the findings of this study indicate a transformation in learning from a lecture-based model to an interactive visual and digital exploration-based learning model. AR enables students to build stronger mental representations of IPAS concepts such as the environment, sustainability, and energy. These clearer mental representations contribute to improved conceptual understanding, memory, and the ability to apply knowledge in real-world contexts.

Thus, it can be concluded that Augmented Reality-based media has a significant effect on the learning outcomes of students in IPAS learning in the fourth grade of elementary school. This media not only improves academic scores but also creates a more active, meaningful learning process that is in line with the learning needs of the digital age.

The Effect of AR on Highly Motivated and Low-motivated Students

Learning motivation is an internal factor that determines the quality of student engagement and effort in achieving learning objectives (Uno, 2008). Students with high motivation generally show enthusiasm, strong curiosity, and readiness to accept challenges, while students with low motivation tend to be passive, easily distracted, and lack initiative in learning (Slameto, 2010). These differences in characteristics indicate that the effectiveness of learning media can vary based on the level of motivation of learners (Pranahadi et al., 2024). The use of Augmented Reality (AR)-based media offers a relevant approach because it is able to provide a more concrete, interesting, and interactive learning experience that can strengthen or compensate for students' learning motivation (Ruijia et al., 2025).

The results showed that highly motivated students in the experimental class achieved an average score of 94.5, higher than the control class, which only achieved 84.1. The Mann–Whitney U test produced a Sig. value of 0.023 < 0.05, indicating a significant difference between the two groups. A similar pattern was also found among low-motivated students. Students in the experimental class who used AR obtained an average of 86.6, while the control class only obtained 76.6, with a significance value of 0.027 < 0.05. These data indicate that AR media has a positive effect on learning outcomes for both highly motivated and low-motivated students, although the interaction patterns differ in each group.

For highly motivated students, AR serves as an intrinsic motivator. This medium provides challenges, novelty, and exploratory experiences that are in line with their internal drive to learn. This is in accordance with Keller (2010) ARCS theory, in which the components of Attention and Relevance are fulfilled through 3D visualization and AR interactivity, while Confidence and Satisfaction are reinforced through the success of students when exploring virtual objects. Additionally, Self-Determination Theory Deci et al. (2000) explains that highly motivated students are more responsive to media that provide autonomy and competence, both of which are facilitated through manipulative experiences in AR.

Conversely, for low-motivated students, AR serves as a compensatory stimulus that triggers situational motivation (Uno, 2008). AR attracts attention through visual, interactive, and contextual elements that can arouse students' initial curiosity. Mayer (2009) multimedia learning theory, asserts that concrete visual representations help students who previously had difficulty understanding abstract material. In other words, AR is able to "draw in" low-motivated students into learning activities through enjoyable, immersive, and easy-to-understand experiences (Akçayır & Akçayır, 2017). This is in line with the findings of Julkifli et al. (2025) and Dzofiroh et al. (2025), who stated that AR can improve attention, focus, and conceptual understanding in both highly and low-motivated students.

Overall, the results of the study confirm that AR media is effective in improving learning outcomes in both motivation groups. For highly motivated students, AR acts as a catalyst that strengthens their readiness and interest in learning. Meanwhile, for low-motivated students, AR serves as a situational motivator that encourages greater engagement and understanding. This shows that AR has the potential to be an inclusive learning medium, capable of accommodating differences in learning motivation and providing a meaningful learning experience for all students. Thus, the use of Augmented Reality-based media in IPAS learning has been proven effective in improving learning outcomes for both highly and low-motivated students.

The Interaction between the Use of AR-Based Media and Learning Motivation

The results of the two-way ANOVA test show a significance value of 0.916 > 0.05, so it can be concluded that there is no interaction between the use of Augmented Reality (AR) media and learning motivation on learning outcomes. Thus, the effects of AR and learning motivation work independently, not as a combination of variables that reinforce each other.

The absence of this interaction indicates that the improvement in learning outcomes in the AR group was mainly due to the characteristics of AR media, such as concrete visualization and interactivity. Meanwhile, students with high motivation showed better learning outcomes due to their internal drive to achieve, regardless of the type of media used.

These findings are in line with Piaget's cognitive development theory, which states that elementary school students are in the concrete operational stage, so that conceptual understanding is more determined by visual presentation and direct experience (Santrock, 2018). At this stage, the effectiveness of media such as AR is more dominant than abstract factors such as motivation. Further support comes from the Multimedia Learning Theory (Mayer, 2009), which explains that the effectiveness of media is determined by the process of visual-verbal information processing, not by the level of motivation.

The results of this study are also consistent with Fiqri et al. (2025), who reported that AR improves learning outcomes but does not interact with learning motivation. Hidayat et al. (2023) also showed that the influence of digital media and motivation work separately because students respond to media mainly through ease of understanding and visual appeal.

Overall, the absence of interaction indicates that AR media is effective at all levels of motivation. AR is able to help students understand IPAS concepts more concretely and systematically, both for students with high and low motivation. Therefore, the effectiveness of AR media can be considered stable and universal in fourth-grade IPAS learning.

Conclusion

Based on the results of the study, it can be concluded that augmented reality–based learning media have a significant effect on the IPAS learning outcomes of fourth grade elementary school students. Students who learned using AR media achieved higher scores compared to those who learned using conventional

media. In addition, learning motivation was also found to contribute to differences in student learning outcomes. However, the analysis showed that there was no interaction between AR media and learning motivation, indicating that the influence of AR media on learning outcomes was consistent across students with different levels of motivation. These findings emphasize that AR media independently improves student learning outcomes, while motivation does not moderate the effect of AR media.

Acknowledgments
The authors would like to express sincere gratitude to the school principals, teachers, and students who participated in this study. Appreciation is also extended to colleagues and reviewers whose suggestions contributed to the improvement of this manuscript.

Author Contributions
Conceptualization, Septi Misliza, Anisah, Yeni Erita; Data curation, Septi Misliza; Formal analysis, Septi Misliza; Investigation, Septi Misliza, Anisah, Yeni Erita, Muhammadi; Writing–original draft, Septi Misliza; Writing–review & editing, Septi Misliza, Anisah, Yeni Erita, Muhammadi.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Ai, T. (2025). Impact of Learning Motivation on Student Learning Outcomes from the Perspective of Educational Psychology. *Lecture Notes in Education Psychology and Public Media,* 13–18. https://doi.org/10.54254/2753-7048/2025.24144

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education : A systematic review of the literature. *Educational Research Review Journal*, *20*, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002

Alawyah, K., Rizal, F., & Irfan, D. (2024). Needs Analysis of Augmented Reality (AR) Based Learning Media Development in Road and Bridge Construction Subjects. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6993–7000. https://doi.org/10.29303/jppipa.v10i9.8475

Alfarizi, M., Nasihudin, & Mahmud, M. R. (2024). Pengembangan Media Pembelajaran Augmented Reality (AR) untuk Meningkatkan Hasil Belajar Siswa Pada Pelajaran IPA Pengembangan Media Pembelajaran Augmented Reality (AR) untuk Meningkatkan Hasil Belajar Siswa Pada Pelajaran IPA. *JRIP: Jurnal Riset Dan Inovasi Pembelajaran*, *4*(3), 1989–2000. https://doi.org/10.51574/jrip.v4i3.2269 Vol.

Alimuddin, J. (2023). Implementasi Kurikulum Merdeka Di Sekolah Dasar. *Jurnal Ilmiah Kontekstual*, *4*(02), 114–121. https://doi.org/10.47637/griyacendikia.v9i1.1094

Anzuye, I. J., Amir, H., & Riyasni, S. (2025). Effects Of Science Augmented Reality Learning Media On Student Learning Outcomes : A Meta Analysis. *Indo-MathEdu Intellectuals Journal, 3,* 4618–4624. http://doi.org/10.54373/imeij.v6i3.3

Arifin, I. N. (2019). The Influence Of Learning Motivation On Basic Concepts Of Natural Sciences 2 Learning Outcomes. *European Journal of Education Studies*. 175–182. https://doi.org/10.5281/zenodo.3459900

Budiono, A. N., & Hatip, M. (2023). Asesmen Pembelajaran Pada Kurikulum Merdeka. *Jurnal Axioma : Jurnal Matematika Dan Pembelajaran*, *8*(1), 109–123. https://doi.org/10.56013/axi.v8i1.2044

Deci, E. L., & Ryan, R. M. (2000). *Self-Determination Theory and the facilitation of intrinsic motivation*. https://doi.org/10.1037/0003-066X.55.1.68

Delcheva, D., & Zhelyazkova, M. (2023). Augmented Reality and STEAM Learning in Primary Education. *Педагогически Форум*, *11*(4), 33–39. https://doi.org/10.15547/pf.2023.025

Dzofiroh, A., Ameliyanti, K. H., & Firah, M. (2025). Pengaruh Media Augmented Reality Terhadap Hasil Belajar Siswa Pada Mata Pelajaran Ipas Kelas Iv C Sdn Barurambat Kota 1. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *10*(2). https://doi.org/10.23969/jp.v10i02.25965

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics,* *5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Fatmawati, E., Munir, M., Riza, L. S., & Khoirunnisa, A. N. (2026). Enhancing Student Cognition in Science Lessons Through Augmented Reality (AR) and Discovery Learning. *Indonesian Journal of Educational Research and Technology*, *6*(1), 1–10. https://doi.org/10.17509/ijert.v6i1.88054

Fiqri, M. A., Nasir, & Nurindah. (2025). Pengaruh Penggunaan Media Augmented Reality (AR) terhadap Hasil Belajar Siswa pada Mata Pelajaran IPA Kelas X di SMA Muhammadiyah Lempangang. *Jurnal Pendidikan MIPA*, *15*(September), 1232–1239. https://doi.org/10.37630/jpm.v15i3.3330

Hafizhah, F., & Setyasto, N. (2024). Augmented Reality-Assisted Scrapbook Media Development in Natural and Social Science Learning. *Jurnal Penelitian Pendidikan IPA*, *10*(7), 4149–4157. https://doi.org/10.29303/jppipa.v10i7.7258

Hidayat, N., & Suryadi. (2023). Improving Student Learning Outcomes. *Jurnal Visi Ilmu Pendidikan*, *15*(1), 29–36. https://doi.org/10.26418/jvip.v15i1.54889

Ibrahim, A., Alang, A. H., Madi, Baharuddin, Ahmad, M. A., & Darmawati. (2018). *Metodologi penelitian*. Gunadarma Ilmu.

Istmadelia, M. Q., & Tyas, D. N. (2024). Development of Augmented Reality-Based Digital Learning Media for Grade V Elementary School on the Topic of Food Chains. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 9180–9188. https://doi.org/10.29303/jppipa.v10i8.7362

Julkifli, F., Hardiansyah, & Hakim, A. R. (2025). The Influence of Augmented Reality (Ar) Media on The Learning Outcomes of SMP Negeri 2 Woha Students in Ict Subjects. *Journal of Educational Sciences*, *9*(5), 4594–4607. https://doi.org/10.31258/jes.9.5.p.4594-4607

Keller, J. M. (2010). *Motivational Design for Learning and Performance (ARCS Theory)*. ARCS theory.

Khoiriyah, S., Latifah, S., & Wiliyanti, V. (2025). Development of Augmented Reality (AR) Physics Learning Media Based on STEM- R for Students ' Concept Understanding. *Jurnal Penelitian Pembelajaran Fisika*, *16*(4), 362–373. https://doi.org/10.26877/jp2f.v16i4.2803

Kurniawan, A., Jumadi, Kuswanto, H., & Syar, N. I. (2024). The 21st Century Education : A Systematic Literature Review Of Transforming Learning Methods To Foster Critical Thinking Skills Through Augmented Reality. *Jurnal Eduscience (JES)*, *11*(3), 601–622. https://doi.org/10.36987/jes.v11i3.6438

Lestari, D. J., Putra, M. J. A., & Zufriady. (2025). Pengembangan Media Pembelajaran Berbasis Augmented Reality Pada Mata Pelajaran IPAS Siawa Sekolah Dasar. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *10*(02). https://doi.org/10.23969/jp.v10i02.26526

Maddawin, A., Morgan, P., Park, A., Suryadarma, D., Long, T. Q., & Vandenberg, P. (2024). International Journal of Educational Development Learning disruptions during the COVID-19 pandemic : Evidence from household surveys in Southeast Asia ☆. *International Journal of Educational Development*, *107*(March), 103053. https://doi.org/10.1016/j.ijedudev.2024.103053

Mayer, R. E. (2009). *Multimedia Learning*. Cambridge University Press.

Mubayyinah, R., Laili, N., & Maula, Q. I. (2024). Pengaruh Media Augmented Reality dalam Pembelajaran IPAS Terhadap Hasil Belajar Siswa Kelas IV. *Atmosfer: Jurnal Pendidikan, Bahasa, Sastra, Seni, Budaya, Dan Sosial Humaniora*, *2*(4), 424–440. https://doi.org/10.59024/atmosfer.v2i4.1156

Pamorti, O. A., & Suryandari, K. C. (2024). Effectiveness of Augmented Reality Based Learning Media to Improve Critical Thinking Skills on IPAS Material. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2211–2219. https://doi.org/10.29303/jppipa.v10i5.7139

Pranahadi, T. Y., Nefosano, H., Studi, P., Profesi, P., & Pakuan, U. (2024). The Use Of Augmented Reality (Ar) Media To Enhance Student Motivation Learning. *Jurnal Bioeduin*, *14*(1), 30–37. https://doi.org/10.15575/bioeduin.v14i1.31544

Prananta, A. W., Rohman, A., Agustin, R., & Pranoto, N. W. (2024). Augmented Reality for Interactive , Innovative and Fun Science Learning : Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, *10*(Special Issue), 45–51. https://doi.org/10.29303/jppipa.v10iSpecialIssue.7519

Pratama, E. A., Aisyah, S., Nichla, S., & Attalina, C. (2025). Pemanfaatan Augmented Reality dalam Pembelajaran IPAS untuk Meningkatkan Minat Belajar Siswa Kelas IV Sekolah Dasar. *Jurnal Cakrawala Pendidikan Dan Biologi*, *2*(3), 95–102. https://doi.org/10.61132/jucapenbi.v2i3.589

Ruijia, Z., Wenling, L., & Xuemei, Z. (2025). Augmented Reality and Student Motivation : A Systematic Review. *Journal of Computer for Science and Mathematics Learning*, *2*(1), 38–52. https://doi.org/10.70232/jcsml.v2i1.23

Sakr, A., & Abdullah, T. (2024). Virtual , augmented reality and learning analytics impact. In *Education and Information Technologies* (Vol. 29, Issue 15). Springer US. https://doi.org/10.1007/s10639-024-12602-5

Santrock, J. W. (2018). *Child Development*. McGraw-Hill.

Saputra, B. B., & Suhartini, E. (2025). Media Pembelajaran STEM Berbasis Augmented Reality dengan Boardbook pada Materi IPAS Augmented Reality-Based STEM Learning Media with Boardbooks for IPAS Material. *Jurnal Pendidikan Matematika Dan Sains*, *13*(Special Issue), 295–305. https://doi.org/10.21831/jpms.v13iSpecial_issue.89716

Siki, I. M., & Leba, I. H. (2025). Effectiveness of Augmented Reality-Based Learning Media Towards Elementary School Students' Understanding of Concepts in Science_ Systematic Literature Review.pdf. *AR:-RIAYAH: Jurnal Pendidikan Dasar*, *9*(1). https://doi.org/10.29240/jpd.v9i1.11760

Slameto. (2010). *Belajar dan Faktor-faktor yang Mempengaruhinya*. Reneka Cipta.

Sudjana, N. (2009). *Penilaian hasil proses belajar mengajar* (14th ed.). PT Remaja Rosdakarya.

Tian, X., & Ironsi, C. S. (2025). Examining the impact of

augmented reality on students ' learning outcomes. *Scientific Reports*, *15*, 1–14. https://doi.org/10.1038/s41598-025-20833-w

Tiarasari, A. (2021). The Effectiveness of Interactive Multimedia to Improve Cognitive Skill on Elementary School Students. *Jurnal Pendidikan Indonesia (JPI)*, *10*(2), 387–395. https://doi.org/10.23887/jpi-undiksha.v10i2.17357

Tutupary, R., Rumahlewang, E., & Batlolona, J. R. (2024). Motivation and Learning Outcomes : A Study on Community Activity Learning Centers. *Jurnal Pendidikan Indonesia, 13*(4), 899–906. https://doi.org/10.23887/jpiundiksha.v13i4.66189

Ummah, K. K., & Mustika, D. (2024). Analisis Penggunaan Media Pembelajaran Pada Muatan IPAS di Kelas IV Sekolah Dasar. *Didaktika: Jurnal Kependidikan*, *13*(2), 1573–1582. https://doi.org/10.58230/27454312.709

Uno, H. (2008). *Teori Motivasi dan Pengukurannya*. Bumi Aksara.

Yansah, O., Asbari, M., Jamaludin, G. M., Marini, A., & Zulela, M. S. (2023). Implementasi Kebijakan Kurikulum Merdeka di Sekolah Dasar: Tantangan dan Peluang. *Journal of Information Systems and Management (JISMA)*, *2*(5), 48–52. https://doi.org/10.4444/jisma.v2i5.639

Yusa, I. W., Wulandari, A. Y. R., Tamam, B., Rosidi, I., Yasir, M., & Setiawan, A. Y. B. (2023). Jurnal Inovasi Pendidikan IPA Development of Augmented Reality (AR) Learning Media to Increase Student Motivation and Learning Outcomes in Science Development of Augmented Reality (AR) Learning Media to Increase Student. *Jurnal Inovasi Pendidikan IPA*, *9*(2), 127–145. http://dx.doi.org/10.21831/jipi.v9i2.52208

Zhang, J., Li, G., Huang, Q., Feng, Q., & Luo, H. (2022). Augmented Reality in K – 12 Education : A Systematic Review and Meta-Analysis of the Literature from 2000 to 2020. *Sustainability*, *14*. https:// doi.org/10.3390/su14159725