The Effectiveness of Virtual Augmented Reality-Based Media to Improve Students' Critical Thinking Skill: An Experimental Study in Elementary School

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Abstract

This research aims to increase the ability of students to think critically using learning media based on *Virtual Augmented Reality* in learning knowledge in natural and social sciences. Methodology study This quantitative design *is pre-experimental and* type *pretest-posttest* for measuring the effectiveness of the use of learning media based on *augmented reality*. Research sample This is 24 students in Grade IV at Tambakbulusan Elementary School. For evaluating the effectiveness of virtual augmented reality media in increasing critical thinking in science learning. Data analysis includes validity and reliability tests, normality tests, t-tests for comparison of pretest and posttest scores, as well as calculation of gain value for measuring improvement in critical thinking for students after using virtual augmented reality media in science learning. Research results show that *Augmented Reality* media can increase the ability to think critically in students, with an average score on the *pretest* of 33.5 and 82.92 on *the posttest*. The paired t-test produces a mark of 0.86, indicating there is a significant difference between the score before and after media usage. In addition, the gain test results were 0.74 with the category enough effective. Then it can be concluded that learning media based on *augmented reality* effectively increases the ability to think at a high level for students in elementary school.

Keywords: Criticall Thinking Skill, Effectiveness, *Virtual Augmented Reality*

Abstrak

Penelitian ini bertujuan untuk meningkatkan kemampuan berpikir kritis siswa dengan menggunakan media pembelajaran berbasis Augmented Reality (AR) dalam pembelajaran Ilmu Pengetahuan Alam dan Sosial. Metodologi penelitian ini kuantitatif dengan desain pre-eksperimental tipe pretes-posttes untuk mengukur keefektifan penggunaaan media pembelajaran berbasis Augmented Reality (AR). Sampel penelitian ini adalah 24 siswa kelas IV di Sekolah Dasar Tambakbulusan untuk mengevaluasi efektivitas media Virtual Augmented Reality dalam meningkatkan berpikir kritis pada pembelajaran Ilmu pengetahuan Alam dan Sosial. Analisis data mencakup uji validitas dan reliabilitas, uji normalitas, uji t untuk perbandingan skor pretest dan posttest, serta perhitungan nilai gain untuk mengukur peningkatan berpikir kritis siswa setelah menggunakan media Virtual Augmented Reality dalam pembelajaran Ilmu pengetahuan Alam dan Sosial. Hasil penelitian menunjukkan bahwa media Augmented Reality dapat meningkatkan kemampuan berpikir kritis siswa, dengan rata-rata skor pretest sebesar 33,5 dan 82,92 pada post-test. Uji t berpasangan menghasilkan nilai sebesar 0,86, menunjukkan terdapat perbedaan signifikan antara skor sebelum dan sesudah penggunaan media. Selain itu, hasil uji gain sebesar 0,74 dengan kategori cukup efektif. Penelitian ini menyimpulkan bahwa media pembelajaran berbasis Augmented Reality efektif meningkatkan kemampuan berpikir tingkat tinggi siswa di Sekolah Dasar.

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Kata Kunci: *Keterampilan Berpikir Kritis, Efektivitas, Virtual Augmented Reality.*

INTRODUCTION

In the era of digitalization, technology has become a key element in various aspects of life, including education. Technology This allows the public to increase quality of life, efficiency, and sustainability (Teguh Khristiant2024). However, in the context of education, adoption technology faces significant challenges. Many teachers have not fully prepared to integrate advanced technology into teaching them, and the learning media used are often still of a conventional nature, such as in two-dimensional form (2023). (Kusuma et al., 2023) Limitations This hinders students from understanding abstract material, especially in learning knowledge, knowledge nature, and social. Limitations This hinders students from understanding abstract material, especially in learning knowledge, knowledge nature, and social. Apart from that, the lack of access to modern technology in several areas also widens the gap in quality education, so that needed step is strategic for pushing the utilization of technology in a way that is2024). is even and optimal (Ma'arif & Nursikin, 2024) Limitations: This hinders students from understanding abstract material, especially in learning Knowledge Knowledge Nature and Social, although it is already delivered through two media dimensions.

Instructional media has two dimensions. No can convey information complex in a way deep and less interesting for maintain attention student (Harefa & Hayati, 2021). Use of two-way media dimensions tend not enough effective For material that is needed understanding deep or simulation complex, because No capable represent object in a way realistic in form three dimensions (Hasan et al., 2021) . This matter impact on difficulties student in understand concepts abstract that is not can seen or touched in a way direct (Masruroh et al., 2023). In addition, the limitations interactivity in media two dimensions often make student not enough involved in a way active in the learning process (Prayugha & Zuli, 2021). Therefore that, innovation in learning media become need urge For create more learning effective

Based on observation early in one of the basic school subjects, teachers are still using conventional learning media like pictures and videos in two dimensions. This media is considered not effective enough in explaining material abstract on science subjects, knowledge, nature, and social (Yuanta, 2020). As a result, students have difficulty understanding scientific concepts like the five senses and human body organ functions. Challenge This shows the existence of a need for more interactive and immersive learning media.

Research location chosen Because schools have their own device technology base, such as a tablet and an internet connection, but they have not yet utilized technology such as augmented reality (AR). This is an open opportunity for implementing learning media that is AR based as an innovation that has not been once applied previously. The potential of this media for increasing quality learning and thinking critically about students becoming interesting aspects for research.

There are several previous studies on augmented reality media, first, research showing that AR is able to improve students' understanding of composing abstracts by presenting virtual elements in three dimensions in a real environment (Tohir et al., 2024). Second, other research found that the use of AR increases student engagement in learning and helps them understand difficult concepts in a better way (Azzalea, 2023). Third, research on AR-based media has great potential to develop skills and criticism in students (Abdul & Elfin, 2024). Fourth, Indah Sari's research concluded that AR technology can enhance students' experiences in an interactive and fun way (Indahsari & Sumirat, 2023). In fact, virtual reality and augmented reality have been used for decades, starting with active applications in the last ten years, with technology becoming cheaper and more available, especially in education. and the perspective of Eastern countries (Abdul &

Elfin, 2024). This research is in line with previous research on the use of AR technology to improve abstract understanding of material and student engagement in the learning process (Nurhasanah et al., 2022). The study showed that AR can help students understand concepts that are difficult to understand in conventional ways, such as physics or biology drafts, through more concrete and interactive visualizations. However, the study was more general and not specific to science material or focused on developing students' critical thinking skills. This study expands on the findings by developing a new media, namely "Virtual Augmented Reality" which is specifically designed for science learning at the elementary school level, with the aim of not only improving draft understanding but also encouraging the development of critical thinking skills in student.

METHOD

This research uses a quantitative study method with a profsign *pre- experimental pretest-posttest.* For testing effectiveness, the use of media-based *virtual augmented reality* (VAR) in science learning increases skills in critical thinking for students. *Pre-experimental* type *pretest-posttest* is design research that measures variables before and after treatment in the same group to see changes that occur after intervention without an existing cont2020).oup (Rukminingsih et al., 2020) The purpose of the pre-experimental method type *pretest-posttest* is to measure change in a variable specific to the same group before and after treatment is given for use in evaluating the effectiveness of the intervention or the treatment applied without 2021).ing it with a control group (Nurainun & Susilowati, 2021) The sample used is purposive.s selected from grade IV elementary school in a way that is *purposive* Before learning with VAR media started, students were given a pretest to measure their ability to think critically. After that, the students follow science learning that uses interactive and interesting VAR media, especially for material function of human organs. After the learning process finished, students were given a posttest to measure their ability to think critically.

Pretests and posttests are very important in designing abecause study *pre- experimental* both of them function to measure changes that occur before and after treatment is given (Ma2023). et al., 2023) A pretest was used to measure the condition of the beginning or ability of the participant study before they accepted intervention or treatment, while the posttest was used to measure change or improvement ability after treatment was2023).(Vivin Syahkina Mardana et al., 2023) With a compare score *pretest* and *posttest,* the researcher can evaluate whether the treatment given is effective in increasing the variables studied, although this design does2019).nvolve a control group (Aripin & Suryaningsih, 2019) Both give a clear picture about the effect of intervention on desired changes, 2019).s improvement in skills to think critically in students (Puspita, 2019) The data obtained from *the pretest* and *pt-test,* will be analyzed using statistical tests, such as *paired test sample t-test* to know whether there is a significant improvement2020).ills for critical thinking for students after using VAR media (Alhakiki & Taufina, 2020) Then know the effectiveness of the intervention using the gain test, which measures the difference between p2019). and posttest scores to evaluate the increase that occurred after treatment (Nasir et al., 2019) Results of the analysis expected show a significant difference between pretest and posttest scores, which indicates that effective use of VAR media increases skills in critical thinking for students.

RESULTS AND DISCUSSION

Analysis results results analysis need learning that lots of students in class IV experienced difficulty in understanding abstract concepts in the eye science lessons. Learning media used during This still life is conventional and partially big in form, two dimensions, which are less effective in helping students understand complex material. The teacher also stated the need for innovative learning media that can increase student involvement as well as critical thinking skills. Augmented Reality (AR) technology provides a solution with present visualization in three interactive and real

dimensions, so that it makes it easier for students to understand complex materi (Aripin & Suryaningsih, 2019) This is in line with Handayani & Nurlina (nd), who stated that integrating visual and verbal elements in learning media is capable of strengthening the learning process and improving student understanding.

At the stage of implementation, augmented reality (AR) media is tested in grade IV of elementary school with involving training shorts for teachers regarding the method of use of AR media in learning. Here are the details.

1. Teacher Training. Prior to implementation, a short training was conducted for fourth-grade teachers at Tambakbulusan Elementary School on how to use augmented reality (AR) media in science learning. This training aims to ensure that teachers understand how to integrate AR technology into their curriculum and teaching method

2. Class Preparation. The class is prepared with the necessary devices for using AR media, such as tablets or smartphones equipped with AR applications. Students are also given an introduction on how to use the media before the lesson begins.

3. Implementation of Learning. AR media is integrated into science learning by presenting lesson materials through AR applications that allow students to interact with the content directly. Students are invited to explore and discuss in groups using AR media, which creates a more active learning atmosphere. Teachers and students gave positive responses to the use of AR media. Teachers stated that this media helped them explain abstract material more easily and improved critical thinking, while students felt that learning was more fun and interesting. However, several suggestions for improvement emerged, such as improving the quality of graphics and adding interactive features to AR media.

The application of augmented reality (AR) in education is in line with various learning theories. Constructivism theory emphasizes that students construct knowledge through direct experience, and AR provides a rich simulated environment for this process (Nerita et al., 2023). Vygotsky's social learning theory highlights the importance of social interaction in learning, which is facilitated by AR's collaborative features (Achyanadia, 2016). In addition, cognitive theory explains that strong mental representations are formed through rich experiences, and AR, with its 3D visualization, supports the formation of these representations (Habsy et al., 2023). The connection with learning theory makes AR very closely related to learning. Although it did not reach a very high level of improvement, these results still show that the use of AR media can stimulate student engagement and support the development of their critical thinking skill.

Figure 1. Initial Display of Augmented Reality

Figure 2. Virtual Augmented Reality Menu

4. Student Engagement

During the implementation, observations were conducted to assess student engagement. The results of the observations showed that students were more enthusiastic and actively participated in learning activities using AR media compared to conventional methods. From the perspective of motivation and engagement, AR-based media creates a more interesting and participatory learning atmosphere. AR technology can increase student motivation by providing authentic and immersive learning experiences (Arshel Rizky Saputra & Ananda Wahyu Lorena, 2021). This media encourages students to be more active in participating in learning, creating a dynamic learning environment (Nurdiniah, 2024).

When students can observe and interact directly with the objects being studied, they can ask questions, analyze information, and test their understanding, which in turn hones their critical thinking skills. The use of technology in learning, especially augmented reality (AR), not only provides interactive visualization but also creates a more immersive learning experience (Resti et al., 2024). AR media allows students to explore the material independently and interact directly with three-dimensional visual representations, thereby increasing their learning motivation (Andriani & Ramadani, 2022). In addition, this media supports collaborative learning, where students can discuss and share their understanding with their classmates while using the media (Ruzaina et al., 2024). The purpose of learning with Virtual Augmented Reality (VAR) is to bring students closer to modern technology while allowing them to access and learn material online. independent at home (Dahliani, 2023).

5. Evaluation of Learning Outcome

After the lesson is finished, students are given a pretest and posttest to measure the improvement of their critical thinking skills. Here are the pretest and posttest scores from the following AR implementation:

Table 1. Pre-test and Post-test Results

No	Name	Pretest	Posttest
1.	R1	25	90
2.	R2	30	85
3.	R3	20	95
4.	R4	40	75

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No	Name	Pretest	Posttest
5.	R5	35	80
6.	R6	30	95
7.	R7	30	75
8.	R8	30	85
9.	R9	30	80
10.	R10	30	85
11.	R11	40	75
12.	R12	25	80
13.	R13	40	80
14.	R14	35	75
15.	R15	35	70
16.	R16	35	75
17.	R17	40	95
18.	R18	30	80
19.	R19	20	80
20.	R20	25	80
21.	R21	40	90
22.	R22	40	85
23.	R23	55	90
24.	R24	45	90

The pre-test and post-test results of 24 students who experienced significant improvement after intervention learning. In the pre-test, the total value student was 805 with an average of 33.54, while in the post-test the total value increased to 1990 with an average of 82.92. This is a reflected total value increase of 1185 points and an average of 49.38 points, as in **Table 2**. Increase This shows that interventions carried out succeed increase increasing critical thinking in students at school.

Table 2. Average Results of Pre-test and Post-test

Data	Student	Total Value	Average
Pre-test	24	805	33.54167
Post-test	24	1990	82.91667

From the average of *the pretest* and *posttest,* the tested *paired t*-test. The results of the t-test show a significant difference between students' pre-test and post-test scores after using AR media, as in **Table 3.** The average pre-test value of 33.54 increased to 82.92 in the post-test, with a Sig. value (2-tailed) of 0.000. This indicates that AR media is effective in increasing student understanding of science and natural sciences material.

Table 2. Paired T-Test Samples Results

Action	Sig. (2-tailed)	Interpretation
Pre-test		
Post-test	0,000	A difference found

Normalized gain test results show a mark of 0.74, which includes improvement in the category. Enough effective as in **Table 4.** This data confirms existence improvement understanding student after learning using AR media compared to before the use of the media.

Table 4. Gain Test Results

Action	Average	N-Gain	Criteria
Pre-test	33.54	0.74	Enough Effective
Post-test	82.92		

Use of media-based *Virtual augmented reality* (AR) in science learning shows improved skills in critical thinking in students, although test results show moderate increases. Improvement This indicates that AR media can give significant influence to understanding abstract concepts, such as the function of human organs, which is normally difficult to understand with conventional methods. With visualization, three dimensions, and interactivity offered by AR, students can observe direct objects or systems taught, so they make it easier to understand and analyze the material.

One of the main reasons why students think critical improvement skills are not very high can be due to limitations in time used in the application of AR media. In research here, the use of AR media is carried out in a limited time frame, which may limit students' chances to explore material more deeply (Istiqomah et al., 2023). Although thus, the students involved in the learning process with AR media showed improvement in their ability to connect concepts learned and apply them in a more context-wide manner (Sari et al., 2012). This shows that with longer time and more application-intensive, the use of AR has the potential to increase skills and critical thinking in students (Murti et al., 2022). Conceptual abstractions can be understood more effectively if served in the form of concrete experiences through visual representation (Melati et al., 2023). However, Sae emphasizes the importance of quality AR media design, including improved graphics and interactive features, to ensure its effectiveness in various educational contexts (Sae & Radia, 2023).

Disadvantages of augmented reality (AR) include the need for sophisticated and expensive hardware, such as smartphones or tech headsets, and limitations of access for users who are not used to technology, which can hinder wide adoption in the learning environment (Rinaldi et al., 202024). For responding to shortcomings of Augmented Reality (AR), it is recommended that educational institutions provide supported devices with AR technology gradually, do training for educators and students to be more familiar with its use, as well as utilize AR-based application devices, simple or costly, to increase accessibility. (Ananda et al., 22023). To maximize AR potential in education, it is very important to overcome technical challenges and ensure equal access. Developers and educators must work the same to create quality AR experiences optimized for various environmental learning. AR allows users to see and interact with a virtual object as if it were real in the world around them (Daulay & Ediputra2024).) In addition, efforts must be done to provide affordable and easy AR devices accessible to all students, regardless of the background behind the social economy they come from.

The success of AR media in increasing skills thinks critically. Students are also influenced by aspects of the interactivity offered by technology. This. AR-based learning allows students to do exploration in a way that is independent and actively involved in the learning process (Manurung et al., 2023). This plays a role in developing the ability to think analytically and reflectively in students, who are an integral part of critical thinking. In addition to increasing understanding of concepts, AR media also has potential for developing critical thinking skills. Ramdani explained that critical thinking covers ability analysis, evaluation, and problem-solving problems (Ramdani et al., 2020). AR media supports development skills. This is an interactive simulation that encourages students to think more in-depth, evaluate information, and complete challenges based on proof (Elmqaddem, 2019). Thus, the development of good AR media can become a tool for learning that

is innovative, relevant, and effective.

CONCLUSION

The use of virtual augmented reality (VAR)-based media in proven science learning is effective in increasing the ability to think critically in students, with analysis showing significant improvement between pretest and posttest. Gaining value obtained by being at the level of enough effectiveness signifies that this AR media succeeds in increasing student understanding of the material as well as their involvement in the learning process. Findings most important from study This is that AR media is not only helping students understand abstract concepts but also encouraging active participation, which is a key element in developing critical thinking skills. This is to perfect research previously, which shows limitations of conventional learning media in overcoming difficulty for students.

However, to maximize the effectiveness of the use of VAR media, it is necessary to do a number of step improvements, such as adjusting material with characteristics for students and training advanced teachers. Limitations to this study, including time-limited implementation and lack of deep data sources, become challenges that must be overcome. Recommendations for the researcher next are to do a study with a longer term and involving more variables, as well as expand the data source to get a better understanding comprehensively. With steps said, AR-based media can give more contribution to a big increase in quality learning in the digital era, as well as strengthen the ability to think critically effectives in a way that is more effective.

REFERENCES

Abdul, H., & Elfin, S. (2024). Pemanfaatan Media Ajar Interaktif Berbasis Digital dalam Meningkatkan Berfikir Kritis Peserta Didik. 327–337.

Achyanadia, S. (2016). Peran Teknologi Pendidikan Dalam Meningkatkan Kualitas Sdm. Jurnal Teknologi Pendidikan, 5(1), 97–106. https://doi.org/10.32832/tek.pend.v5i1.486

Alhakiki, A., & Taufina, T. (2020). Pengaruh Quantum Teaching Kerangka TANDUR Terhadap Hasil Belajar Matematika di Sekolah Dasar. Jurnal Basicedu, 4(3), 534–540. https://doi.org/10.31004/basicedu.v4i3.395

Ananda, R., Irmawan, B., Juanda, S., & Aswadi, M. K. (2023). Analisis Pengelolaan Sarana dan Prasarana Pendidikan di Sekolah Dasar. JIIP - Jurnal Ilmiah Ilmu Pendidikan, 6(12), 9672–9678. https://doi.org/10.54371/jiip.v6i12.3297

Andriani, M. W., & Ramadani, A. (2022). Pengaruh Penggunaan Media Augmented Reality Berbasis Android Terhadap Kemampuan Berpikir Kritis Siswa Kelas Sekolah Dasar. JUPE : Jurnal Pendidikan Mandala, 7(2), 567–576. https://doi.org/10.58258/jupe.v7i2.3849

Aripin, I., & Suryaningsih, Y. (2019). Pengembangan Media Pembelajaran Biologi Menggunakan Teknologi Augmented Reality (AR) Berbasis Android pada Konsep Sistem Saraf. Sainsmat : Jurnal Ilmiah Ilmu Pengetahuan Alam, 8(2), 47. https://doi.org/10.35580/sainsmat82107192019

Arshel Rizky Saputra, & Ananda Wahyu Lorena. (2021). Implementasi Teknologi Augmented Reality dalam Pengajaran Bahasa Asing: Studi Eksperimental. PUSTAKA: Jurnal Bahasa Dan Pendidikan, 1(1), 35–39. https://doi.org/10.56910/pustaka.v1i1.1718

Azzalea, R. S. (2023). Penggunaan Teknologi Augmented Reality (AR) dalam Pembelajaran Matematika: Dampaknya terhadap Pemahaman Siswa. Duniailmu.Org, 3(2), 1.

Dahliani, L. (2023). Media pembelajaran pertumbuhan tanaman hidroponik menggunakan

demonstrasi dan discovery learning berbasis Aplikasi Canva: Studi Kasus di Era Digital. Jurnal Penelitian Tindakan Kelas, 1(3), 144–151. https://doi.org/10.61650/jptk.v1i3.295

Daulay, M. I., & Ediputra, K. (2024). Vol : 1 No : 5 , Oktober - November 2024 Pengaruh Penggunaan Teknologi Augmented Reality Terhadap Minat dan Kemampuan Imajinatif Siswa Kelas IV SDN 26 Bantan Pada Pembelajaran IPA The Effect of Using Augmented Reality Technology on the Interest and Imagin. 000(November), 6853–6861.

Elmqaddem, N. (2019). Augmented Reality and Virtual Reality in education. Myth or reality? International Journal of Emerging Technologies in Learning, 14(3), 234–242. https://doi.org/10.3991/ijet.v14i03.9289

Habsy, B. A., Fitriano, L., Sabrina, N. A., & Mustika, A. L. (2023). Tinjauan Literatur Teori Kognitif dan Konstruktivisme dalam Pembelajaran. Tsaqofah, 4(2), 751–769. https://doi.org/10.58578/tsaqofah.v4i2.2358

Handayani, W., & Nurlina, L. (n.d.). Strategi Pembelajaran BIPA Berbasis Audio Visual Dengan Pendekatan Budaya : Kajian Literatur. 344–353.

Harefa, N. A. J., & Hayati, E. (2021). Media Pembelajaran Bahasa dan Sastra Indonesia dan Teknologi Informasi. In IKIP Gunungsitoli. http://eprints.unpam.ac.id/id/eprint/8800

Hasan, M., Milawati, Darodjat, Khairani, H., & Tahrim, T. (2021). Media Pembelajaran. In Tahta Media Group.

Indahsari, L., & Sumirat, S. (2023). Implementasi Teknologi Augmented Reality dalam Pembelajaran Interaktif. Cognoscere: Jurnal Komunikasi Dan Media Pendidikan, 1(1), 7–11. https://doi.org/10.61292/cognoscere.v1i1.20

Istiqomah, N., Lisdawati, L., & Adiyono, A. (2023). Reinterpretasi Metode Pembelajaran Sejarah Kebudayaan Islam: Optimalisasi Implementasi dalam Kurikulum 2013 di Madrasah Aliyah. IQRO: Journal of Islamic Education, 6(1), 85–106. https://doi.org/10.24256/iqro.v6i1.4084

Kusuma, J. W., Supardi, Akbar, M. R., Hamidah, Ratnah, Fitrah, M., & Sepriano. (2023). Dimensi Media Pembelajaran (Teori dan Penerapan Media Pembelajaran Pada Era Revolusi Industri 4.0 Menuju Era Society 5.0) (Issue August). http://eprints.uny.ac.id/id/eprint/49351

Ma'arif, A. I., & Nursikin, M. (2024). Pendidikan Nilai di Era Digital: Tantangan dan Peluang. Afeksi: Jurnal Penelitian Dan Evaluasi Pendidikan, 5(2), 326–335. https://doi.org/10.59698/afeksi.v5i2.254

Manurung, A. S., Fahrurrozi, F., Utomo, E., & Gumelar, G. (2023). Implementasi Berpikir Kritis dalam Upaya Mengembangkan Kemampuan Berpikir Kreatif Mahasiswa. Jurnal Papeda: Jurnal Publikasi Pendidikan Dasar, 5(2), 120–132. https://doi.org/10.36232/jurnalpendidikandasar.v5i2.3965

Masruroh, H., Hadi, W. P., Ahied, M., Tamam, B., & Sutarja, M. C. (2023). Efektivitas Penggunaan Media Pembelajaran Berbasis Augmented Reality Terhadap Pemahaman Konsep Siswa. Jurnal Natural Science Educational Research, 6(3), 2654–4210.

Melati, E., Fayola, A. D., Hita, I. P. A. D., Saputra, A. M. A., Zamzami, Z., & Ninasari, A. (2023). Pemanfaatan Animasi sebagai Media Pembelajaran Berbasis Teknologi untuk Meningkatkan Motivasi Belajar. Journal on Education, 6(1), 732–741. https://doi.org/10.31004/joe.v6i1.2988

Murti, N. L. P. ., Widiana, I. ., & Wibawa, I. M. . (2022). Pengaruh Pendekatan Stem Berbasis Aktivitas Ekonomi. Junal Pendidikan Dasar Indonesi, 6(2), 23–34.

Nasir, A. M., Sari, I. E., & Yasmin, Y. (2019). Efektivitas Penerapan Model Realistic Mathematic Education (RME) dengan Menggunakan Alat Peraga Terhadap Prestasi Belajar. Jurnal Studi

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Guru Dan Pembelajaran, 2(1), 22–32. https://doi.org/10.30605/jsgp.2.1.2019.1246

Nerita, S., Ananda, A., & Mukhaiyar, M. (2023). Pemikiran Konstruktivisme Dan Implementasinya Dalam Pembelajaran. Jurnal Education and Development, 11(2), 292–297. https://doi.org/10.37081/ed.v11i2.4634

Nurainun, E., & Susilowati, E. (2021). Pengaruh Pijat Oksitosin Terhadap Produksi ASI Pada Ibu Nifas : Literature Review. Jurnal Kebidanan Khatulistiwa, 7(1), 20. https://doi.org/10.30602/jkk.v7i1.611

Nurdiniah, S. (2024). Langkah-langkah Partisipasi Guru dalam Pendekatan Pembelajaran Aktif di Muslimeen Suksa School, Thailand. Karimah Tauhid, 3, 8581–8598. https://ojs.unida.ac.id/karimahtauhid/article/view/14890%0Ahttps://ojs.unida.ac.id/karimahtauhid/article/download/14890/5631

Nurhasanah, A., Pribadi, R. A., & Ismawati, F. (2022). Penerapan Metode Pembelajaran Blended Learning dalam Meningkatkan Motivasi dan Pemahaman Konsep Belajar Siswa di Sekolah Dasar. Jurnal Ilmiah Telaah, 7(1), 20. https://doi.org/10.31764/telaah.v7i1.6694

Prayugha, A. W., & Zuli, F. (2021). Implementasi Augmented Reality Sebagai Media Promosi Universitas Satya Negara Indonesia Berbasis Android Menggunakan Metode Marker Based Tracking. Jakarta, 4(1), 12–17.

Puspita, A. (2019). Efektivitas Pendekatan Kontekstual Untuk Meningkatkan Keterampilan Literasi Sains Siswa Sekolah Dasar. EDUPROXIMA : Jurnal Ilmiah Pendidikan IPA, 1(1). https://doi.org/10.29100/eduproxima.v1i1.1024

Ramdani, A., Jufri, A. W., Jamaluddin, J., & Setiadi, D. (2020). Kemampuan Berpikir Kritis dan Penguasaan Konsep Dasar IPA Peserta Didik. Jurnal Penelitian Pendidikan IPA, 6(1), 119–124. https://doi.org/10.29303/jppipa.v6i1.388

Resti, N., Ridwan, R., Palupy, R. T., & Riandi, R. (2024). Inovasi Media Pembelajaran Menggunakan AR (Augmented Reality) pada Materi Sistem Pencernaan. Biodik, 10(2), 238–248. https://doi.org/10.22437/biodik.v10i2.34022

Rinaldi, R., Fahmi, K., & Masyitah, M. (2024). Tinjauan Literatur: Pemanfaatan Teknologi Augmented Reality sebagai Media Pembelajaran Interaktif Di Tingkat Sekolah Dasar. Likhitaprajna Jurnal Ilmiah Fakultas Keguruan Dan Ilmu Pendidikan Universitas Wisnuwardhana, 26(1), 20–28. https://doi.org/10.37303/likhitaprajna.v26i1.279

Rukminingsih, Adnan, G., & Latief, M. A. (2020). Metode Penelitian Pendidikan. Penelitian Kuantitatif, Penelitian Kualitatif, Penelitian Tindakan Kelas. In Journal of Chemical Information and Modeling (Vol. 53, Issue 9).

Ruzaina, F., Haris, A., & Ernie. (2024). Pengaruh Penggunaan Media Pembelajaran Augmented Reality (AR) Assemblr Edu terhadap Minat Belajar IPA Peserta Didik. Jurnal Pemikiran Dan …, 6(2), 1012–1020. http://ejournal-jp3.com/index.php/Pendidikan/article/view/1188%0Ahttps://ejournal-jp3.com/index.php/Pendidikan/article/download/1188/902

Sae, H., & Radia, E. H. (2023). Media Video Animasi Dalam Pembelajaran IPA Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SD. Indonesian Journal of Education and Social Sciences, 2(2), 65–73. https://doi.org/10.56916/ijess.v2i2.474

Sari, W. S., Dewi, I. N., & Setiawan, A. (2012). Multimedia Presentasi Pembelajaran Berbasis Augmented Reality untuk Pengenalan Pancaindra dalam Mendukung Mata Pelajaran IPA Tingkat Sekolah Dasar. Isbn, 2012(Semantik), 24–29.

Teguh Khristianto, Widiyanto Tri Handoko, Agus Prasetyo Utomo, & Zuly Budiarso. (2024). Peran Penting Keterlibatan Masyarakat Dalam Implementasi Smart City Di Kota Semarang. IKRA-ITH Informatika : Jurnal Komputer Dan Informatika, 8(1), 262–269. https://doi.org/10.37817/ikraith-informatika.v8i1.3220

Tohir, A., Handayani, F., Sulistiana, R., Wiliyanti, V., Arifianto, T., & Husnita, L. (2024). Augmented Reality dalam Proses Pemahaman Pembelajaran. Jurnal Review Pendidikan Dan Pengajaran, 7(3), 8.

Vivin Syahkina Mardana, Muhammad Rijal, & Rahmiati Darwis. (2023). Efektivitas Media Pembelajaran Alam Sekitar terhadap Minat dan Hasil Belajar Kognitif Siswa pada Materi Fotosintesis. Jurnal Pendidikan Mipa, 13(3), 736–743. https://doi.org/10.37630/jpm.v13i3.1169

Yuanta, F. (2020). Pengembangan Media Video Pembelajaran Ilmu Pengetahuan Sosial pada Siswa Sekolah Dasar. Trapsila: Jurnal Pendidikan Dasar, 1(02), 91. https://doi.org/10.30742/tpd.v1i02.816