Lectura: Jurnal Pendidikan
Volume 16, Nomor 2, Agustus 2025, Halaman 448-459
P-ISSN: 2086-4876
E-ISSN: 2549-063X
DOI: https://doi.org/10.31849/prmgc141
Link: https://journal.unilak.ac.id/index.php/lectura/article/view/27333

The Effect of AR Assemblr Edu Media on Critical Thinking Skills on Food Web Material

Diva Fithriya Handayani
Universitas Muhammadiyah Prof. Dr. Hamka
E-mail: divahandayni@gmail.com

Sri Lestari Handayani
Universitas Muhammadiyah Prof. Dr. Hamka
E-mail: srilestarih@uhamka.ac.id

Submitted: 05-06-2025 Accepted: 13-06-2025 Published: 09-08-2025

Abstract
Critical thinking is one of the important 21st century skills developed at the elementary school level. However, students often struggle to understand ecosystem concepts such as food webs due to limited use of interactive learning media. This study contributes by integrating food web material and the development of critical thinking through Assemblr Edu-based Augmented Reality (AR) media. This study aims to examine the outcome of Assemblr Edu-based AR media on fifth-grade students' critical thinking skills in learning food web. This study uses a quantitative method, namely a quasi-experimental design with a Pretest-Posttest Only Control Group. The participants consisted of 62 students of SDN Ciracas 07 Pagi. The sample technique used cluster random sampling, which involved randomizing existing classes rather than individuals. It was separated into two groups, 31 experimental students and 31 control students. An essay test was employed as the research instrument. It was established using five indications of critical thinking skills, namely Providing simple explanations, building basic skills, drawing conclusions, providing further explanation, and organizing strategies and tactics. The results of the independent sample t-test analysis showed that the two groups had a significant difference indicated by the significance value (sig. 0.048 <0.05). In addition, the effect size value of 0.513 is in the medium category. These findings suggest that Assemblr Edu-based AR media has a considerable impact on students' critical thinking skills. However, the use of this medium requires the support of compatible devices, stable internet connection, and teacher assistance in using digital media.

Keywords: critical thinking, augmented reality, assemblr edu, food web, elementary school

INTRODUCTION

As education adapts to the demands of the digital age, fostering the 4Cs becomes crucial in preparing students to navigate complex global challenges effectively. Rahmaniar & Latief (2021) state students are required to have 21st century skills known as the 4Cs, especially collaboration, critical thinking, creative, and communication in the era of globalization and rapid technological advances. These skills not only support academic achievement, but also prepare students to be able to adapt and contribute effectively in an increasingly connected and complex society, both at the local and global levels (Realitawati et al., 2024). Mastery of the 4Cs allows students to face challenges with confidence and make positive contributions to social change and complex problem solving.

As one of the four skills, critical thinking is considered crucial for improving students' cognitive abilities to analyze and evaluate problems systematically. Skills are considered the result of psychomotor learning, which is comparable to the results of cognitive learning (Mahrunnisya, 2023). Skills, according to Nasihudin & Hariyadin (2021), are the ability to complete tasks well. Ramadani (2021) states that critical thinking is an organized problem-solving process involving mental actions such as formulating problems, providing arguments, performing deduction and induction, conducting evaluations, and making decisions. Fitriya et al. (2022) define critical thinking as a set of intellectual abilities that enable students to systematically analyze problems, distinguish them precisely, and evaluate relevant information to design appropriate solutions. Based on this opinion, critical thinking skills can be defined as cognitive abilities that involve systematic and logical processing of data, including analyzing, evaluating, and understanding arguments to draw conclusions based on existing evidence. This skill is not innate from birth, but must be developed gradually through practice and a supportive learning environment (Susanto et al., 2020). Students who have critical thinking skills have characteristics. Marudut et al. (2020) define critical thinking as individuals who have two characteristics: the ability to understand existing assumptions and the ability to draw conclusions based on observations, the ability to think deductively, the ability to provide logical interpretations, and the ability to evaluate the strengths and weaknesses of an argument. Therefore, critical thinking indicates a desire to actively engage in the thinking process, which includes the ability to argue and communicate in an appropriate and clear manner.

To evaluate students' critical thinking skills, several indicators were identified and applied. Amalia et al. (2021) state providing simple explanations, building basic skills, drawing conclusions, providing further explanations and organizing strategies and tactics. While Susanti et al. (2023) put forward four indicators, namely problem identification, analysis, problem solving, and conclusion drawing. With critical thinking skills, students not only memorize, but are also able to evaluate information and conclude based on scientific evidence, making them more effective in solving problems and understanding concepts in depth.

In this context, elementary schools play a key role in facilitating critical thinking development (Handayani et al., 2021). Teachers' role is a very important in developing students' critical thinking abilities through creating a conducive learning atmosphere, using creative learning tools, and encouraging meaningful interactions (Agustin & Wardhani, 2023). Amid the growth of information technology, learning media must adapt

in order to support students' educational requirements in obtaining quality education. One innovation that can be used is Augmented Reality (AR) based media, which is a technique that mixes the actual environment with interactive 3D virtual elements (Panduwinata et al., 2021). AR allows us to see the real world either directly or through devices such as cameras while "adding" computer-generated elements, such as static images, audio recordings, or videos.(Saputra et al., 2020). According to Yusup et al. (2023) AR can be divided into two groups based on how it works; (1) Marker less AR, this type of AR allows users to display 3D models without requiring markers; generally, marker less AR uses the GPS on smartphones to interact with the surrounding environment. However, cameras are still often used to display AR in the form of videos; (2) Marker-based AR, this type of AR is a technology that requires additional components, such as a camera that scans markers, also known as markers, which can be analyzed to generate AR. These markers serve to position virtual objects that will be displayed by using the camera on the device to analyze the visible markers, then displaying virtual objects such as 3D models. In this way, users can move the device to view virtual objects from various angles. The use of AR encourages active student involvement and allows for more contextual and meaningful learning (Utami & Rusnilawati, 2025). Teachers are required to have skills in designing interactive learning through the implementation of AR-based media.

At the elementary school level, Natural and Social Sciences (*Ilmu Pengetahuan Alam dan Sosial/IPAS*) is a compulsory subject that studies natural phenomena through the stages of the scientific process with real learning experiences, such as observation, experimentation, and analysis. This material not only focuses on science, but also on the environment, technology, and society (Nisa & Prayogo, 2022). One of the IPAS materials in grade V is food webs, which are a combination of several interconnected or overlapping food chains in the same ecosystem. This material requires deep understanding and critical thinking skills to accurately analyze the relationships between organisms.

Observations and interviews at SDN (*Sekolah Dasar Negeri*) Ciracas 07 Pagi revealed obstacles in IPAS learning related to the concept of food webs. Although a student-centered approach has been implemented, students remain passive and find it difficult to analyze inter-organism relationships within food webs. Students have difficulty in analyzing animals that are included in level I, II, and III consumers, to predators in food webs. The learning media used at this time is already in the form of digital media such as PowerPoint, digital-based quizzes, and learning videos, but it is still limited and has not utilized Assemblr Edu's AR based digital media. This condition causes students to feel bored and have difficulty understanding the material, which negatively affects students' critical thinking abilities.

In response to the rapid growth of digital technology, various AR platforms are easily accessible via the internet, one of which is Assemblr Edu, an AR media with interactive 3D visualization designed to support the learning process. Assemblr Edu is able to make abstract concepts more real, enrich learning materials with interactive features that attract students' attention, and reduce boredom during learning (Majid et al., 2023). According to Dewi et al. (2022), assemblr EDU has several outstanding features, including: (1) comprehensive virtual classrooms, where students can easily share notes, files, photos, videos, and projects in 3D and AR formats; (2) ready-to-use learning resources, such as hundreds of learning materials covering various topics to add variety to learning activities; (3) living materials, such as classrooms, can be transformed into

environments like a zoo or forest using 3D and AR displays; (4)users can create their own learning materials or projects using over 1,000 ready-to-use 3D elements for various designs; (5) accessible anytime and anywhere via smartphone, tablet, or computer. Therefore, using AR media based on assemblr Edu will facilitate teachers in the learning process, because it is easy to create materials, has visualizations that bring AR to life, and can increase student activity.

Previous research has examined the educational effectiveness of AR-based media. Qorimah et al. (2022) indicated that the utilization of AR media is vital in learning process because if only using videos and images only makes students imagine the material abstractly. As a result, media utilizing AR can support students in comprehending complex or abstract material. Amalia et al. (2023) use AR media in the form of a combination of holographic pyramids with learning videos that have demonstrated effectiveness in fostering students' critical thinking skills, although the manufacturing process takes quite a long time. Handayani et al. (2023) also created learning media incorporating AR for teaching food chain concepts. Research Selindawati et al. (2024) has developed media on food web materials, but the research is more focused on improving communication skills. The research conducted by Utami & Rusnilawati (2025) aims to improve critical thinking skills of fourth grade students through the use of AR media. However, the focus of this study is on the effectiveness of two learning approaches that use various types of media in the learning process.

Despite various research innovations, only a few studies have specifically combined food web material with the development of critical thinking skills in elementary school students. In addition, not many studies have directly examined how AR (AR) media developed by Assemblr Edu affects students' ability to think critically about food web topics. As technology continues to advance at a rapid pace, learning problems in the field, and the limitations of learning media innovations used, solutions are needed that are able to present more contextual and interesting learning. AR refers to an interactive medium that integrates real environments with virtual 3D components and encourages students' to actively engage during the learning process. Therefore, this study is innovative in testing the effect of Assemblr Edu-based AR media on the critical thinking skills of fifth-grade students, particularly on the subject of food webs, which tends to be abstract and difficult for students to understand. Based on this, this study aims to determine the effect of using Assemblr Edu-based AR media on the critical thinking skills of fifth-grade students on the topic of food webs.

METHOD

This study employed a quantitative method, with the method adopted is quasi-experimental in nature. The study used a pretest-posttest only control group design. This design was chosen to suit a formal school context, where random assignment of individuals was not feasible. Thus, the sample was divided into experimental and control groups depending on pre-existing classroom groupings. Students in the experimental group was taught with Assemblr Edu-based AR media, whereas those in the control group learned without the use of this technology.

This research was conducted at SDN Ciracas 07 Pagi, East Jakarta. The study population consisted of 123 fifth grade students who were divided into four classes, namely classes VA-VD. The sampling method employed is Cluster Random Sampling,

which is taking samples by randomizing the existing classes, not individually. The participants consisted of 62 fifth-grade students from SDN Ciracas 07 Pagi. Two classes were selected through cluster random sampling: class V-C (experimental group) and class V-A (control group), each consisting of 31 students.

An essay test was designed as the instrument, referring to five indicators of critical thinking as outlined by Amalia et al. (2021), namely Providing simple explanations, building basic skills, drawing conclusions, providing further explanations, and organizing strategies and tactics. This instrument was tested to determine that it was feasible. The instrument validity test was conducted using Pearson Correlation. Of the 24 questions tested, 23 questions were valid with a significance value > 0.361. 20 questions with high interpretation, 3 questions with moderate interpretation, and there is 1 significance value <0.361 which means invalid so it is removed from the instrument. After testing the validity, 20 questions that were declared valid with high interpretation were tested for reliability. The results show the Cronbach's Alpha of 0.932 which means more than 0.361. Therefor the instrument is deemed reliable with a very high interpretation, indicating that the 20 questions of the test instrument can be trusted and can be used.

Statistical analyses were performed on the collected data using SPSS version 27. To assess the assumptions of parametric analysis, the Shapiro Wilk test was performed to assess data normality, while Levene's test was applied to check the homogeneity of variance between groups. Hypothesis testing uses to compare the mean scores of both groups, use the independent sample t-test, experimental and control, which are not paired or not related to each other. In addition, Cohen's d was calculated to assess the strength of the effect following the treatment. The effect size is classified as presented in the following table.

Table 1. Interpretation for Effect Size Test

Effect size	Description
$0.00 \leq ES < 0.20$	Ignored
$0.20 \leq ES < 0.50$	Small
$0.50 \leq ES < 0.80$	Medium
$0.80 \leq ES < 1.30$	High
$ES \geq 1{,}30$	Very High

Source: (Nirwana & Wilujeng, 2021)

FINDINGS AND DISCUSSION

Findings

In this study, participants were divided into two groups: an experimental group and a control group. The experimental class used Assemblr Edu-based AR media, while the control class only used PowerPoint without Assemblr Edu-based AR media. Both groups were given post-tests before and after the treatment. After the data was collected, a prerequisite test was conducted, including normality tests on pre-and post-test results for both groups, were conducted as the first step in analyzing the collected data. Normality testing in this study was conducted using the Shapiro Wilk test to determine whether the data had a normal distribution. Data are considered normal distribution if the value Sig.

> 0.05, indicating normality in the sample. The outcomes of the normality analysis are presented in the table that follows.

Table 2. Normality Test Results

Results	Statistic	df	Sig.
Experiment Pre-Test	0.967	31	0.432
Control Pre-Test	0.979	31	0.789
Experiment Post-Test	0.943	31	0.100
Control Post-test	0.937	31	0.067

As shown in Table 2, the experimental group's pre-test has a significance value of 0.432 and the control pre-test has a significance value of 0.789, then both groups show a significance value > 0.05, this signifies that the sample data has a normal distribution, so H_0 is accepted. A significance value of 0.100 was obtained from the post-test data experimental group, whereas that of the control group was 0.067, this shows that the significance value is > 0.05, this signifies that the sample data has a normal distribution, so H_0 is accepted.

Following the normality test, a homogeneity analysis was conducted to ascertain whether both groups exhibited equal variance. In this study, the Levene's test was used for the homogeneity assessment. If the significance value > 0.05, the data is considered homogeneous and H_0 is accepted. The outcomes of the homogeneity analysis are presented in the table that follows.

Table 3. Homogeneity Test Results

Result		Levene Statistic	df1	df2	Sig.
	Based on Mean	2.149	1	60	0.148

A significance value of 0.148 is shown in the table above. This demonstrates that significance value is > 0.05, this indicates that the two groups of data used in the study come from the same variance or homogeneous, so H_0 is accepted. in conclusion, means that there is no difference in the variance between the experimental group and the control group before using Assemblr Edu-based AR media and those who do not use the media, meaning that the two groups have relatively the same initial conditions. Once the assumptions of normality and homogeneity were fulfilled by the data, hypothesis testing was carried out using an Independent Samples t-test to compare the mean post-test scores between the unpaired experimental and control groups.

Table 4. Independent Sample t-Test Results

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Post-Test	2.021	60	0.048	3.226	1.596	0.034	6.418
	2.021	55.642	0.048	3.226	1.596	0.029	6.423

Referring to table 4, obtained a Signification value at (sig. 2-tailed) of 0.048. This demonstrates that is the significance value is <0.05, meaning that H_0 is rejected and H_1 is accepted. It can be concluded that, this result indicates a significant difference in the average post-test score between students in the experimental class who used Assemblr Edu-based AR media and control group did not get the same media treatment. The result also suggests that the usage of Assemblr Edu-based AR media contributed to the experimental class more effectively to enhancing students' critical thinking skills. Then, an effect size test using Cohen's was conducted to measure the level of effect after therapy. The results are presented in the table that follows.

Table 5. Effect Size Analysis Results

	Mean	Std. Deviation	N	Cohen's Effect Size Results
Experimental Class	80.13	7.107	31	0.513
Control Class	76.90	5.331	31	

Based on table 5, Cohen's d was calculated at 0.513, which falls into the medium category. This indicates that the application Assemblr Edu-based AR media promotes the development of students' critical thinking skills. When viewed from the mean score, the experimental class scored 80.13 while the control class reached 76.90, so there was a difference of 3.23 points. The difference is evidence that the class that used Assemblr Edu-based AR media showed higher achievements in critical thinking skills on food web material. Thus, the improvement in scores obtained by the experimental class demonstrates that Assemblr Edu-based AR media is effective and appropriate to be utilized as a means to assist students in developing critical thinking skills in IPAS instruction at the elementary level, particularly on the subject of food webs.

Discussion

This study was conducted over three meetings in each class. The experimental class that used AR media based on Assemblr Edu showed higher critical thinking skills than the control class. These critical thinking skills were measured through five indicators proposed by Amalia et al (2021), and further developed into sub-indicators of critical thinking, such as focusing questions, asking and answering questions that require explanations, observing, considering observation results, making deductions, considering induction results, identifying assumptions, and integrating with others. These sub-indicators were then developed into question indicators to be used for measuring students' critical thinking skills. The findings indicated a substantial disparity in the post-test outcomes of students' the experimental group's ability to think critically that utilized Assemblr Edu-based AR media and the control group that didn't. This finding shows that use of Assemblr Edu-based AR media contributes to developing critical thinking skills. The impact is not only statistically significant, but also practically meaningful, as indicated by the effect size value which shows a medium category. This indicates that the use of Assemblr Edu-based AR media has a significant contribution in increasing student engagement and understanding during the learning process.

In today's technological era, teachers must have the ability to create interactive learning, as done by the AR platform (Utami & Rusnilawati, 2025). The utilization of appropriate instructional media serves as a vital aspect in encouraging the development of students' critical thinking skills, among which them is implemented through AR-based tools using the Assemblr Edu platform. As described by Ningrum et al. (2021) AR technology integrates the actual environment with 3D features, including textual, visual, and audiovisual content. AR plays an important role in designing contextual learning processes. The use of AR in the classroom has the potential to attract students' interest and maintain their attention during lessons. The application of this technology will become increasingly relevant in the future, in line with technological advances and the growing demand for digital-based education. Thus, this media can enhance learning quality through visualization. This research uses marker-based AR with the help of the Assemblr Edu platform, which allows students to scan markers in the form of images or QR codes to access 3D objects through the camera.

Assemblr Edu-based AR media provides interactive 3D visualization of objects that support students in grasping abstract or difficult concepts, such as the relationship between organisms (producers, level I-III consumers, and predators) in an ecosystem. Assemblr Edu makes users more creative in delivering lesson material, increasing students' interest in learning. In addition to creating a more enjoyable learning environment, the use of Assemblr Edu also makes the learning experience more meaningful because it encourages students to actively participate in improving their understanding of what they are learning. This is consistent with Susanto et al. (2020) stated that critical thinking is not an innate skill, but rather one that must be learned over time by habits and practice. In this study, food webs were created using the Assemblr Edu platform by illustrating how organisms in an ecosystem are interconnected through AR visualization. Therefore, this material requires critical thinking skills. Students who have not yet demonstrated critical thinking skills should be developed through appropriate media or learning strategies. According to Ariadila et al. (2023) teachers can enhance students' critical thinking skills by asking appropriate questions, analyzing data using proper arguments and logic, and evaluating assumptions and arguments underlying both their own and others' thinking.

Research conducted by Surani & Fricticarani (2023) also confirmed that digital learning media based on the Assemblr Edu application provides an interesting and interactive learning experience, facilitates a clearer understanding of concepts through more realistic 3D visualizations, and improves students' ability to apply the concepts they have learned to real situations. This is reinforced by Andriani & Ramadani (2022) which suggests that AR variables impact with respect to students' critical thinking skills with a contribution of 75.2%. Furthermore, Bawono & Putra (2023) stated that Assemblr Edu-based AR learning medium that has been produced is extremely viable, and effective in the learning process. By utilizing Assemblr Edu-based AR media, students become more focused and faster in understanding the meaning or concept of the lesson being presented by the teacher (Pradita et al., 2024).

The findings of this research provide important implications for learning in elementary schools. AR media based on Assemblr Edu has been demonstrated to help students enhance their conceptual comprehension and critical thinking skills, particularly in regard to food web material. The success of the application of this learning media is

also shown from the learning process, where students actively participate during teaching and learning activities. This shows that teachers must make innovations in learning by using innovative technology such as Assemblr Edu-based AR media in learning activities, especially in materials that require systematic understanding.

Although the study findings indicated enhanced critical thinking skills through the use of Assemblr Edu-based AR media, several technical issues were encountered during its implementation. One of the main challenges was the media's dependency on a stable internet connection, which caused some students to have difficulties in accessing the application. Some students' devices also did not support the application or were incompatible especially when scanning markers, hindering optimal individual engagement. Although an alternative link was provided as a solution to access the media, some student devices were still unable to access. This had an impact on learning as students who could not access had to share their devices with other students. Therefore, to overcome the limitations of the research, the implementation of Assemblr Edu-based AR media should be accompanied by adequate technological infrastructure support, technical training for teachers, and initial explanation to students before using Assemblr Edu-based AR media.

CONCLUSION

This study's findings show that using Assemblr Edu-based AR media improves fifth-grade students' critical thinking skills when learning food web. reinforced by the significance value of 0.048 (<0.05) was obtained from the Independent Sample t-test, indicating a discrepancy the mean post-test score comparing the control and experimental groups. The mean post-test score in the experimental group was 80.13, compared to 76.90 in the control group. In addition to statistical significance, Cohen's d value of 0.513 indicates that the media' efficacy is categorized as moderate. These results prove that the Assemblr Edu-based AR media applied to the experimental class is more helpful in developing students' critical thinking skills. These results also confirm that implementing AR media through Assemblr Edu can foster a more interactive learning atmosphere and support the development of conceptual understanding as part of students' critical thinking abilities, especially food web material. Despite improving critical thinking skills, this research also has some obstacles such as internet network disruptions and limitations of incompatible devices. To address these challenges, future implementations should be supported by sufficient infrastructure, teacher training, and clear initial guidance for students. Future research can explore the application of this media to other complex science topics and different educational levels to expand generalizability. It is also recommended to explore alternative AR media development that can store local content on the device (cache) after one-time access, so that it does not always depend on internet connection during learning. A group-based learning strategy can be used so that it only uses one device for each group, so that it can see the effect of collaborative learning with AR.

REFERENCES

Agustin, A., & Wardhani, H. A. K. (2023). Pengaruh Media Augmented Reality (Ar) Berbantuan Assemblr Edu terhadap Hasil Belajar Siswa SMP IT Robbani Sintang. *Edumedia: Jurnal Keguruan dan Ilmu Pendidikan, 7*(2), 7–13. https://doi.org/10.51826/edumedia.v7i2.952

Amalia, A., Rini, C. P., & Amaliyah, A. (2021). Analisis Kemampuan Berpikir Kritis Siswa Kelas V dalam Pembelajaran IPA di SDN Karang Tengah 11 Kota Tangerang. *Sibatik Journal: Jurnal Ilmiah Bidang Sosial, Ekonomi, Budaya, Teknologi, dan Pendidikan*, *1*(1), 33–44. https://doi.org/10.54443/sibatik.v1i1.4

Amalia, N. R., Sihotang, I. P., Nurhayani, N., & Sam, S. R. (2023). Pengaruh Media Augmented Reality terhadap Kemampuan Berpikir Kritis Siswa Sekolah Dasar. *Fondatia*, *7*(1), 41–51. https://doi.org/10.36088/fondatia.v7i1.2914

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

Ariadila, S. N., Silalahi, Y. F. N., Fadiyah, F. H., Jamaluddin, U., & Setiawan, S. (2023). Analisis Pentingnya Keterampilan Berpikir Kritis terhadap Pembelajaran bagi Siswa. *Jurnal Ilmiah Wahana Pendidikan*, *9*(20), 664–669. https://doi.org/https://doi.org/10.5281/zenodo.8436970

Bawono, A., & Putra, G. (2023). Pengembangan Augmented Reality Berbasis Assemblr Edu pada Muatan Pelajaran IPS kelas V SD. *Elementary School Teacher Journal*, *6*(1), 47–55. https://doi.org/https://doi.org/10.15294/9xea3q58

Dewi, P. R. P. I., Wijayanti, N. M. W., & Juwana, I. D. P. (2022). Efektivitas Penerapan Media Pembelajaran Digital Assemblr Edu pada Mata Pelajaran Matematika di SMK Negeri 4 Denpasar. *Jurnal Pengabdian Kepada Masyarakat Widya Mahadi*, *2*(2), 98–109. https://doi.org/10.59672/widyamahadi.v2i2.1961

Fitriya, D., Fadhillahwati, N. F., Amaliyah, A., & Pujianti, P. (2022). Analisis Keterampilan Berfikir Kritis Siswa Sekolah Dasar pada Pembelajaran Matematika Kurikulum 2013. *Journal Scientific of Mandalika (JSM)*, *3*(5), 362–366. https://doi.org/10.36312/10.36312/vol3iss5pp362-366

Handayani, A. D., Pebriyana, C. D., Gymanstiar, D. A., Amanah, I. N., & Utami, R. M. (2023). Design of Augmented Reality-Based Food Chain Learning Media for Grade V Elementary School Students. *Journal of Software Engineering, Information and Communication Technology (SEICT)*, *4*(1), 43–60. https://doi.org/10.17509/seict.v4i1.59635

Handayani, S. L., Budiarti, I. G., Kusmajid, K., & Khairil, K. (2021). Problem Based Instruction Berbantuan E-Learning: Pengaruhnya terhadap Kemampuan Berpikir Kritis Peserta Didik Sekolah Dasar. *Jurnal Basicedu*, *5*(2), 697–705. https://doi.org/https://doi.org/10.31004/basicedu.v5i2.795

Mahrunnisya, D. (2023). Keterampilan Pembelajar di Abad Ke-21. *JUPENJI : Jurnal Pendidikan Jompa Indonesia*, *2*(1), 101–109. https://doi.org/10.57218/jupenji.vol2.iss1.598

Majid, N. W. A., Rafli, M., Nurjannah, N., Apriyanti, P., Iskandar, S., Nuraeni, F., Putri, H. E., Herlandy, P. B., & Azman, M. N. A. (2023). Effectiveness of Using Assemblr Edu Learning Media to Help Student Learning at School. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 9243–9249. https://doi.org/10.29303/jppipa.v9i11.5388

Marudut, M. R. H., Bachtiar, I. G., Kadir, & Iasha, V. (2020). Peningkatan Kemampuan Berpikir Kritis dalam Pembelajaran IPA. *Jurnal Basicedu: Research & Learning in Elementary Education*, *4*(3), 577–585. https://doi.org/https://doi.org/10.31004/basicedu.v4i3.401

Nasihudin, N., & Hariyadin, H. (2021). Pengembangan Keterampilan dalam Pembelajaran. *Jurnal Pendidikan Indonesia*, *2*(04), 733–743. https://doi.org/10.59141/japendi.v2i04.150

Ningrum, V. F., Sumarni, W., & Cahyono, E. (2021). Development of Augmented Reality-Based Learning Media on Concept of Hydrocarbon to Improve Multi-Representation Ability. *Jurnal Penelitian Pendidikan IPA*, *7*, 256–265. https://doi.org/10.29303/jppipa.v7ispecialissue.1038

Nirwana, A., & Wilujeng, I. (2021). Pengaruh Pembelajaran IPA Model Problem Based Learning Berbantuan Diagram Vee terhadap Kemampuan Berpikir Kritis Peserta Didik SMP. *Physics and Science Education Journal (PSEJ)*, *1*(4), 8. https://doi.org/10.30631/psej.v1i1.708

Nisa, N. C., & Prayogo, M. S. (2022). Peningkatan Hasil Belajar Siswa SD/MI pada Mata Pelajaran IPA melalui Model Pembelajaran Kontekstual. *Indonesian Journal Of Teacher Education*, *3*(2), 390–397. https://journal.publication-center.com/index.php/ijte/article/view/1365

Utami, A. N. W., & Rusnilawati, R. (2025). Augmented Reality-based Discovery Learning: An Effective Strategy to Improve Critical Thinking in Sciences for Grade IV. *Lectura : Jurnal Pendidikan*, *16*(1), 293–306. https://doi.org/https://doi.org/10.31849/lectura.v16i1.25775

Panduwinata, L., Wulandari, R., & Zanky, M. (2021). Pengembangan Media Pembelajaran Berbasis Augmented Reality (AR) pada Materi Prosedur Penyimpanan Arsip. *Lectura: Jurnal Pendidikan*, *12*(1), 15–28. https://doi.org/10.31849/lectura.v12i1.5958

Pradita, A. R, Aeni, A. N., & Sujana, A. (2024). Pengaruh Media Augmented Reality untuk Meningkatkan Pemahaman Konsep Siswa Kelas IV SDN Tegalkalong pada Materi Fotosintesis. *Inkuiri: Jurnal Pendidikan IPA*, *13*(1), 45322. https://doi.org/10.20961/inkuiri.v13i1.83995

Qorimah, E. N., Laksono, W. C., Hidayati, Y. M., & Desstya, A. (2022). Kebutuhan Pengembangan Media Pembelajaran Berbasis Augmented Reality (AR) pada Materi Rantai Makanan. *Jurnal Pedagogi dan Pembelajaran*, *5*(1), 57–63. https://doi.org/10.23887/jp2.v5i1.46290

Rahmaniar, A., & Latief, A. (2021). Analisis Literatur Teknologi dalam Integrasi Pendidikan STEM pada Pembelajaran IPA. *Jurnal Literasi Pendidikan Fisika (JLPF)*, *2*(2), 143–148. https://doi.org/10.30872/jlpf.v2i2.680

Ramadani, A. (2021). Pengaruh Penggunaan Media Pembelajaran Augmented Reality (Ar) Berbasis Android terhadap Kemampuan Berpikir Kritis Siswa Kelas 5 SDN Berbeluk 1. *PGRI Bangkalan*, *5*(2), 1–12.

Realitawati, R. Ikrom, F. D., Herawan, E., & Kadarsah, D. (2024). Penerapan 4C Skills dalam Pembelajaran Abad 21 di Sekolah Dasar. *Jurnal Madrasah Ibtidaiyah*, *10*(1), 22–23. https://doi.org/10.31602/muallimuna.v10i1.15533

Saputra, H. N., Salim, S., Idhayani, N., & Prasetiyo, T. K. (2020). Augmented Reality-Based Learning Media Development. *Al-Ishlah: Jurnal Pendidikan*, *12*(2), 176–184. https://doi.org/10.35445/alishlah.v12i2.258

Selindawati, S., Hayu, W. R. R., & Gunadi, G. (2024). Pengembangan Media Pembelajaran Berbasis Augmented Reality untuk Meningkatkan Keterampilan Komunikasi pada Mata Pelajaran IPAS. *Karimah Tauhid*, *3*(4), 5143–5156. https://doi.org/10.30997/karimahtauhid.v3i4.13025

Surani, D., & Fricticarani, A. (2023). Pengaruh Penggunaan Media Augmented Reality Assemblr Edu dalam Meningkatkan Minat Belajar Siswa SMP. *Jurnal Penelitian, Pendidikan dan Pengajaran: JPPP*, *4*(3), 209–216. https://doi.org/10.30596/jppp.v4i3.16429

Susanti, S., Pomalao, S., Resmawan, R., & Hulukati, E. (2023). Kemampuan Berpikir Kritis Siswa dalam Menggunakan Multimedia Interaktif. *Journal on Mathematics Education*, *1*(1), 37–46.

Susanto, A., Qurrotaini, L., & Mulyandini, N. (2020). Peningkatan Kemampuan Berpikir Kritis Siswa pada Mata Pelajaran IPS melalui Model Controversial Issue. *Jurnal Holistika*, *4*(2), 71. https://doi.org/10.24853/holistika.4.2.71-76

Yusup, A, H., Azizah, A., Reejeki, Endang, S., & Meliza, S. (2023). Literature Review: Peran Media Pembelajaran Berbasis Augmented Reality dalam Media Sosial. *JPI: Jurnal Pendidikan Indonesia*, *2*(5), 1–13. https://doi.org/10.59818/jpi.v3i5.575