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Development of Assemblr Edu-Based Augmented Reality Learning Media to Improve Learning Outcomes of Fifth Grade Students at SDN Kalibanteng Kidul 01

Eprilia Hesvina[1], Eka Titi Andaryani[1*]

[1] Department of Primary School Teacher Education, Faculty of Education and Psychology, Universitas Negeri Semarang, Semarang, Indonesia.

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Corresponding Author:
Eka Titi Andaryani
ekatitiandaryani@mail.unnes.ac.id

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Abstract: This study aimed to examine the effectiveness of Augmented Reality (AR) learning media developed using the Assemblr Edu application for teaching food chain concepts in Grade V elementary school IPAS learning. This research uses a development approach with the ADDIE model with qualitative and quantitative methods. Quantitative data were obtained through pretest and posttest scores, while qualitative Data collection was carried out by distributing questionnaires, interviews and observations. The effectiveness of the AR learning media was analyzed using a normality test, paired sample t-test, and N-Gain analysis. The results showed that the pretest and posttest data were normally distributed. The paired sample t-test revealed a significant difference between students' learning outcomes before and after using the AR learning media. N-Gain analysis showed moderate to high level improvements in student learning outcomes. In addition, classical mastery learning increased substantially after the implementation of the media. The results of this study show that AR-based learning media using Assemblr Edu is effective in improving elementary school students' understanding of the concept of the food chain. Therefore, the AR learning media developed can be used as an alternative innovative learning method in science learning. particularly for abstract topics that require concrete and interactive visualization.

Keywords: Assemblr edu; Augmented reality; Elementary school; Food chain; Learning outcomes

Introduction

To form superior human resources, a role in education is required. High-quality education is not solely oriented toward the mastery of knowledge but also toward the development of character, Creativity and the ability to adapt to changing times. This is in line with the National Education System Act Number 20 of 2003, which states that education aims o foster the holistic development of students' potential so that they emerge as individuals who are spiritually grounded, ethically sound, physically and mentally healthy, intellectually competent, creatively capable, independent in action, and accountable in their responsibilities (Qorimah et al., 2022). To achieve these objectives, learning processes must be designed systematically, relevantly, and in harmony with the development of science and technology.

The rapid advancement of digital technology has brought significant changes to the field of education. Technology now plays a role not only as a tool, but has become a key element in designing more efficient solutions interactive, and meaningful learning experiences. These changes have influenced students' ways of thinking, learning styles, and learning needs, thereby demanding innovation in learning strategies (Fatasya et al., 2023). One of the main challenges in education today is designing learning processes that can optimally enhance students' learning independence and conceptual understanding.

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One strategy to improve the quality of learning is through the use of effective learning media, which functions as an intermediary in conveying learning messages from teachers to students, thereby helping to clarify the material presented. Well-designed instructional media can increase students' motivation, attention, and understanding, while also fostering more active interaction among students, teachers, and learning resources (Firmadani, 2020; Muliyadi et al., 2023; Munandar et al., 2024). Moreover, appropriate instructional media can overcome limitations of space and time and provide more concrete and meaningful learning experiences (Januarti et al., 2024; Pagarra et al., 2022; Susilawati et al., 2025).

In line with this, a study by Rahman et al. (2024) shows that student learning outcomes are significantly influenced by learning motivation. The analysis results show that motivation contributes 16.5% to learning achievement, while the remaining percentage is influenced by other factors such as teaching methods, learning environment, and parental involvement. This finding reinforces the notion that improving learning outcomes requires support both from within the students themselves and from their surrounding environment.

Teachers play a central role in designing and implementing active, creative, and enjoyable learning processes. They are required to possess professional, pedagogical, and technological competencies in order to adapt learning to the demands of the modern era. Teachers' creativity in utilizing instructional media greatly influences students' learning motivation and learning outcomes. The use of information technology in learning has been proven to create more engaging and interactive learning environments (Istyasiwi et al., 2021).

At the elementary school level, learning Natural and Social Sciences (IPAS) helps students more easily understand how the natural and social environment around them works. IPAS examines natural phenomena, living organisms, and human interactions in daily life. IPAS learning is contextual in nature and ideally involves concrete visualizations so that students can observe, ask questions, classify, and draw meaningful conclusions from the concepts learned (Rahayuningsih et al., 2022).

One IPAS topic that is often perceived as difficult by elementary school students is the food chain. Food chain is defined as a sequential interaction among organisms in which energy and nutrients are transferred through processes of consumption and predation, which illustrates interdependence within an ecosystem. Understanding the concept of food chains is essential because it helps students comprehend ecosystem balance and the roles of each organism within it (Alexandra, 2022). However, due to its abstract nature, this topic is often difficult for students to understand when it is delivered solely through lectures or two-dimensional media such as textbooks.

The results of initial observations and interviews conducted in Class V A of SDN Kalibanteng Kidul 01 indicate that most students experience difficulties in understanding food chain material. Daily assessment data show that approximately 59% of students have not yet achieved learning mastery. Students still struggle to distinguish the roles of producers, primary consumers, secondary consumers, and decomposers. This condition indicates that the learning process has not been fully effective in bridging abstract concepts with concrete learning experiences.

One contributing factor to the low learning outcomes is the continued use of conventional instructional media. Learning that relies primarily on textbooks and two-dimensional images has not been able to provide clear visualizations of natural processes and systems, such as food chains. If this condition persists, it may negatively affect students' conceptual understanding and learning outcomes (Musyaffa et al., 2024). It is very important to have innovation in learning media in the current digital era, which is expected to encourage students' motivation to learn and make it easier for students to understand learning materials more deeply (Wartoyo et al., 2023). Augmented Reality (AR) is a learning medium that can help students understand learning more easily, where there are virtual elements, either two or three dimensions, above the real world and displays them in real time, enabling interactive and immersive learning experiences. (Firdanu et al., 2020).

Numerous studies have shown that Augmented Reality–based instructional media are effective in science learning. AR can present three-dimensional visualizations that support the understanding of abstract concepts and increase student engagement in the learning process (Amdani et al., 2022). AR media also offer advantages such as interactivity, ease of use, and the potential to enhance students' focus and learning motivation (Qorimah et al., 2022).

In previous research, it has been proven that the integration of Augmented Reality in teaching the concept of the food chain improves students' conceptual understanding and has a positive effect on learning outcomes. Handayani et al. (2023) reported that AR-based food chain learning is more effective than conventional learning methods. Other studies have also emphasized the need for developing AR-based media to enhance elementary school students' conceptual understanding (Qorimah et al., 2022). In addition, AR-based learning media have been shown to increase students' learning motivation and focus (Ni'mah et al., 2023).

One platform that can be utilized to develop AR-based instructional media is the Assemblr Edu application. Assemblr Edu is an Augmented Reality–based learning platform that enables teachers and students to create and access AR content easily without requiring advanced programming skills (Chairudin et al., 2023). Through this application, food chain material can be visualized in the form of three-dimensional objects that can be directly observed using smartphones. In addition to enhancing conceptual understanding, the use of Assemblr Edu also contributes to improving students' digital literacy from an early age (Arahman et al., 2026).

Based on the theoretical and empirical review, so it is proven that learning media with Augmented Reality, especially through the use of the Assemblr Edu application, has significant potential to improve the learning outcomes of elementary school students. However, the development of AR-based media that is specifically tailored to the characteristics However, the utilization of such technology among fifth-grade students in learning food chain concepts remains limited. Therefore, the development of this learning media is an innovative solution to improve the learning outcomes of class V A students at SDN Kalibanteng Kidul 01 in science learning in the digital era.

Method

Research Design

This research uses a development design (R&D) with a mixed approach, which consists of quantitative and qualitative data, which aims to see the effectiveness of Augmented Reality (AR) media developed using the Assemblr Edu application to improve student learning outcomes in the food chain material. Quantitative data were obtained through pretest and posttest scores. Meanwhile, the qualitative approach was applied to analyze data from observations, questionnaires, and interviews to gain an in-depth understanding of the development process and users' responses to the media.

The research stages are carried out by conducting Analysis, Design, Development, Implementation, and Evaluation according to the provisions of the ADDIE model. and was chosen because it provides a systematic and structured framework for the effective development and evaluation of instructional media within an educational context.

Research Procedure

The development process was guided by the ADDIE instructional model. During the initial phase, an analysis of learning needs was undertaken by examining classroom conditions through direct observation, conducting interviews with the class teacher, and collecting students' responses using questionnaires. This stage aims to identify learning problems, the need for interactive learning media, and students' difficulties in understanding the concept of the food chain.

During the design phase, learning objectives were defined, relevant food chain materials were determined, and initial storyboards were developed. In addition, the interface layout and instructional flow of the AR-based media were planned using the Assemblr Edu platform, with careful consideration given to the learning characteristics and developmental level of fifth-grade elementary students

Three-dimensional models are created during the development stage, AR learning media, arranging instructional narratives, and setting interactive features within the application. The developed product was then validated by material experts and media experts to assess content accuracy, visual quality, and usability. Revisions were made based on expert feedback.

During the implementation phase, the revised media was tested in classrooms through both large-scale and small-scale trials. The small-scale trials served to identify technical issues and initial user understanding. Meanwhile, this large-scale trial involved all students in the class with the aim of analyzing whether the learning media was effective in real classroom conditions.

The concluding phase focused on both formative and summative evaluation procedures. Formative evaluation was implemented continuously during the development stages to support ongoing refinement of the media, whereas summative evaluation was performed by examining differences between students' pretest and posttest scores, along with analyzing feedback obtained from students and the classroom teacher regarding the AR-based learning media.

This study used the ADDIE development model, which consists of: Analysis, Design, Development, Implementation, and Evaluation. which was applied sequentially in refining, guiding, and assessing Augmented Reality-based learning media with the help of the Assemblr Edu platform. Figure 1 below will explain the research procedure.

As shown in Figure 1, the analysis stage focused on identifying learning problems and media needs through observations, interviews, and questionnaires. The design stage involved preparing learning objectives, content, and media layouts. The development stage included creating AR content and validating the product with experts. The implementation stage is carried out with large-scale and small-scale tests, while the evaluation stage examined the effectiveness of the media through learning outcomes and user responses.

Figure 1. Research procedure based on the ADDIE development model

Research Setting and Participants

This research was conducted at SDN Kalibanteng Kidul 01, Semarang, Central Java, in the 2025/2026 academic year in the first semester. The participants consisted of fifth-grade students. Saturated sampling was used due to the limited number of students.

The small-scale test consisted of seven students, and the large-scale trial consisted of all 28 students. In addition, the classroom teacher and expert validators, consisting of media and subject-matter experts, participated as data sources for the validation and evaluation processes.

Data Collection Techniques and Instruments

Testing and non-testing methods are carried out to collect data. The testing method involved administering pretests and posttests to assess student learning outcomes before and after implementing AR-based learning media. Non-testing methods included interviews, documentation, observation, and questionnaires.

Pretest and posttest question sheets, as well as observation sheets were used as instruments in this study, validation questionnaires for experts, response questionnaires for teachers and students, and interview guidelines. These instruments were developed to obtain data on learning outcomes, media feasibility, usability, and user responses.

Data Analysis

Quantitative data analysis was carried out using descriptive and inferential statistical methods. A normality test was conducted as a prerequisite for parametric analysis. The level of effectiveness of AR-based learning media was analyzed using a paired t-test to identify differences in scores between before and after using the media. In addition, N-Gain analysis was employed to measure the level of improvement in students' learning outcomes.

Qualitative data obtained from observations, interviews, and questionnaires were analyzed descriptively to support the quantitative findings and provide a complete picture regarding the implementation and level of success of the media that has been designed.

Result and Discussion

Research Findings

This study investigates the effectiveness of Augmented Reality (AR) learning media designed with the Assemblr Edu platform to teach the concept of the food chain in fifth grade science learning at the elementary school level. Before presenting the statistical analysis results, this section provides an overview of the AR learning media that has been developed, including its instructional content, interactive features, and design. The evaluation is based on a statistical examination of student learning outcomes measured before and after the media's implementation.

Profile of Augmented Reality (AR) Learning Media

Augmented Reality (AR) based learning media has several components, namely: (1) three-dimensional (3D) visualizations of food chain components, (2) narrative text explanations accompanying the displayed objects, and (3) audio explanations to support students' understanding of the material. All media components were developed using the Assemblr Edu application, with the process of designing and editing visual content assisted by Canva to enhance the visual appeal and clarity of the media, as shown in the following figure.

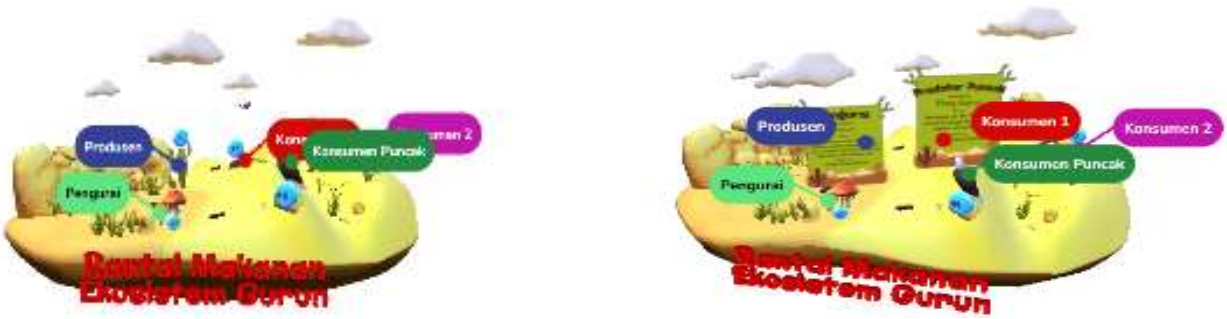

Figure 2. Visualization of the augmented reality (AR) food chain in the desert ecosystem

Figure 3. Visualization of the augmented reality (AR) food chain in the forest ecosystem

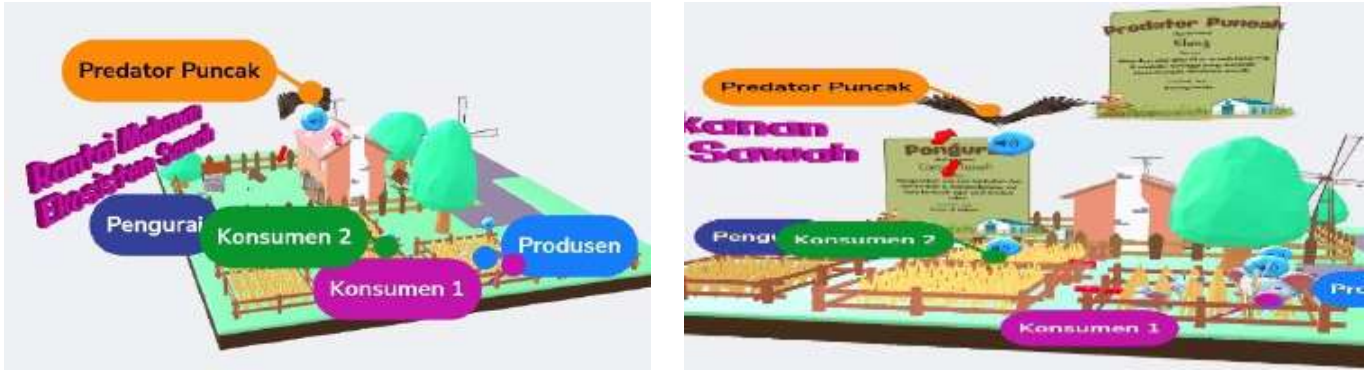

Figure 4. Visualization of the augmented reality (AR) food chain in the rice field ecosystem

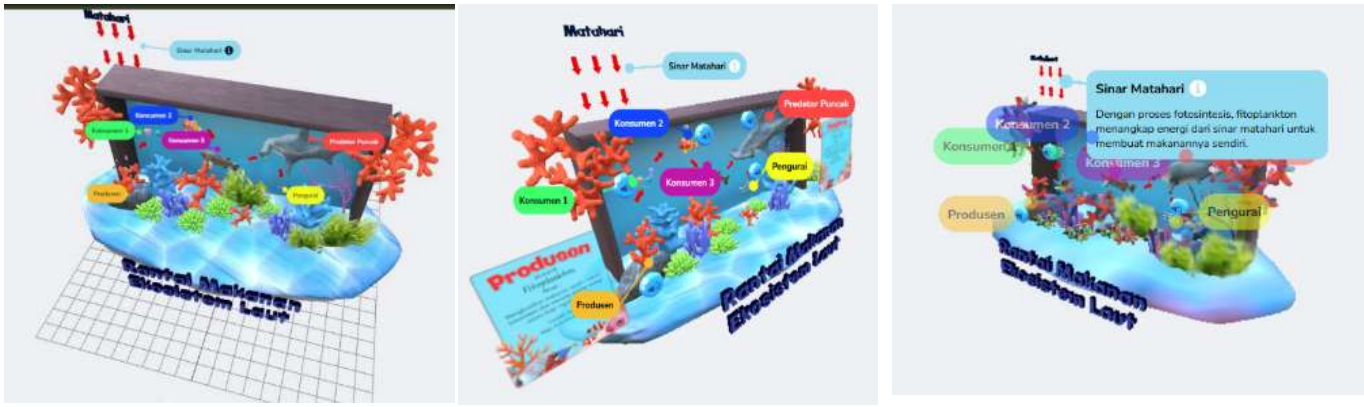

Figure 5. Visualization of the augmented reality (AR) food chain in the marine ecosystem

Figure 6. Concrete food chain diorama of the forest ecosystem

Figure 7. Concrete food chain diorama of the desert ecosystem

Figure 8. Concrete food chain diorama of the marine ecosystem

Figure 9. Concrete food chain diorama of the rice field ecosystem

This learning is also supported by concrete dioramas as additional learning media to complement digital and interactive Augmented Reality (AR) based learning media. The diorama was developed to provide a more tangible representation of the structure and relationships among organisms within the food chain, thereby helping students strengthen their understanding of concepts obtained through AR visualization. The appearance of the concrete diorama as supplementary learning media is presented in the figures 6, 7, 8 and 9.

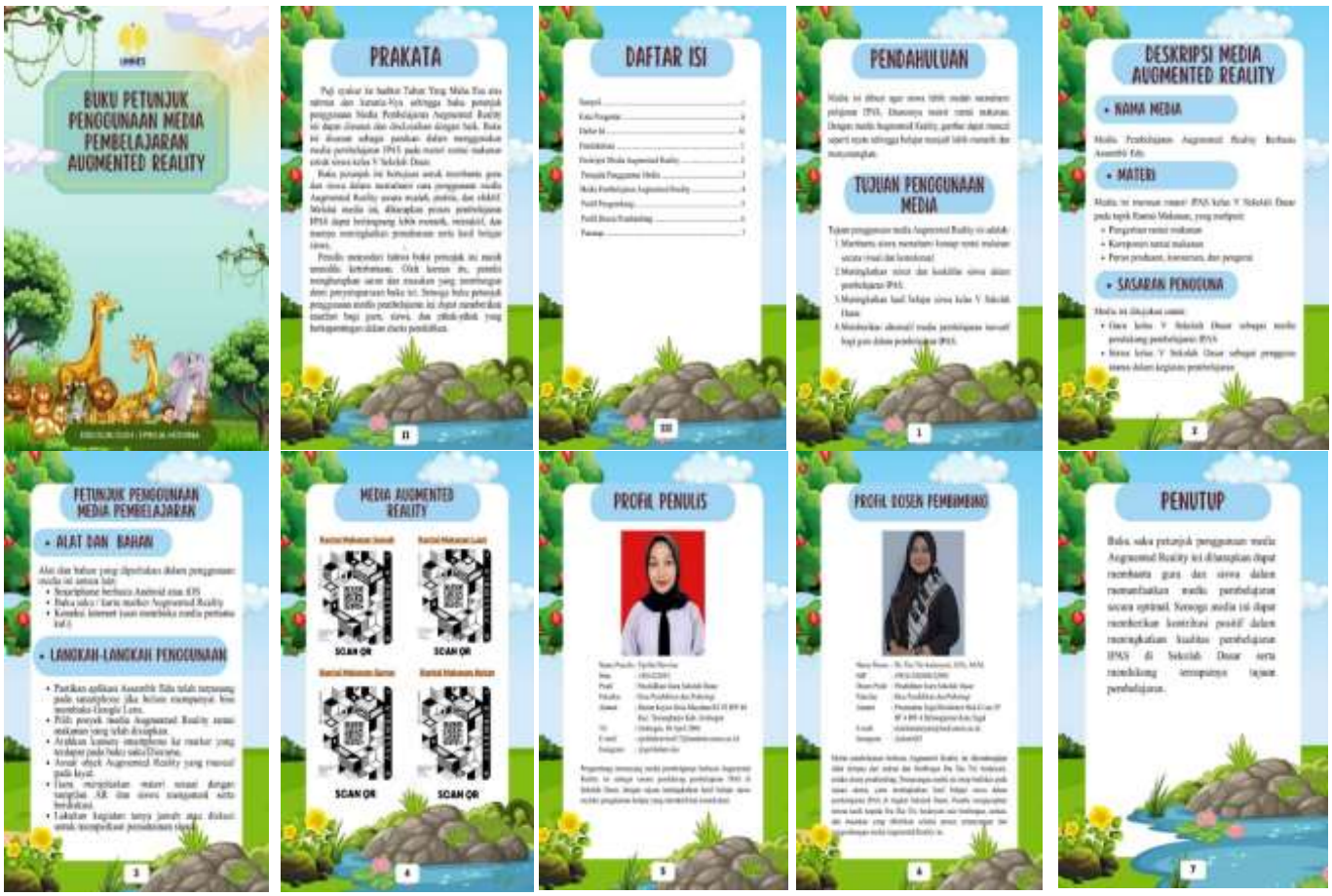

Figure 10. Appearance of the pocket guidebook for using augmented reality (AR) learning media

Normality Test

A normality test was conducted to verify that the learning outcome data met the assumptions of parametric statistical analysis. The Shapiro-Wilk test was used for samples less than 50.

Table 1. Normality Test Results of Pretest and Posttest Scores (Small-Scale Trial)

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Pretest	7	100.0%	0	0.0%	7	100.0%
Posttest	7	100.0%	0	0.0%	7	100.0%

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.268	7	.137	.867	7	.173
Posttest	.202	7	.200*	.891	7	.282

Table 2. Normality Test Results of Pretest and Posttest Scores (Large-Scale Trial)

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Pretest	28	100.0%	0	0.0%	28	100.0%
Posttest	28	100.0%	0	0.0%	28	100.0%

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.132	28	.200*	.947	28	.166
Posttest	.113	28	.200*	.950	28	.198

The results indicated that the significance values (Sig.) of pretest and posttest scores in the small-scale trial were 0.173 and 0.282, respectively, while in the large-scale trial they were 0.166 and 0.198. Because all significance values > 0.05, in the pretest and posttest in both experiments, the data were normally distributed. Therefore, parametric statistical tests could be appropriately applied in subsequent analyses.

Mean Difference Test (Paired Sample t-Test)

This test is used to identify statistically significant differences between student learning outcomes before and after the implementation of AR-based learning media through the Assemblr Edu application.

Based on a small-scale trial, the Sig. (2-tailed) value was 0.000 < 0.05, a significant difference was found between the pretest and posttest scores. The average score increased from 57.85 to 88.85. In the large-scale trial, a significant (2-tailed) score of 0.000 was obtained, meaning there was a statistically significant difference in the pretest and posttest results. There was an increase in the average student score, which was initially 60.89 in the pretest, then 97.67 in the posttest.

Table 3. Results of the Paired Sample t-Test in the Small-Scale Trial

Paired Samples Test									
		Paired Differences					t	df	sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence interval of the difference Lower	Upper			
Pairl	Pretest-posttest	31.00000	5.68624	2.14920	36.25890	25.74110	14.424	6	.000

Table 4. Results of the Paired Sample t-Test in the Large-Scale Trial

Paired Samples Test									
		Paired Differences					t	df	sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence interval of the difference Lower	Upper			
Pairl	Pretest-posttest	26.78571	12.40775	2.34485	31.59694	21.97449	11.423	27	.000

The application of Augmented Reality learning media with the help of the Assemblr Edu platform has a significant positive effect on improving student learning outcomes.

Learning Gain Analysis (N-Gain)

To measure the magnitude of learning improvement, an N-Gain analysis was conducted. The results of the small-scale N-Gain trial were 0.7554

(75.54%), with a high category, meaning that AR learning media is very effective in improving students' conceptual understanding in small group learning.

In the large-scale trial, the N-Gain value was 0.6850 (68.5%), categorized as moderate. Despite being classified as moderate, this value reflects a substantial and consistent improvement in learning outcomes at the class level. Overall, the N-Gain results show that Assemblr Edu-based AR learning media is successful in improving students' understanding of the food chain concept.

Table 5. N-Gain Results of the Small-Scale Trial

Pretest Average	Posttest Average	Average Difference	N-Gain	N-Gain %	Criteria
57.85	88.85	31	0.7554	75.54%	High

Table 6. N-Gain Results of the Large-Scale Trial

Pretest Average t	Posttest Average	Average Difference	N-Gain	N-Gain %	Criteria
69.89	97.67	27.78	0.6850	68.5%	Medium

In addition to improving students' average grades, this also reflects the effectiveness of the learning media. In large-scale trials, only 7.14% of students met the mastery criteria, with most students failing to achieve the expected learning standards. After implementing AR-based learning media, learning mastery reached 100%. This represents an increase of 92.85%, indicating that the developed media successfully enabled all students to achieve the required learning objectives.

The improvement in learning outcomes can also be seen from the change in score distribution, where the posttest result was 77, an increase from the previous posttest which was only 24, while the highest score improved from 90 to 100. Overall, it can be seen that this media also supports students who have low initial abilities, not only providing benefits for students who already have good achievements.

The small-scale trial exhibited a pattern consistent with the large-scale trial. Students' average scores increased significantly, and mastery learning reached 100% in the posttest. The consistency of the results in both trials indicates that the successful implementation of AR-based learning media is stable and feasible for use in a wider classroom environment for science learning on the topic of the food chain.

Visualization of Learning Outcomes

To compare the pretest and posttest results, they are presented with a bar graph depicting the increase in score, minimum, maximum and average value. The visual representation shows that student learning outcomes experienced a significant increase after the implementation of AR-based learning media, accompanied by a significant increase in classical mastery from 7.14% to 100% in large-scale trials.

Discussion

This discussion focuses on the interpretation of research findings related to the success of Assemblr Edu-based Augmented Reality learning media in influencing student learning outcomes in the science food chain material.

Based on the results of the normality test, it was found that the data was normally distributed, providing a strong foundation for the use of parametric statistical analysis. This indicates that the observed improvement in students' learning outcomes was not due to data irregularities but rather to the instructional intervention applied. Consequently, the effectiveness of the developed AR learning media can be evaluated objectively and scientifically.

The main finding in this study was that in small and large scale trials, significant differences were found in both the pretest and posttest. The paired sample t-test results, which yielded a significance value of 0.000, indicate that the use of AR-based learning media using Assemblr Edu contributes significantly to student learning outcomes. The notable increase in average scores suggests that AR media effectively supported students in understanding food chain concepts that are typically abstract and difficult to grasp.

This improvement can be attributed to the characteristics of three-dimensional objects in Augmented Reality media, namely interactive visualization, integration between digital content and concrete dioramas. Through this approach, students not only receive information verbally but also engage in visual and kinesthetic learning experiences. These results align with Edgar Dale's Cone of Experience theory, where learning experiences with multisensory and concrete engagement lead to deeper and more meaningful understanding.

The N-Gain results revealed a high improvement category in the small-scale trial and a moderate category in the large-scale trial. This difference can be explained by the more intensive interaction between students, teachers, and learning media in small-group settings, which allows for more optimal use of AR features. Nevertheless, the moderate N-Gain value in the large-scale trial still demonstrates strong instructional

effectiveness, as all students achieved mastery learning after using the AR-based media.

The effectiveness of Augmented Reality-based learning media in improving the understanding of science concepts in elementary school students has also been proven in previous research. AR technology supports the conversion of abstract content into more concrete, interactive, and easily understood learning experiences. Furthermore, the incorporation of AR increases students' learning motivation and engagement, which ultimately leads to improved academic achievement.

Another advantage of this learning media lies in its suitability to the Discovery Learning learning model. Students are encouraged to observe, explore, and independently discover food chain concepts through direct interaction with AR objects. This process fosters critical thinking skills and promotes active student engagement during the learning process.

empirically and theoretically based on the results of observations in the learning process and based on statistical results, this media has been proven to be effective, where the media has a significant increase in student learning outcomes on the science food chain material, both in small-scale and large-scale trials consistently.

Therefore, the application of this media is recommended as an alternative innovative learning method in elementary science education, especially in materials such as food chains which require concrete and visual representation.

Conclusion

Based on the research results, it can be concluded that Augmented Reality-based learning media designed with the Assemblr Edu application is suitable and successful for elementary school students in the food chain material, science subjects. The media integrates three-dimensional visual representations, animations, textual explanations, audio support, and clear user guidance, thereby facilitating a more concrete, interactive, and engaging learning experience for students. Expert validation results demonstrate that the media achieves very high feasibility in terms of content accuracy and instructional design. In addition, the implementation of the AR-based learning media led to an improvement in students' learning outcomes, as indicated by higher posttest scores compared to pretest scores with a moderate gain category. The results of this study prove that AR-based learning media using Assemblr Edu effectively improves students' conceptual understanding and learning achievement in food chain material, and can therefore serve as an innovative instructional solution to support IPAS learning in elementary education, particularly for abstract concepts through interactive, technology-enhanced learning environments.

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References

Alexandra, W. (2022). Penerapan Teknologi Augmented Reality Berbasis Android Untuk Pembelajaran Rantai Makanan Pada Hewan. *Jurnal Informatika Dan Rekayasa Perangkat Lunak*, *3*(1), 107–116. https://doi.org/10.33365/jatika.v3i1.1864

Amdani, R, N., & Irma Purnamasari, A. (2022). Pengembangan Media Belajar Menggunakan Augmented Reallity Berbasis Android Pada Konsep Panca Indera. *JATI (Jurnal Mahasiswa Teknik Informatika)*, *6*(1), 399–407. https://doi.org/10.36040/jati.v6i1.4719

Arahman, D. P., & Isdaryanti, B. (2026). Pengaruh Media Interaktif IPAS Berbasis Assemblr Edu Dengan Model PBL Terhadap Hasil Belajar Siswa Kelas V SDTQ. *Science: Jurnal Inovasi Pendidikan Matematika Dan IPA*, *6*(2), 690–700. https://doi.org/10.51878/science.v6i2.9714

Chairudin, Muhamad, Nurhanifa, Yustianingsih, T., Aidah, Z., Atoillah, & Hadi, M. S. (2023). Studi Literatur Pemanfaatan Aplikasi Assemblr Edu Sebagai Media Pembelajaran Matematika Jenjang SMP/MTs. *Communnity Development Journal*, *4*(2), 1314–1315. Retrieved from https://core.ac.uk/download/pdf/560364816.pdf

Fatasya, T. S., Rahmatullah, Y., Husna, I., & Ratnawati, D. (2023). Pengembangan Media Pembelajaran

Pengenalan Bangun Ruang Berbasis Augmented Reality Untuk Anak Sekolah Dasar. *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika)*, *8*(3), 995–1009. https://doi.org/10.29100/jipi.v8i3.3834

Firdanu, R., Achmadi, S., & Adi Wibowo, S. (2020). Pemanfaatan Augmented Reality sebagai Media Pembelajaran mengenai Peralatan Konstruksi dalam Dunia Pendidikan Berbasis Android. *JATI (Jurnal Mahasiswa Teknik Informatika)*, *4*(2), 276–282. https://doi.org/10.36040/jati.v4i2.2657

Firmadani, F. (2020). Media Pembelajaran Berbasis Teknologi Sebagai Inovasi Pembelajaran Era Revolusi Industri 4.0. *Prosiding Konferensi Pendidikan Nasional*, *2*(1), 93–97. Retrieved from https://ejurnal.mercubuana-yogya.ac.id/index.php/Prosiding_KoPeN/article/view/1084/660

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

Istyasiwi, M. E., Aulianty, Y., & Sholeh, D. A. (2021). Pengembangan Media Digital Kartu Domino Rantai Makanan (Dorama) Pada Pembelajaran Ipa Di Sekolah Dasar. *Prima Magistra: Jurnal Ilmiah Kependidikan*, *2*(2), 254–263. https://doi.org/10.37478/jpm.v2i2.1115

Januarti, I. M., & Muliyadi, L. (2024). Development of Ethnoscience-Based Student Worksheet Using the Guided Inquiry Learning Model to Increase Students' Learning Motivation and Scientific Literacy: A Review. *International Journal of Science Education and Science*, *1*(1), 13–18. https://doi.org/10.56566/ijses.v1i1.109

Muliyadi, L., Doyan, A., Susilawati, Hamidi, Hakim, S., & Munandar, H. (2023). Training on Using PhET Virtual Media on Newton's Law of Gravity for Class X Students at Islamic Senior High School of Syaikh Abdurrahman Kotaraja, East Lombok. *Unram Journal of Community Service*, *1*(1), 15–18. Retrieved from https://journals.balaipublikasi.id/index.php/jcss/article/view/68

Munandar, H., Doyan, A., Susilawati, S., Hakim, S., Muliyadi, L., & Hamidi, H. (2024). Increasing Motivation to Study Physics Using PhET Media on Mechanical Energy Material. *MANDALIKA : Journal of Social Science*, *2*(1), 1–5. https://doi.org/10.56566/mandalika.v2i1.70

Musyaffa, I. F., & Isdaryanti, B. (2024). Pengembangan Media Pembelajaran Aplikasi Kebudayaan Indonesia (Si Budi) Berbasis Augmented Reality Untuk Meningkatkan Hasil Belajar Siswa Kelas IV Sekolah Dasar Irsyad. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *09*(02), 2507–2522. https://doi.org/10.23969/jp.v9i2.13351

Ni'mah, N., & Zutiasari, I. (2023). Development of Learning Media Based on Smart Apps Creator (SAC) to Improve Student Learning Outcomes. In *Proceedings of the BISTIC Business Innovation Sustainability and Technology International Conference* (Vol. 22, pp. 143–150). https://doi.org/10.2991/978-94-6463-302-3_18

Pagarra, H., & Syawaludin. (2022). *Media Pembelajaran*. Badan Penerbit UNM.

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

Rahayuningsih, P., Hidayah, W., Primar, C. N., & Nurmelia. (2022). Fungsi, Dan Peran Media Pembelajaran Sebagai Upaya Peningkatan Kemampuan Belajar Siswa. *Education Journal : Penelitian Ibnu Rusyd Kotabumi*, *1*(2), 95. https://doi.org/10.31800/jurnalkwangsan.v1i2.7

Rahman, D. A., & Andaryani, E. T. (2024). Pengaruh Motivasi Belajar Terhadap Hasil Belajar IPAS Kelas V SD Negeri Gayamsari 02 Kota Semarang. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *9*(4), 467–474. Retrieved from https://journal.unpas.ac.id/index.php/pendas/article/view/16965/8942

Susilawati, Doyan, A., Rokhmat, J., Muliyadi, L., Rizaldi, D. R., Fatimah, Z., Ikhsan, M., & Ardianti, N. R. (2025). Integration of Smartphone-Based Learning Media and Project-Based Learning to Enhance Creativity and Scientific Literacy in Physics. *International Journal of Information and Education Technology*, *15*(7), 1449–1459. https://doi.org/10.18178/ijiet.2025.15.7.2346

Wartoyo, P., Bayu, Agung, E. I. M., & Arifin, A. M. (2023). *Mudah Membuat Augmented Reality*. Universitas Negeri Makassar.