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The Effect of Augmented Reality-Assisted Spinner Learning Media on Science Learning Outcomes of Fifth Grade Students at MIN 2 Ngawi

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ABSTRACT

This study addresses the difficulty in visualizing abstract science concepts often leads to low student understanding and engagement in elementary science learning. Conventional teaching methods dominate, and interactive technology based media are limited. The research evaluated the effect of Augmented Reality (AR)-assisted spinning-wheel media (Spinner) on fifth grade students learning outcomes. Employing a quasi-experimental design with a nonequivalent control group. The study used purposive sampling to recruit 54 students, dividing them into experimental and control groups. Data were collected via a validated 20 item multiple choice test and analyzed using an independent samples t-test. The experimental groups average score significantly increased from 52.96 to 78.52, while the control group only improved from 45.93 to 58.89. Statistical analysis confirmed a significant difference between the two groups ($p < 0.05$). These findings demonstrate that integrating AR with spinning media effectively improves learning outcomes in the Natural and Social Sciences (IPAS) subject. This study concludes that AR-assisted interactive media offers an innovative solution for enhancing conceptual understanding in elementary science learning. Therefore, AR-assisted learning media can serve as an innovative for improving conceptual understanding in primary science education.

1. Introduction

The teaching of Natural and Social Sciences (IPAS) plays a crucial role in introducing students to the interactions among living organisms in our surroundings. Through this curriculum, students are expected to understand the reciprocal relationships between living organisms and their environment (Istmadelia & Tyas, 2024). One of the challenges in the IPAS learning process is conveying abstract concepts, such as ecosystems and food chains (Pratama et al.,

2022). Therefore, careful planning is required to ensure the learning process achieves its established objectives (Nadlir et al., 2024). The use of visual learning media is crucial because elementary school students are still in the concrete operational stage, they require tangible representations to grasp learning concepts more easily (Hafifah et al., 2025). The combination of verbal and visual information has been proven effective in enhancing students retention of the material. This aligns with dual coding theory, which posits that presenting verbal and visual information simultaneously makes it easier for students to understand and retain information in memory (Damayanti et al., 2023). The appropriate use of learning media can help students organize information within their cognitive structures, thereby making their understanding and knowledge easier to recall. The learning process in the classroom significantly influences students learning outcomes. Therefore, teachers are expected to effectively manage the instructional components, from formulating learning objectives to selecting appropriate strategies (Muhadi et al., 2025).

Based on observations conducted in fifth grade at MIN 2 Ngawi, students often struggle to visualize the energy flow process occurring in the abstract food chain. This is due to the dominant use of the lecture method in instruction and the infrequent use of learning media, such as YouTube. The use of one-way media and a lack of interactivity can pose a serious obstacle to the development of students character (Ramadhani & Febriani, 2023). Furthermore, based on interviews with homeroom teachers, many students daily exam scores remain low and have not met the Minimum Competency Criteria (KKM). Of the 54 fifth grade students classes A and B, 31 students (57%) have not met the learning competency standards, while 23 students (43%) have. One way to address the challenges faced in the learning process is to utilize innovative interactive learning tools, such as a spinner equipped with Augmented Reality (AR). According to educational media theory, effective learning media shift students roles from passive consumption toward active cognitive reconstruction. AR technology fulfills this by integrating digital objects such as three-dimensional (3D) models, animations, and videos into the real world in real time (Juwita et al., 2021). Based on concept visualization theory, AR bridges the gap between abstract scientific processes and students sensory perceptions by presenting unobservable phenomena, such as the mechanisms of energy transfer in food chains, as visible, concrete graphics (Nurhasanah et al., 2019). By making the learning experience more concrete, AR significantly minimizes cognitive load, thereby enabling fifth grade students to internalize complex ecological interactions without relying solely on imagination.

The use of AR technology helps promote spatial cognitive development by providing an immersive learning environment. To maximize this effect, AR can be integrated with Spinner, a learning tool in the form of a spinning wheel designed to enhance student activity, participation, and concentration (Maharani et al., 2025; Surodiana et al., 2023). This integrated medium introduces key gamification elements that are highly collaborative and interactive. This medium shifts classroom dynamics from teacher-centered to student-centered by transforming lessons into active explorations. Students simply spin the wheel to unlock AR representations. This high level of interactivity fosters intrinsic motivation and

sustained student engagement, as students are physically and mentally engaged in solving challenges throughout the learning process (Pahlevi & Mulyati, 2025; Putri et al., 2025). Numerous studies show that interactive multimedia with visual simulations consistently improves knowledge retention and student performance.

The novelty of this study lies in the strategic integration of a physical spinning wheel with digital Augmented Reality (AR) technology, which creates a hybrid learning ecosystem tailored to the developmental characteristics of elementary school students (Iskandar et al., 2025). While previous research has extensively explored AR and gamification separately, empirical studies combining both in elementary science education remain scarce. This study directly contributes to the 21st-century learning paradigm by demonstrating how affordable conventional teaching aids can be enhanced with modern interactive technology to foster critical thinking and digital literacy from an early age. Given this urgency, this study is expected to provide strong empirical evidence regarding improvements in student learning outcomes and serve as a practical reference for educators in adapting educational technology. Therefore, this study aims to determine the effect of Augmented Reality-based Spinner learning media on the learning outcomes of fifth grade students in the IPAS subject at MIN 2 Ngawi.

2. Methodology

This quantitative study employed a quasi-experimental design, specifically an Unequal Control Group Design. To determine the sample, the researcher used a non-probability sampling method, namely purposive group sampling. The experimental and control groups were selected from existing classes (all classes) without individual randomization to ensure the smoothness of the learning process (Asih Mardati et al., 2025). The population in this study consisted of all fifth grade students at MIN 2 Ngawi in the 2025/2026 academic year, totaling 54 students. This population was divided into class VA as the experimental group and class VB as the control group, with students in each class. Data collection was conducted using a multiple-choice test on food chain material. The content validity of the instrument was evaluated by experts, while its empirical validity was assessed through a pilot test on other students, followed by analysis using SPSS. Test items were selected based on an r value greater than the critical r value in the table at a significance level of 0.05 and a Cronbach's Alpha reliability coefficient greater than 0.60. In addition to validity and reliability tests, difficulty and discrimination analyses were also conducted to ensure the quality of the test items.

The data collection procedure in this study consisted of three stages: a pretest, the implementation of an interactive AR-assisted Spinner learning media, and a posttest. The independent variable in this study was the an interactive AR-assisted Spinner learning media, while the dependent variable was learning outcomes. Data analysis was performed using SPSS version 24, employing prerequisite analysis tests and hypothesis tests via Paired Sample T-Tests and Independent Sample T-Tests. These tests were conducted to determine whether there was a significant difference between the mean learning outcomes of the two classes (Silaban et al.,

2025). This study prioritizes scientific integrity by protecting student identities and has obtained permission from the madrasah.

3. Results and Discussion

The results of studies conducted in MIN 2 Ngawi will be presented in this section to answer the research questions that have been set. The presentation of the data begins with an instrument validation report to ensure the reliability of the data, followed by a description of the pretest and posttest data from the experimental and control classes. Furthermore, the results of prerequisite analysis and hypothesis testing to determine the effect of the use of Spinner learning media assisted by Augmented Reality (AR) on improving student learning outcomes in science subjects on food chain material. This study was designed in several specific phases so that the learning process can run regularly. These stages include: learning planning, media preparation, implementation in the classroom, assessment, and evaluation. The learning planning phase involves the use of teaching modules that are aligned with the independent curriculum for fifth grade science, which focuses on ecosystems and food chains. The media preparation phase includes the use of spinning wheel (spinner) media and Augmented Reality (AR)-assisted 3D digital models that have been adapted to the food chain material. Implementation in the classroom this study uses experimental design by comparing the results of learning between the experimental group using AR Spinner media and the control group using conventional lecture methods. The process of implementing AR-assisted Spinner learning media and Augmented Reality visualization, used throughout learning activities, is shown in Figures 1 and 2.



Figure 1. AR-Assisted Spinner Learning Media

The use of spinner media by students in determining learning activities and group discussion topics is shown in Figure 1. Next, Figure 2 presents one of the Augmented Reality visualizations that displays the components of the food chain in three dimensions to provide a more realistic experience of observing ecological relationships. The real implementation of AR Spinner in the experimental classroom was carried out through several stages of systematic learning to optimize the interaction between teachers and students. Learning begins with the implementation of a pretest to measure the initial cognitive abilities of students

before being given treatment, after the delivery of the main topic and explanation of interactive rules by the teacher, then continued with the formation of small collaborative groups. The learning activity begins when the group representative spins the spinning wheel (spinner) manually.



Figure 2. Augmented Reality visualization of food series materials

When the wheel stops at a specific ecological category or organism, students scan the marker on the device using a smartphone camera. In real-time, a three-dimensional (3D) digital model of the organism will appear on the screen, complete with animations illustrating its feeding behavior as well as its position in the energy flow. Through this process, class dynamics is transformed from passive learning into active exploration. Students collaboratively discuss ecological relationships in groups, and the teacher serves as a facilitator who asks lighting questions, guides observations, and helps students understand the role of each organism in the structure of the food chain as a whole. After the learning process is complete, the evaluation phase is continued with the provision of posttest to analyze cognitive development thoroughly from the use of interactive data. Before the instrument was used in the hypothesis testing, an instrument validation test was first conducted to ensure the validity and reliability of the IPAS learning outcome items. The pilot test was administered to 24 sixth grade students outside the research sample. Based on the validity analysis conducted using *Pearson's Product-Moment* correlation, out of the 40 test items that were pilot tested, 22 items were deemed valid, and 18 items were deemed invalid. The details of these test items are presented in Table 1.

Table 1. Description of Validity Test Results

Description	Item Number	Number
Valid	1,3,4,5,7,9,11,12,15,17,18,20, 21,24,25,26,27,30,32,33,35,40	22
Invalid	2,6,8,10,13,14,16,19,22,23, 28,29,31,34,36,37,38,39	18
Total		40

Based on Table 1, the validation process indicates that more than half of the initial items met the statistical criteria for research application. 22 valid items successfully capture the core indicators of the food chain and ecosystem, ensuring a comprehensive representation of the content. In contrast, 18 invalid items were excluded from the final instrument due to low correlation coefficients, which

prevented them from accurately measuring student performance. As a result, only verified valid items are passed to the next stage of reliability testing. To ensure consistency and stability prior to data collection, 22 valid test items were analyzed for statistical reliability. This procedure evaluates internal consistency, thus minimizing measurement errors throughout the student evaluation. A comprehensive analysis of this instrument is systematically compiled and presented in Table 2.

Table 2. Reliability Test Results

Cronbach's Alpha	N of Item	Description
.836	22	Very High

The statistical data in Table 2 indicate that the 22-item test achieves a "Very High" reliability standard with a Cronbach's Alpha coefficient of 0.836, confirming its strong internal consistency and minimal measurement error. Additionally, assessment of item difficulty and discrimination indices demonstrates that the questions are moderately challenging and exhibit excellent discriminatory power. differentiation capabilities. These balanced psychometric attributes ensure the instrument is well-suited to the cognitive capacity of fifth graders, effectively eliminates evaluation bias, and accurately distinguishes varying levels of student achievement. Consequently, this reliable baseline provides a solid empirical justification for deploying the instrument in the final data collection.

Student learning outcome data obtained from *pretest* and *posttest* scores in both the experimental and control classes were described to provide an overview of the distribution of student scores. These descriptive statistics include the mean, minimum, maximum, and standard deviation to examine differences in learning achievement between the two research groups. Students initial abilities were measured through a pretest given to the experimental group and the control group before the intervention began, and a posttest given at the end of the learning cycle to evaluate the cognitive learning outcomes of the two groups. Descriptive statistical test results can be seen in Table 3.

Table 3. Results of Descriptive Statistical Tests

Group	Test	N	Minimum	Maximum	Mean	Std. Deviation
Experiment	Pretest	27	35	70	52.96	10.120
	Posttest	27	60	95	78.52	9.488
Control	Pretest	27	30	60	45.93	9.203
	Posttest	27	45	75	58.89	9.233

Based on the table above, the experimental class scores increased from a pretest of 52.96 to a posttest score of 78.52, whereas the control class rose from 45.93 to 58.89. Both classes experienced an increase in scores, but the increase in the experimental class was much higher than that of the control class. The figure shows a significant increase in student scores; the bar chart above indicates a more significant increase in the experimental class than in the control class. This significant difference in results demonstrates that interactive AR Spinner media

enhances student cognitive engagement and knowledge retention compared to conventional methods.

Before drawing research conclusions in the hypothesis-testing phase, the students learning data is first tested through several stages of preliminary analysis. These stages aim to ensure that the data obtained meet the basic assumptions for the use of parametric statistics, including tests of normality and homogeneity. Normality Test. The normality test is used to determine whether student learning outcome data normally distributed. The normality test was conducted using the Shapiro-Wilk test via SPSS. The data is considered normally distributed if the significance value (sig.) is greater than 0.05. The following table presents the results of the normality test. The following are the results of the normality test presented in Table 4.

Table 4. Results of the Normality Test

Group	Test	Statistic	df	Sig.
Experimen	Pretest	.943	27	.147
	Posttest	.956	27	.293
Control	Pretest	.940	27	.124
	Posttest	.939	27	.113

The Shapiro-Wilk normality test indicates that all obtained data show significance values above 0.05, confirming that learning outcomes for both classes are normally distributed. In the meantime, a homogeneity test was conducted using Levene's test in SPSS to determine whether the variance of the pretest and posttest data for Class V A and V B is homogeneous. The homogeneity test was conducted using Levene's test in SPSS. Data is considered homogeneous if the value of its significance (Sig.) is greater than 0.05. The following are the results of the homogeneity test data analysis. The following are the results of the homogeneity test presented in Table 5.

Table 5. Homogeneity Test Results

Levene Statistic	df1	df2	Sig.
.254	3	104	.858

Based on the results of the homogeneity test using Levene's test, the significance value was 0.858, and this value is greater than the significance level of 0.05; therefore, it can be concluded that the variances of the two classes are homogeneous. After fulfilling all prerequisite tests, the next step is to conduct a hypothesis test to answer the research questions in this study. The testing was conducted in two stages, including a *paired sample t-test* and an *independent sample t-test*. This test was conducted to determine whether there was a significant difference between students learning outcomes before (pretest) and after (posttest) the intervention in both classes. The decision criterion is that if the Sig. (2-tailed) value is less than 0.05, then the null hypothesis (H_0) is accepted, and the alternative hypothesis (H_1) is rejected. The following are the results of the *paired-sample t-test* for both classes. Below are the test results of the paired Sample T-Test described in Table 6.

Table 6. Results of the Paired Sample T-Test

Group	Test	Mean	N	t (t-statistic)	df	Sig. (2-tailed)
Experimen	Pretest- Posttest	-25.556	27	-13.918	26	.000
Control	Pretest- Posttest	-12.936	27	-12.046	26	.000

Based on the table above, the results of the experimental class test show a Sig. (2-tailed) value of $0.000 < 0.05$ with a mean of 25.556. In the control class, a Sig. (2-tailed) A value of $0.000 < 0.05$ was obtained with a mean of 12.936. This indicates that both classes experienced a significant improvement in learning outcomes; however, the improvement in the experimental class was greater. This test was conducted to compare the effectiveness of the two classes at the *posttest* stage. The basis for decision-making is that if the Sig. (2-tailed) value is less than 0.05, then the null hypothesis (H_1) is accepted, and the alternative hypothesis (H_0) is rejected. The results of the self-test of the T-Test sample are applied in Table 7.

Table 7. Results of the Independent Sample T-Test

Variable	t (t-statistic)	df	Mean Difference	Sig. (2-tailed)
Learning Outcomes	7.704	52	19.360	.000

Based on the table above, the F-value is 7.704 with a 2-tailed significance value of 0.000. Since this significance value is less than 0.05, there is a significant difference in learning outcomes between the experimental and control classes at the *posttest* stage. The mean difference of 19.360 indicates that the experimental class outperformed the control class. These statistical findings demonstrate that interactive AR Spinner media significantly improve students' understanding of the ecosystem, as its visual and physical interaction advantages provide a much more profound learning impact than traditional textbooks. These findings indicate that integrating augmented reality into primary classrooms fosters a more dynamic, effective, and sustainable learning environment.

This study shows that the use of an Augmented Reality (AR)-assisted Spinner tool significantly improves the learning outcomes of fifth grade students at MIN 2 Ngawi in the field of natural sciences, specifically on the food chain. The average score of the experimental class increased sharply, from 52.96 to 78.52, indicating that this intervention effectively helps students in understanding concepts previously considered abstract. The advantages of using this tool were evidenced by the results of the independent samples t-test. A t-statistic value of 7.704 was obtained with a significance level of 0.000, which is less than 0.05. These results indicate that the difference in learning outcomes between students using the Spinner AR media and those in the control class with average scores ranging from 45.93 to 58.89 is not due to chance but rather the effectiveness of the chosen media

intervention. According to Agustin & Aqua Kusuma Wardhani (2023), integrating digital technology into IPAS learning in elementary school significantly impacts students cognitive development by presenting interactive content that captures their attention.

The effectiveness of the AR Spinner in improving learning outcomes stems from its ability to address the challenges elementary school students face with abstract thinking. Based on a review of media theory and augmented reality, meaningful learning can be achieved by reducing students cognitive barriers. This medium transforms theoretical science content into interactive 3D visual objects, thereby facilitating students memory retention and conceptual understanding. The integration of spinning media and AR technology has proven effective in transforming the abstract concept of the food chain into a real 3D learning experience. This finding validates previous research that the use of interactive visual media contributes greatly to improving students' science learning outcomes (Rahmawati et al., 2026; Yunita et al., 2025). The use of the physical Spinner medium provides a tactile aspect that plays a crucial role for elementary school students. The Spinner serves as a concrete control tool before students view the results on the screen. Integrating hands-on teaching aids with digital technology can help students absorb information more easily; interacting with concrete objects can reduce student confusion, and digital technology provides additional explanations, making abstract concepts easier to understand (Ismail et al., 2018). Through interactive 3D visualizations, an interactive AR-assisted Spinner learning media helps students transform abstract concepts into a more concrete understanding (Munawarah, 2025). AR technology successfully bridges the abstract concept of the food chain by visualizing the invisible flow of energy as an interactive digital model that can be observed in real time.

Significant improvements in learning outcomes are achieved owing to the nature of the AR Spinner, which transforms how students acquire information shifting from passive recipients to active participants in an interactive learning experience. Active learning fosters a deeper conceptual understanding in students than passive instructional approaches (Dani et al., 2026). The abstract concept of the food chain can be visualized in real-time 3D format this interactive medium can simulate dynamic processes within an ecosystem, greatly assisting students in understanding interdependence among living organisms (Qorimah et al., 2024). The instrument's validity research instrument, comprising 20 questions deemed valid and used in the study, ensures that the data on score improvements truly reflect students cognitive abilities. Multisensory and interactive experiences yield stronger memory retention relative to verbal and visual methods alone, as per Edgar Dale's Cone of Experience theory. The integration of Spinner media with AR provides a tangible learning experience that enhances student engagement. This interactive and immersive learning experience through AR technology also contributes significantly to the strengthening of learning motivation as well as the reconstruction of students' conceptual understanding (Destyani et al., 2026).

This study offers both practical and theoretical benefits. In practice, the findings suggest that integrating physical and digital learning media can help teachers to

enhance instructional effectiveness. Theoretically, this research contributes to the development of educational technology by demonstrating that a simple physical medium (the spinner), when integrated with digital technology, can become an innovative solution in schools. This is supported by Muspiroh et al. (2025) who state that technology-based learning is clearer when integrated with physical or concrete media and interactive digital simulations, making abstract concepts easier for students to grasp. The structural novelty of this research lies in the application of a hybrid framework that integrates conventional media in the form of a spinning wheel with easily accessible Augmented Reality (AR) digital assets. This research makes a substantial contribution to the transformation of 21st-century science and science learning in elementary schools. Furthermore, this research provides an innovative framework for creating a technology based, active learning environment that is adaptive to current developments. Although this study yielded positive results, it has limitations. The study was conducted over a relatively short period, so it may not yet fully reflect students long-term retention of understanding. Additionally, this study was limited to a single school. Recommendations for future research include conducting observations with a longer intervention duration and a broader, more diverse sample to assess the long-term impact of AR media use on other IPAS subject topics.

4. Conclusion

Based on the research findings and discussion, this study concludes that Augmented Reality (AR)-supported spinner media has a significant positive impact on the IPAS learning outcomes of fifth-grade students at MIN 2 Ngawi. The integration of a physical spinner with AR technology effectively visualizes the abstract concept of the food chain, transforming it into a concrete and easily understandable 3D interactive experience. This medium also demonstrably increases students' active engagement and motivation for exploration within the classroom. It is proven to be an effective tool for enhancing students' IPAS competencies and offering a strategic pathway for digital transformation within the elementary school curriculum, creating innovative and meaningful learning experiences. To enhance the durability of students' long-term memory, extending the treatment period must be applied in future research. This step needs to be accompanied by an increase in the number of samples from various schools with different characteristics, so that the evaluation of the application of hybrid media becomes more comprehensive.

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