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The Effect Of Inquiry Model Assisted By Augmented Reality Media On Students' Learning Outcomes In Elementary School Sciences

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***Abstract*— This study aims to test the extent to which the Inquiry model assisted by Augmented Reality (AR) can improve student learning outcomes in the subject of Science at SDN 4 Bandungrejosari. The Inquiry model encourages active involvement of students in the learning process, while AR is used as an interactive visual aid that clarifies abstract concepts and improves student understanding. This study uses a quantitative method with a quasi-experimental design of the Nonequivalent Control Group Design type. The sample consisted of an experimental class with 26 students who learned using the Inquiry model assisted by AR and a control class with 26 students who used conventional methods. Data collection was carried out through pretest-posttest and analyzed using non-parametric statistical tests. The results showed a significant effect of the use of the Inquiry model assisted by AR on student learning outcomes. Students who learned with this model experienced a higher increase in learning outcomes than students who used conventional methods. This proves that the integration of AR in Inquiry-based learning effectively strengthens conceptual understanding, improves memory, and encourages active involvement of students in the learning process, which ultimately has a positive impact on their learning outcomes.**

Keywords*— *Inquiry Model, Augmented Reality, Learning Outcomes.

I. INTRODUCTION (*HEADING 1*)

The learning model is a representation of a systematic thinking pattern. A model usually includes concepts that are interconnected as a whole (Mirdad, 2020). This was also expressed by Magdalena & et al., (2024) in the context of learning, the learning model is interpreted as structured steps that aim to organize learning experiences in order to achieve certain goals, while also functioning as a guideline in the process. Therefore, learning is an activity that is well designed and implemented in stages. In addition, the Ministry of Education and Culture Regulation No. 65 of 2013 concerning Process Standards, in the implementation of the K-13 curriculum there are several learning models that must be applied, including the inquiry learning model, discovery learning model, project-based learning model, problem-based learning model and cooperative learning model (Yusuf, 2018). In this case, the teacher tries to achieve success in learning by choosing the right method or model, which emphasizes student activities more than teacher activities (M Riki Mauli & Aziziy, 2023). So the learning model is a systematic pattern that helps achieve learning goals by actively involving students. Models such as inquiry allow teachers to relate material to real situations, so that students can apply knowledge in everyday life.

Science learning at the elementary school level must be designed to optimally involve student activity. Teachers play a role in creating a learning process that provides opportunities for students to develop process skills, including searching, finding, concluding, and communicating various relevant concepts, values, and experiences (Anindita et al., 2018; Maulidah & Aslam,

2021). As a branch of science that has unique characteristics, science studies natural phenomena factually which include real events and the cause-and-effect relationships that accompany them. Therefore, it is important for teachers to design learning that is interesting and in accordance with student characteristics. According to Putri et al., (2018) success in implementing science learning depends on teachers' deep understanding of various learning models that are theory-based and applied (Ichsan et al., 2018). In addition to understanding the role and function of the subjects taught, teachers also need to master various teaching methods so that the learning process can transform from merely transferring knowledge to activities that encourage active student participation (Berliana et al., 2018; Maulidah & Aslam, 2021). This is in line with the demands of educational policies that emphasize a paradigm shift from conventional teaching to constructivism-based learning, where students are encouraged to reflect on experiences, develop analytical and imaginative thinking, and actively contribute to society.

In the context of elementary school learning, Natural Sciences (IPA) has a crucial role in shaping students' mindsets and skills in solving problems. Science learning in elementary schools, especially on topics such as "What's on Our Earth", faces obstacles in understanding abstract concepts that are difficult to observe directly (Desstya, 2015). Based on the results of interviews with grade V teachers at Elementary School 4 Bandungrejosari, Malang, the use of the Discovery Learning model which is not yet fully optimal and the learning approach which is still limited in variation causes student learning outcomes to be less than optimal. Therefore, innovation in technology-assisted learning models is needed to improve student learning outcomes.

The learning model is a conceptual framework that systematically organizes learning experiences, functioning as a guide for teachers in designing and implementing teaching and learning activities (Hendracipta, 2021). The selection of methods, strategies, and techniques that are appropriate to the characteristics and learning styles of students is an important aspect in creating meaningful learning experiences and supporting the development of critical, creative, and collaborative thinking skills (Nasir et al., 2019).

In science learning, the Inquiry learning model is an approach that emphasizes students' critical thinking and analytical skills to be actively involved in the process of searching and finding answers to the problems presented (Bahwiah, 2021). According to Muliastrini, (2019) the Inquiry Model is a scientific and student-centered learning approach, its learning activities emphasize the critical and analytical thinking process to identify and find answers to problems faced independently. With increased understanding, students can channel their ideas to others (Sugianto et al., 2020). so that the application of the Inquiry model can help students in learning to find an answer to a problem (Hendrawati et al., 2019). Basically, the inquiry-based learning model is one alternative that can be applied to create change in the science learning process (Ayuniar et al., 2023). the inquiry approach has been proven effective in training students to think critically, work scientifically, and convey learning outcomes independently (Efendi & Wardani, 2021). This approach, which is based on constructivism theory, encourages students to build knowledge through direct experience, exploration, and interaction with the environment, so that the application of the inquiry model makes a positive contribution to improving learning outcomes (Muliastrini & Handayani, 2022).

Rapid technological developments have brought significant changes in various aspects of life, including education. Technological advances encourage the creation of learning media that are more interactive, innovative, and in accordance with student needs, so that the learning process becomes more effective and interesting (Prasetyo, 2022). According to Nistrina, (2021) AR is a technology that allows students to interact with visual objects that appear to be integrated with the real world, creating a more realistic learning experience. According to Thahir & Kamaruddin, (2021) emphasized that the use of AR in learning provides significant benefits for teachers and students, especially in improving conceptual understanding through direct experience compared to conventional methods. In addition, the use of technology also motivates students to acquire factual knowledge with the help of digital tools in science learning (Nugraha et al., 2017).

This study was previously conducted by Jahi et al. (2024) and Gultom et al. (2023) to fill the gap in the application of Augmented Reality (AR) in the Inquiry learning model, which is still rarely used in science learning in elementary schools. Although AR has been widely applied in education, this study focuses on how the combination of AR with the Inquiry model can increase student engagement, clarify abstract concepts, and significantly improve learning outcomes. The innovation in this study lies in the integration of AR as an exploration tool in the Inquiry model, allowing students to actively investigate science concepts through more concrete and interactive three-dimensional visualizations (Budiarti & Harlis, 2020; Affandi et al., 2014).

The combination of inquiry learning models assisted by Augmented Reality technology also makes the teaching and learning process not tied to class hours or classrooms, because students can study learning materials anywhere and anytime, potentially improving student learning outcomes, especially in science learning (Dhiyatmika et al., 2015). This innovation is expected to not only increase student interaction and participation, but also be able to optimize the delivery of learning materials through various forms of representation and actions that support a more immersive learning process (Setyawan et al., 2019).

Research on the application of AR media-assisted inquiry models in science learning is expected to provide a deep understanding of the material in Chapter 4 getting to know our earth, Sub Chapter 1 what is on our earth, IPAS. This innovative learning approach, as well as being a reference for curriculum developers and education practitioners in designing learning strategies that are more relevant to the needs of the times.

II. METHODOLOGY

This study uses a quantitative research approach with a quasi-experimental design (Quasi-Experimental Design) which is a pretest-posttest design without randomization or Non-equivalent control group design, where there is a control group used for comparison, but its members are not determined randomly.

Table 1 Nonequivalent Control Group Design

	Pretest	Treatment	Posttest
Experiment	**O1**	**X**	**O2**
Control	**O3**		**O4**

This study involved fifth grade students as the population, which included classes VA and VB. The sampling method was carried out using a saturated sampling technique, namely all members of the population were sampled. In this study, class VA was designated as the experimental group, while class VB was the control group. The researcher determined the two groups based on the implementation of the pretest and the results of interviews with class teachers who stated that the abilities of students in both classes were equal. The total number of students who were sampled was 52 people, with each class consisting of 26 students.

Table 2 Population and sample of class V

Group	Class	Amount
Experiment	VA	26 Siswa
control	VB	26 Siswa
Total number		**52 Siswa**

In this study, data collection was carried out by Test. The test used was an objective test for each pretest and post-test with a multiple-choice form consisting of 10 questions. Before being given to students, the test was first tested for validity, reliability, level of difficulty, and test of question discrimination.

In this study, data collection was carried out by Test. The test used was an objective test for each pretest and post-test with a multiple-choice form consisting of 10 questions. Before being given to students, the test was first tested for validity, reliability, level of difficulty, and test of question discrimination.

The validity test technique in this study is using the Point Biseria Correlation technique or product moment because the data is dichotomous (true or false). The validity of the analysis questions using the SPSS 23 for Windows program. The instrument in this case is said to be valid if it has r count > r table. Each answer on the student activity measurement tool can be stated into the category of true or false. For questions answered correctly, a score of 1 is given, while for questions answered incorrectly, a score of 0 is given.

Reliability is an index that shows a number of instruments can be trusted and relied upon. The reliability test in this study used SPSS 23 for Windows. The reliability test of the test was calculated using KR-20 (Arikunto, 2010:173). It was done by comparing the calculated r with the r-table, the calculated r for each question item can be seen in the Kuder and Richardson-20 column (KR-20). With the testing criteria if KR 20 ≥ 0.60 then it is said to be reliable and if KR 20 ≤ 0.60 then it is not reliable.

The difficulty level index helps to determine how difficult or easy a question is for students. The difficulty level index in this study uses Ms. Excel 2010.

The test of question discrimination power is used to measure the extent to which a question item can differentiate between students who have high and low understanding of the material being tested. The test of question discrimination power can be calculated using the help of Ms. Excel 2010.

The data analysis technique that will be carried out in this study is Mann-Whitney. Mann-Whitney U is a non-parametric statistical test used to compare two independent groups when the data is not normally distributed or ordinal (Sugiyono, 2017). If the results (Asymp. Sig. (2-tailed)) <0.05 then the data can be said to be significant, while if the results (Asymp. Sig. (2-tailed)) > 0.05 then the data is said to be insignificant (Field, 2013). Furthermore, to measure how much impact a treatment or difference between two groups in a study has on student learning outcomes, the Effect Size (r) calculation can be used (Fritz et al., 2012).

The hypothesis in this study is formulated as follows: H_0 (Null Hypothesis): There is no significant influence between the Inquiry model assisted by Augmented Reality media on the learning outcomes of elementary school science students. H_1 (Alternative Hypothesis): There is a significant influence between the Inquiry model assisted by Augmented Reality media on the learning outcomes of elementary school science students.

III. Results and Discussion

In the validity test, the researcher tested the test items in class V of SDN 2 Sukun. From this test, the validity of each item will be seen. The validity test of the question items uses correlation. So it is said to be valid if the instrument in this case is said to be valid if it has r-count > r-table. How to calculate it with N = 26 at 5% significance in the distribution of r values in the statistical table. The results obtained from 46 items of various questions, there are 23 valid questions and 23 invalid questions.

In addition to looking at the validity of the question items, in order to produce good questions, a reliability test is carried out with the test criteria if KR-20 ≥ 0.60 then it is said to be reliable and if KR-20 ≤ 0.60 then it is not reliable. Because the results obtained KR-20 (0.861) > 0.60 then the question is said to be reliable.

Reliability Statistics

Cronbach's Alpha	N of Items
.861	46

Next, test the level of difficulty of the questions by testing all valid data in the validity test. The results of the test of the level of difficulty of the questions using Microsoft Excel 2010 contained 12 easy questions and 11 medium questions with a total of 23 questions.

Next, test the discriminatory power of questions that have been verified valid from the Question validity test using Microsoft Excel 2010. Based on the results of the question discriminatory power test, there are 3 questions that must be discarded. So that the data analysis test, the researcher only used 20 questions consisting of 10 pretest questions and 10 post-test questions.

Based on the normality test conducted, the students' learning outcomes before being given treatment (pretest). The pretest in the control class obtained Sig. data of 0.014 <0.05, which means that the control class pretest data is not normally distributed. While the experimental class pretest, obtained Sig. data of 0.02 <0.05, which means that the experimental class pretest data is not normally distributed.

The results of the normality test conducted after treatment (post-test). Post-test in the Control class, obtained Sig. data of 0.134 > 0.05 which means that the post-test data of the control class is normally distributed. While the post-test in the experimental class, obtained Sig. data of 0.001 < 0.05 which means that the post-test data of the experimental class is not normally distributed.

To analyze data that is not normally distributed or insignificant, you can use a non-parametric test using Mann-Whitney U. The Mann-Whitney U test is measured from the output of the Asymp. Sig (2-tailed) value, if the Asymp. Sig (2-tailed) value <0.05 then the data can be said to be significant.

The results of the non-parametric test using the Mann-Whitney U test to determine the results of the pretest of students in the experimental and control classes obtained Sig. data of 0.005 <0.05, so the pretest data in both classes is said to be significant.

Ranks

	Kon Eks	N	Mean Rank	Sum of Ranks
Pret test	Kontrol	26	20.75	539.50
	Eksperimen	26	32.25	838.50
	Total	52		

Test Statistics[a]

	Pret test
Mann-Whitney U	188.500
Wilcoxon W	539.500
Z	-2.831
Asymp. Sig. (2-tailed)	.005

a. Grouping Variable: Kon Eks

The results of the non-parametric test that has been carried out using the Mann-Whitney U test to determine the results of the post-test of students in the experimental and control classes. The Sig. data obtained is 0.00 <0.05, so the post-test data in both classes is said to be significant.

Ranks

	Kon Eks	N	Mean Rank	Sum of Ranks
Post Test	Kontrol	26	19.25	500.50
	Eksperimen	26	33.75	877.50
	Total	52		

Test Statistics[a]

	Post Test
Mann-Whitney U	149.500
Wilcoxon W	500.500
Z	-3.561
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Kontol Eksperimen

The results of the Effect Size (r) calculation determine how strong the influence is between the experimental and control groups after treatment.

Table 11 Interpretation of r Values

	Z Value	Total Sample (N)	Effect Size (r) Formula	Kategori
post-test	-3.561	26	-0.698369557	Besar

The result of the interpretation of the r value of 0.698> 0.50 is a large category. so it can be said that ho is rejected and ha is accepted. then it can be interpreted that there is a significant influence on the learning outcomes of fifth grade students who use the inquiry learning model assisted by augmented reality.

Based on the results of the Mann-Whitney U pretest analysis of the experimental and control classes, the Z value was obtained = -2.831 and Asymp.Sig. (2-tailed) = 0.005 < 0.05, so it can be concluded that the pretest results are significant.

The results of the Mann-Whitney U post-test analysis of the experimental and control classes obtained a Z value = -3.561 and Asymp.Sig. (2-tailed) = 0.000 <0.05. The interpretation of the post-test results showed that there was a very significant difference between student learning outcomes in the experimental class using the AR-assisted inquiry model and the control class using conventional methods. This significant difference indicates a higher increase in student learning outcomes in the experimental class.

The calculation result of the Effect Size r value of 0.698 is included in the very large category (>0.50), this shows that the AR-assisted inquiry model has a large influence on student learning outcomes.

Based on the results of Effect Size (r) to measure the influence between the experimental group and the control group, the results obtained were 0.69> 0.05 with a large category. So it can be said that ho is rejected and ha is accepted. It can be concluded that there is a significant difference between student learning outcomes using the Inquiry learning model assisted by Augmented Reality media and conventional learning.

The difference is caused by the application of the Inquiry learning model assisted by Augmented Reality media, which not only encourages active involvement of students in the learning process through exploration and problem solving (Bahriah, 2021), This approach allows students to develop and synthesize analytical information independently, thereby improving conceptual understanding and science learning achievement. In addition, involvement in practice activities rather than simply memorizing material strengthens students' memory and understanding more deeply but also contributes to improving learning outcomes. This approach allows students to develop analytical skills and synthesize information independently, so that conceptual understanding and science learning achievement increase significantly. In addition, active involvement in exploratory and interactive activities rather than simply memorizing material strengthens students' memory and deepens their understanding, which ultimately has a positive impact on their learning outcomes (Sutarningsih, 2022).

Improving student learning outcomes using the inquiry model (1) increasing motivation and curiosity since the orientation stage, with the help of AR students can see 3D objects or simulations of real phenomena directly (Berliana et al., 2018). (2) developing critical thinking and problem-solving skills through problem formulation and investigation. AR integration students see simulations of live phenomena, so students can ask questions based on real observations, not just theories in books (Nadhifah, 2016; Yanti & Prahmana, 2017). (3) helping students understand concepts more deeply through direct experience in collecting and analyzing data (Muhali et al., 2021). With AR students can interact directly with virtual objects, they can see the structure of the earth's layers with the naked eye. (4) improving memory and communication skills through presentation and reflection of learning

outcomes. AR integration helps students analyze information (5) utilizing AR technology to increase student interactivity and engagement, so that learning is more interesting and easier to understand.

AR technology makes it easier for students to visualize abstract concepts that are difficult to understand with conventional methods (Templeton, 2020). AR provides an interesting learning experience and increases students' motivation to be more involved in learning (Carolina, 2022). According to Pulungan, (2017) student activeness in the learning process plays an important role in improving learning outcomes. Augmented reality is more interesting for students to learn and is more effective so that student learning outcomes increase from previous learning outcomes obtained by students (Muhali et al., 2021). The findings of this study are in line with the theory put forward by Halidi et al. (2015) which states that the use of AR-based learning media can be well received by students and has been proven effective in supporting classroom learning.

Based on the description above and the results of the research data analysis, it can be concluded that learning with the AR-assisted Inquiry model has an effect on student learning outcomes at SDN 4 Bandungrejosari. The use of this model helps students understand the material more clearly, making learning more enjoyable, efficient, effective, and meaningful. Thus, it can be concluded that "There is an effect of the AR-assisted inquiry model on student learning outcomes in the subject of science at SDN 4 Bandungrejosari."

IV. CONCLUSION

The results of the study showed that the Inquiry model assisted by Augmented Reality (AR) media has a significant influence on the learning outcomes of science in grade V. The use of this model has been proven to improve student understanding through more interactive and in-depth exploration. In addition, learning becomes more interesting, so that students are more active in following the learning process. The integration of AR technology in the Inquiry model provides an innovative learning experience and is able to strengthen students' memory of the material being studied.

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