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EFFECTS OF INQUIRY LEARNING MODEL ON STUDENTS' CRITICAL THINKING AND SCIENCE ACHIEVEMENT

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh model pembelajaran inkuiri terhadap kemampuan berpikir kritis dan hasil belajar siswa kelas IV sekolah dasar. Penelitian menggunakan pendekatan kuantitatif dengan metode eksperimen semu (quasi experiment) melalui desain *nonequivalent control group pretest–posttest*. Populasi penelitian meliputi seluruh siswa kelas IV SDIT Adzkia 1 dan SDIT Adzkia 2 Padang, dengan sampel sebanyak 51 siswa yang ditentukan menggunakan teknik *simple random sampling*, terdiri atas 24 siswa kelas eksperimen dan 27 siswa kelas kontrol. Instrumen penelitian berupa tes esai yang telah diuji validitas, reliabilitas, daya pembeda, dan tingkat kesukaran. Analisis data dilakukan melalui statistik deskriptif dan inferensial dengan uji prasyarat normalitas (Shapiro–Wilk) dan homogenitas (Levene), serta uji hipotesis menggunakan MANOVA pada taraf signifikansi 0,05. Hasil penelitian menunjukkan bahwa rata-rata nilai posttest kemampuan berpikir kritis dan hasil belajar kelas eksperimen (83) lebih tinggi dibandingkan kelas kontrol (73). Hasil uji MANOVA menunjukkan nilai signifikansi 0,000 < 0,05, yang berarti model pembelajaran inkuiri berpengaruh signifikan terhadap kemampuan berpikir kritis dan hasil belajar siswa secara simultan. Temuan ini menunjukkan bahwa pembelajaran berbasis inkuiri efektif meningkatkan keterlibatan aktif, kemampuan analitis, dan pemahaman konseptual siswa. Model pembelajaran inkuiri direkomendasikan sebagai strategi pedagogis inovatif untuk meningkatkan kualitas pembelajaran IPA sekaligus mengembangkan kompetensi berpikir tingkat tinggi siswa sekolah dasar.

Kata Kunci: *Model Inkuiri, Berpikir Kritis, Hasil Belajar, Pembelajaran IPA, Sekolah Dasar*

ABSTRACT

The purpose of this study was to analyze the effect of the inquiry learning model on critical thinking skills and learning outcomes of fourth-grade elementary school students. The research employed a quantitative approach with a quasi-experimental method using a nonequivalent control group pretest–posttest design. The population consisted of all fourth-grade students of SDIT Adzkia 1 and SDIT Adzkia 2 Padang, with a sample of 51 students selected through simple random sampling, comprising 24 students in the experimental class and 27 students in the control class. The research instrument was an essay test that had been validated in terms of validity, reliability, discrimination index, and difficulty level. Data analysis was conducted using descriptive and inferential statistics, including prerequisite tests of normality (Shapiro–Wilk) and homogeneity (Levene), followed by hypothesis testing using MANOVA at a significance level of 0.05. The results showed that the average posttest scores of critical thinking skills and learning outcomes in the experimental class (83) were higher than those of the control class (73). The MANOVA test yielded a significance value of 0.000 < 0.05, indicating that the inquiry learning model had a significant effect on students' critical thinking skills and learning outcomes simultaneously. These findings indicate that inquiry-based learning effectively enhances students' active engagement, analytical ability, and conceptual understanding.

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Therefore, the inquiry learning model is recommended as an innovative pedagogical strategy to improve the quality of science learning while fostering higher-order thinking skills in elementary school students.

Keywords: *Inquiry Model, Critical Thinking, Learning Outcomes, Science Learning, Elementary School*

INTRODUCTION

21st-century education demands a fundamental transformation in the orientation, strategies, and practices of learning in schools. Developments in science, digital technology, and global dynamics require students to master not only factual knowledge but also higher-order thinking skills, adaptability, and reflective and contextual problem-solving (Zebua, 2025). Within this framework, the learning paradigm is shifting from a surface learning approach to deep learning, which emphasizes in-depth conceptual understanding, knowledge integration, and the ability to apply concepts in real-world situations. Deep learning enables students to construct meaning through exploration, analysis, evaluation, and reflection, resulting in more meaningful and sustainable knowledge (Kosasih et al., 2022).

Strengthening deep learning-based instruction is also aligned with Indonesia's national education policy. The Educational Process Standards in Ministerial Regulation of Education, Culture, Research, and Technology Number 16 of 2022 emphasize that learning must develop critical, creative, and reflective thinking skills and encourage active student involvement in the learning process. Meanwhile, Ministerial Regulation of Education, Culture, and Technology Number 21 of 2016 concerning Content Standards emphasizes that student competencies include critical, creative, collaborative, communicative, and independent thinking skills. These policies demonstrate that developing higher-order thinking skills is not merely a pedagogical necessity but also a regulatory requirement that must be implemented in learning practices in elementary schools (Kosasih et al., 2022).

Critical thinking is an essential competency that students must possess to build knowledge and deeply understand concepts. This skill plays a role in stimulating higher-level cognitive processes such as analyzing information, evaluating arguments, and making rational and logical decisions (Khoriah et al., 2025). In the context of learning, critical thinking skills enable students to develop ideas, solve problems, and draw conclusions based on valid evidence. Therefore, strengthening critical thinking skills is a crucial component of learning, particularly in Natural Sciences (IPA) subjects, which characteristically demand scientific processes, logical reasoning, and problem-solving (Al-Qoyyim & Kurniawan, 2025).

Science learning has great potential to develop deep learning because it emphasizes not only conceptual mastery but also scientific process skills such as observation, classification, measurement, prediction, hypothesis formation, experimentation, data analysis, and conclusion drawing (Ramadhan et al., 2026). These skills require students' active involvement in the scientific inquiry process, making learning meaningful and applicable. Therefore, science learning is ideally designed as a constructive process that allows students to construct knowledge independently through direct experience, rather than simply receiving information from a teacher (Krajcik & Czerniak, 2025).

However, empirical conditions in the field indicate that science learning in elementary schools does not fully support the development of critical thinking skills. Based on observations conducted at SDIT Adzkia 2 Padang, it was found that the practice questions used were still dominated by low cognitive levels (C1–C3) which only require the ability to remember, understand, and apply. These questions did not yet lead to the ability to analyze, evaluate, and

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create (C4–C6) which are indicators of critical thinking. This condition has an impact on the low ability of students to solve problems and analyze concepts in depth. This is reflected in the value of the Science Daily Assessment with an average of 75.00 which is still below the Minimum Completion Criteria (KKM) of 80.

Interviews with classroom teachers revealed that the assessment instruments used still rely on student worksheets (LKPD) and textbooks, without developing questions based on Higher Order Thinking Skills (HOTS). Furthermore, the learning methods employed tend to be conventional and teacher-centered, resulting in limited student participation. This situation results in learning becoming less engaging and less meaningful, and failing to maximize students' critical thinking potential. Poor critical thinking skills also directly impact learning outcomes, as students struggle to understand concepts, analyze information, and draw logical conclusions.

This phenomenon aligns with the results of the Programme for International Student Assessment (PISA) international study, which showed that Indonesian students' scientific literacy and higher-order thinking skills are still relatively low compared to those of other countries. PISA questions generally require analytical, reasoning, and problem-solving skills, making these achievements an important indicator of the need for learning innovations that systematically develop critical thinking skills (Mahapoonyanont & Songsang, 2024).

One relevant learning model to address these challenges is the inquiry-based learning model. This model emphasizes the process of investigation, exploration, and knowledge discovery by students through the stages of formulating problems, formulating hypotheses, designing experiments, collecting data, analyzing information, and drawing conclusions. The inquiry approach positions students as active subjects of learning, encouraging them to think analytically, reflectively, and systematically. Each stage of the inquiry model directly activates elements of deep learning as students engage in the construction of meaning, integration of experiences, and evaluation of learning outcomes.

Theoretically, the inquiry learning model has several advantages, including its ability to develop cognitive, affective, and psychomotor aspects in a balanced manner; providing a learning space tailored to students' learning styles; and aligning with modern learning psychology theory, which views learning as a process of behavioral change through experience. Furthermore, this model can enhance student engagement, analytical skills, evaluation skills, and collaboration in the learning process. Implementing the inquiry model has the potential to improve the quality of science learning while strengthening critical thinking skills and learning outcomes (AlAfnan, 2025).

The integrative relationship between deep learning, science learning, critical thinking skills, and inquiry models demonstrates that improving learning quality cannot be achieved simply by adding materials but requires a transformation of the instructional approach. Effective learning must provide opportunities for students to explore ideas, test hypotheses, solve problems, and construct understanding independently. Therefore, learning innovations are needed that can activate higher-level cognitive processes and create meaningful learning experiences.

Based on the description, the application of the inquiry learning model in science learning is seen as a relevant pedagogical strategy to improve critical thinking skills and learning outcomes of elementary school students. This model is not only aligned with the demands of 21st-century education and national curriculum policies, but also able to address empirical problems in the field related to students' low critical thinking skills.

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METHODS

This study employed a quantitative approach using a quasi-experimental method with a nonequivalent control group pretest–posttest design. The research was conducted at SDIT Adzkia 1 Padang and SDIT Adzkia 2 Padang involving 51 fourth-grade students selected through simple random sampling. The sample consisted of 24 students in the experimental class and 27 students in the control class. The experimental class received instruction using the Inquiry Learning Model, while the control class was taught using conventional learning methods.

The research variables consisted of the Inquiry Learning Model as the independent variable and students' critical thinking skills and science learning outcomes as the dependent variables. Data were collected using an essay test instrument developed based on indicators of critical thinking and science learning achievement. Prior to implementation, the instrument was tested for validity, reliability, discrimination index, and difficulty level to ensure its suitability for data collection.

Data analysis was conducted using descriptive and inferential statistics. Descriptive statistics were used to present the distribution of students' scores, while inferential statistics were applied to test the research hypotheses. Before hypothesis testing, prerequisite analyses including the Shapiro–Wilk normality test and Levene's homogeneity test were performed. Hypothesis testing was conducted using Multivariate Analysis of Variance (MANOVA) at a significance level of 0.05 to determine the effect of the Inquiry Learning Model on students' critical thinking skills and science learning outcomes simultaneously.

RESULT AND DISCUSSION

Result

Data on students' critical thinking skills were obtained through a posttest administered after the implementation of the learning treatment in both classes. The assessment measured students' ability to interpret information, analyze problems, evaluate evidence, and formulate conclusions based on the science learning materials that had been studied. The results were then analyzed descriptively to identify differences in achievement between students who learned using the Inquiry Learning Model and those who learned through conventional instruction. The comparison of posttest scores for critical thinking skills is presented in Figure 1.

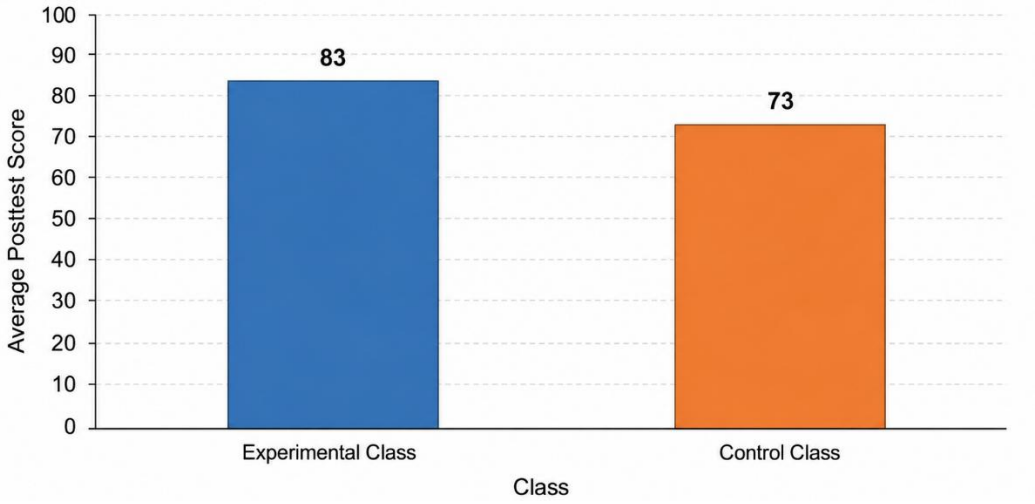

Figure 1. Posttest Graph of Critical Thinking Skills of Class IVM3 and Class IVK1

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Based on Figure 1, the average posttest score of the experimental class is higher than the control class, for the experimental class it is 83 for the control class 73. There was an increase in critical thinking skills after being given treatment using the Inquiry learning model, and the average posttest score of the experimental class was 83 while in the control class it was 73. These results show that the critical thinking abilities of the two classes have differences, it can be seen that the experimental class that uses the Inquiry learning model of students tend to be more active in the science learning process than the control class that uses direct learning where students tend to be passive. This shows that the critical thinking abilities of the experimental class are superior to the control class.

Students' learning outcomes were measured through a posttest administered at the end of the instructional process. The test consisted of science questions designed to assess students' mastery of concepts and understanding of the material taught during the research period. The scores obtained from both classes were analyzed descriptively to determine the level of student achievement following the implementation of different learning approaches. The comparison of learning outcomes between the experimental and control classes is shown in Figure 2.

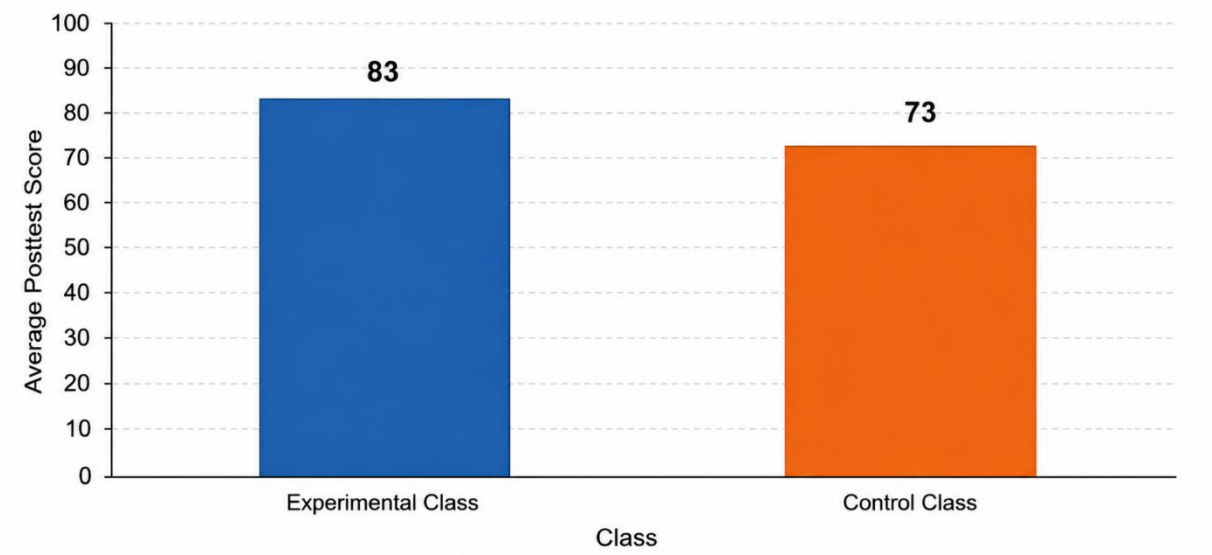

Figure 2. Posttest Graph of Learning Outcomes of Class IVM3 and Class IVK1

Based on Figure 2, the average posttest score of the experimental class is higher than the control class, for the experimental class the average score is 83 for the control class the average score is 73. There was an increase in critical thinking skills after being given treatment using the Inquiry learning model, and the average posttest score of the experimental class was 83 while in the control class it was 73. These results show that the critical thinking skills of the two classes have differences, it can be seen that the experimental class that uses the Inquiry learning model, students tend to be more active in the science learning process than the control class that uses direct learning, students tend to be passive. This shows that the learning outcomes of the experimental class are superior to the control class.

Prior to hypothesis testing, prerequisite analyses were conducted to ensure that the research data met the assumptions required for parametric statistical testing. The prerequisite tests consisted of a normality test and a homogeneity test. These analyses were performed to determine whether the data were normally distributed and whether the variances between groups were homogeneous. The results of the prerequisite tests are presented below.

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The normality test was conducted using the Shapiro–Wilk procedure because the number of research participants in each group was fewer than 100 students. The test was performed on the posttest scores of critical thinking skills obtained from both the experimental and control classes. The results of the normality test are presented in Table 1.

Table 1. Normality Test of Critical Thinking Ability

	Kolmogorov-Smirnova			Shapiro-Wilk		
Class	**Statistics**	**df**	**Sig.**	**Statistics**	**df**	**Sig.**
Experimental Class	.156	24	.134	.954	24	.334
Control Class	.156	24	.137	.943	24	.187

Table 1 shows the results of the normality test with a significance level of > 0.05, indicating that the data is normal. The critical thinking ability variable data for the experimental class obtained a sig value of 0.334, indicating that the critical thinking ability value for the experimental class was normally distributed, while the sig value for the control class was 0.187, indicating that the distribution was normal.

Homogeneity of Variance Test

After the homogeneity test of variance is carried out, it is the second requirement that must be done before using the multivariate analysis test (MANOVA). In the homogeneity test of the Variance Covariance Matrix to see Y1 and Y2 (critical thinking ability and learning outcomes) can have a significant effect on variable X (Inquiry model) simultaneously while in the homogeneity test of variance, namely to see the influence of variable Y1 (critical thinking ability) on variable X (Inquiry model) and variable Y2 (Learning outcomes) on variable X (Inquiry model) individually. The results of the homogeneity test of the variance covariance matrix can be seen in Table 2 as follows.

Table 2. Levene's Test of Equality of Error Variances

Levene Statistics	**df1**	**df2**	**Sig.**
.184	1	49	.670

Table 2 shows a significant value indicating an influence between critical thinking skills and learning outcomes. If the significance level is 0.05, then the critical thinking skills and learning outcomes are > α. Therefore, H0 is accepted, indicating that the variance covariance matrix for the critical thinking and learning outcomes variables individually is the same for the treatment variable. Therefore, a multivariate analysis (MANOVA) can be conducted.

Hypothesis testing was conducted using Multivariate Analysis of Variance (MANOVA) to examine the simultaneous effect of the Inquiry Learning Model on students' critical thinking skills and learning outcomes. The analysis was performed after all prerequisite assumptions had been satisfied. The results of the multivariate test are presented in Table 3.

Table 3. Multivariate Test

Multivariate Tests						
Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Intercept	Pillai's Trace	.997	9168.212b	2,000	48,000	.000
	Wilks' Lambda	.003	9168.212b	2,000	48,000	.000

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	Hotelling's Trace	382,009	9168.212b	2,000	48,000	.000
	Roy's Largest Root	382,009	9168.212b	2,000	48,000	.000
Inquiry Model	Pillai's Trace	.627	40.368b	2,000	48,000	.000
	Wilks' Lambda	.373	40.368b	2,000	48,000	.000
	Hotelling's Trace	1,682	40.368b	2,000	48,000	.000
	Roy's Largest Root	1,682	40.368b	2,000	48,000	.000

a. Design: Intercept + Inquiry
b. Exact statistics

Based on the results shown in Table 3, all multivariate statistics, including Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root, produced significance values of 0.000. The significance values were lower than the predetermined significance level of 0.05. These results indicate the presence of statistically significant differences between the experimental and control groups when critical thinking skills and learning outcomes were analyzed simultaneously. The findings demonstrate that the learning treatment applied in the experimental class contributed to differences in student performance compared with the control class. Thus, the multivariate analysis confirmed the existence of a significant effect on the dependent variables examined in this study. To identify the effect of the Inquiry Learning Model on each dependent variable individually, a Tests of Between-Subjects Effects analysis was conducted. The results of this analysis are presented in Table 4.

Table 4. Tests of Between-Subjects Effects

Source	Dependent Variable	F	Sig.
Inquiry Model	Critical Thinking	58,458	.000
	Learning outcomes	73,967	.000

Based on Table 4, the results indicate that the significance value for critical thinking skills was 0.000 with an F value of 58.458. Similarly, the significance value for learning outcomes was 0.000 with an F value of 73.967. Both significance values were lower than 0.05, indicating statistically significant differences between the experimental and control groups for each dependent variable. The findings show that the Inquiry Learning Model was associated with differences in students' critical thinking skills and science learning outcomes. Overall, the statistical results demonstrate that both dependent variables exhibited significant variations following the implementation of the learning treatment.

Discussion

The application of the Inquiry learning model in science learning in grade IV of SDIT Adzkia 2 Padang shows high effectiveness in improving critical thinking skills and student learning outcomes. This effectiveness is demonstrated through a comparison of posttest results between the experimental class and the control class, where the average learning outcome of the experimental class reached 83, while the control class was 72. This increase indicates that inquiry-based learning is able to provide a significant impact on students' cognitive achievements. This finding is in line with (Siregar, 2025) opinion which emphasizes that

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discovery-based learning can improve higher-order thinking skills and conceptual understanding more meaningfully than direct learning.

The results of the hypothesis test using MANOVA analysis confirmed the research findings with a significance value of 0.000 < 0.05, indicating that the Inquiry model significantly influenced critical thinking skills and learning outcomes simultaneously. (Antonio & Prudente, 2024) explained that the Inquiry model is designed to foster higher-order thinking skills through the process of scientific investigation. Activities such as formulating problems, collecting data, and evaluating findings not only improve conceptual understanding but also train students to think logically, analytically, and reflectively. The present findings support the study conducted by Alerbitu et al. (2025), which revealed that the implementation of the Inquiry Learning Model contributes significantly to improving students' academic performance and learning achievement.

The findings of this study are consistent with the results reported by Maylia et al. (2024), who found that inquiry-based learning contributes positively to the development of elementary students' critical thinking skills by encouraging active investigation, information analysis, and evidence-based reasoning. From the aspect of critical thinking skills, the Inquiry model has been proven to encourage students to think reflectively, rationally, and systematically in solving problems. This is evident in students' active involvement in formulating questions, developing hypotheses, collecting and analyzing data, and drawing conclusions independently. (Guo et al., 2024) states that critical thinking is a reflective and rational process used to determine the right decisions. The Inquiry learning process provides space for students to develop these skills through exploratory activities and collaborative discussions. Thus, learning is not only oriented towards the final result, but also on the thinking process that students go through.

Theoretically, the success of the Inquiry model in improving critical thinking skills is supported by Piaget's (2016) constructivism theory, which emphasizes that knowledge is actively constructed through interaction with the environment. In the experimental class, students not only receive information from the teacher but also actively construct knowledge through direct learning experiences. This condition differs from the control class that uses the Direct Instruction model, which is more teacher-centered. (Vafamehr et al., 2026) explain that direct learning is effective for mastering procedural material, but provides less space for the development of higher-order thinking skills. This difference in the characteristics of the approach explains why the increase in critical thinking skills is more significant in the class that applies the Inquiry model.

The improvement in students' critical thinking skills supports the findings of Parwati et al. (2024), who demonstrated that guided inquiry learning significantly enhances critical thinking and scientific attitudes by engaging students in systematic learning activities. In terms of learning outcomes, the application of the Inquiry model shows a high level of effectiveness because it can improve conceptual understanding in a deep and meaningful way. (Sotto, 2021) stated that learning outcomes reflect changes in students' cognitive, affective, and psychomotor abilities after participating in the learning process. In this study, students' active involvement in the investigation, data collection, and conclusion-drawing processes enabled them to understand the material more systematically and contextually. (Gomez, 2025) added that students with high learning outcomes generally have good motivation, discipline, and learning planning, which in the Inquiry model develop through independent investigation activities.

The advantages of the Inquiry model are also evident in increased student motivation and self-confidence. The process of independently finding answers provides a meaningful learning experience that fosters a sense of satisfaction with the results achieved. (Zebua, 2025)

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stated that 21st-century learning requires active student involvement for deeper and more sustainable conceptual understanding. In this regard, the Inquiry model provides an authentic learning experience because students learn through a process of discovery, not simply receiving information. This strengthens conceptual understanding while increasing student learning resilience.

The relationship between critical thinking skills and learning outcomes in this study shows a mutually reinforcing correlation. Students with strong critical thinking skills tend to be able to understand concepts more deeply and solve problems effectively, thereby improving learning outcomes. Conversely, good learning outcomes provide positive feedback for the development of critical thinking skills. (Andreucci-Annunziata et al., 2023) emphasized that students with strong critical thinking skills generally achieve more optimal learning outcomes because they are able to analyze and evaluate information systematically. These findings indicate that these two variables have a mutually supportive relationship in the learning process.

The higher learning outcomes achieved by the experimental group are consistent with the findings of Utari and Susiloningsih (2025), who reported that inquiry-based learning can improve students' understanding of concepts and overall academic achievement in elementary education. The practicality of implementing the Inquiry model is also evident in its ability to create an active, collaborative, and student-centered learning environment. Students are given the opportunity to discuss, express their opinions, and work together in groups to solve problems. This situation aligns with (Gillies, 2023) opinion that learning that provides space for students to explore ideas will increase participation and engagement in learning. In other words, the Inquiry model not only improves cognitive aspects but also develops students' social skills and scientific attitudes.

Research findings indicate that the Inquiry learning model is an effective, relevant, and applicable learning strategy for improving critical thinking skills and learning outcomes in elementary school students. The implementation of this model can shift the role of teachers from primary sources of information to facilitators of learning, thus providing students with broader opportunities to develop their potential for independent thinking and learning. The Inquiry Model is recommended as an innovative learning approach that aligns with the demands of 21st-century education, which emphasizes the development of critical thinking, creativity, communication, and collaboration skills.

CONCLUSION

The application of the Inquiry learning model in science learning in grade IV of SDIT Adzkia 2 Padang has been proven to have a positive and significant influence on students' critical thinking skills and learning outcomes. Improved critical thinking skills are demonstrated through students' skills in observing, analyzing, evaluating, and drawing logical conclusions during the inquiry-based learning process. Meanwhile, improved learning outcomes are seen from students' active involvement in the process of discovering concepts, collecting data, and solving problems independently and collaboratively. The effectiveness of this model shows that student-centered learning can improve the quality of the learning process and outcomes simultaneously. The implications of this study suggest that teachers are advised to use the Inquiry model as an innovative and contextual alternative learning strategy to develop students' higher-order thinking skills. Further research is recommended to expand the application of this model to different educational levels, subjects, and methodological approaches to strengthen the generalizability of the findings and enrich the study of inquiry-based learning in the context of 21st-century education.

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