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Improving Elementary Students' Critical Thinking Skills through the Use of STEM-Based Teaching Materials in Integrated Science and Social Studies Instruction

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ABSTRACT

This study investigates the effectiveness of STEM-based teaching materials and student worksheets (LKPD) in enhancing the critical thinking skills of fourth-grade students in Integrated Science and Social Studies (IPAS). Employing a pre-experimental research design, the study was conducted at MI Baiturrahim with a sample of 28 students. Data were collected through teacher interviews and critical thinking tests administered as pretests and posttests. Due to the non-normal distribution of the data (significance value = 0.012, α = 0.05), the Wilcoxon signed-rank test was applied, yielding a significance value of 0.001 (< 0.05), indicating a statistically significant improvement in students' critical thinking skills after the intervention. The N-gain score of 0.6444 categorizes the improvement as moderate. These findings suggest that integrating STEM-based instructional materials into IPAS lessons can effectively foster students' critical thinking abilities at the elementary level.

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1. INTRODUCTION

Critical thinking skills, including problem-solving and analytical reasoning, are essential competencies for students in the 21st century. Mastery of higher-order thinking skills (HOTS), particularly critical thinking, is vital in preparing students to navigate a world that is increasingly complex, dynamic, and knowledge-based (Chaojing, 2023; Kwangmuang et al., 2021; Sasson et al., 2018). Critical thinking serves as a fundamental component of the learning process, as it enables learners to analyze information, evaluate arguments, and formulate solutions based on logical and reflective reasoning (Muyassaroh & Nurpadilah, 2021; Raj et al., 2022; Stephen, 2024). Critical thinking assists students in addressing everyday problems through intellectual processes that involve analysis, evaluation, and objective decision-making (Aini et al., 2020; Suparya, 2020). Furthermore, this skill enables learners to form reasoned beliefs and make appropriate decisions based on available information (Juliyantika

& Batubara, 2022; Darmawan et al., 2025). Therefore, critical thinking is not only relevant in responding to the increasingly complex and dynamic global challenges, but it also plays a significant role in enhancing students' understanding of subject matter and deepening the overall learning process (Paul & Elder, 2020). Therefore, strengthening students' critical thinking must be systematically integrated into the learning process at all levels of education, including elementary school.

Indonesia's recent education reform through the Merdeka Curriculum reflects a strategic response to global demands for competence and character-based learning (Kemendikbudristek, 2022; Rahayu et al., 2022; Wijayanti & Ekantini, 2023). Designed to promote flexibility, student-centeredness, and interdisciplinary integration, this curriculum aims to equip learners with not only academic knowledge but also essential 21st-century skills, including critical thinking (Anas et al., 2025; Laili & Pradikto, 2025; Martinez, 2022; Supriani, 2022). However, despite these progressive policy frameworks, many educators continue to encounter challenges in designing and implementing instructional strategies that can effectively cultivate students' critical thinking abilities. Empirical findings and classroom observations suggest that conventional, teacher-centered methods still dominate, often focusing on one-way knowledge transmission and providing limited opportunities for exploration, dialogue, and contextual problem-solving (Mpho, 2018; Yang & Jansem, 2025). In the context of 21st-century education, where reflective and analytical thinking is crucial, it is imperative for teachers to shift toward more innovative, student-centered pedagogies that actively engage learners in critical inquiry and independent reasoning.

The low achievement of Indonesian students in international assessments such as the Programme for International Student Assessment (PISA) reinforces the urgency of this issue. The 2022 PISA results released by the OECD show that Indonesia's average score in science literacy was 383, significantly below the OECD average of 485 (OECD, 2023). This score not only reflects limited content mastery but also highlights deficiencies in higher-order thinking skills such as critical thinking, problem-solving, and analytical reasoning (Heryani et al., 2024; Khurma et al., 2025; Tajudin & Chinnappan, 2016). PISA explicitly measures students' ability to apply their knowledge to analyze, reason, and evaluate information, core components of critical thinking (Gómez & Suárez, 2020; Sirén & Sulkunen, 2025). In the science domain, Indonesian students continue to struggle with interpreting data, drawing logical conclusions, and evaluate arguments based on evidence (Chusni et al., 2020; Esti et al., 2023). These findings indicate that the current instructional approaches have not been fully effective in nurturing students' critical thinking skills within scientific contexts (Baharin et al., 2018; Fajrina et al., 2020; Siddiqua et al., 2023). Consequently, the 2022 PISA results serve as a strong signal for the need to innovate learning practices that more actively engage students both cognitively and affectively. Instruction must be designed to train students to explore, analyze, and reflectively solve real-world problems. This points to the need for more cognitively demanding instructional practices that activate and nurture critical reasoning.

One promising approach is STEM education. The STEM (Science, Technology, Engineering, and Mathematics) approach is an innovative strategy relevant for developing students' critical thinking skills through interdisciplinary integration in solving real-world problems (Bugingo et al., 2024). This approach encourages exploration, experimentation, and product creation that require logical, analytical, creative, and reflective thinking skills (Hasançebi et al., 2021; Sumarni & Kadarwati, 2020). Integrating STEM into learning fosters broad thinking, meaningful learning experiences, and problem-solving skills by actively

engaging students in designing and applying technology while enhancing their cognitive, manipulative, affective, and conceptual abilities (Muyassaroh et al., 2022). Various studies have shown that STEM-based learning is significantly more effective in enhancing critical thinking abilities compared to conventional methods (Arisha & Surya, 2024; Mulyani, 2019). In the context of elementary education, the IPAS subject (Natural and Social Sciences) provides a strategic space to implement this approach due to its integrative nature across science, social, and environmental aspects. However, the limited availability of teaching materials and student worksheets (LKPD) that effectively facilitate critical thinking processes remains a major obstacle (Alditia, 2024; Dwijayanti et al., 2022). Textbooks commonly used in schools tend to focus on memorization and lack sufficient stimulus for exploration or real-world problem-solving (Niam & Asikin, 2021). Therefore, innovation in STEM-based teaching materials and LKPD is crucial, not only to provide information but also to actively engage students in meaningful and contextual learning experiences.

At the elementary level, the IPAS subject, which integrates natural and social sciences, offers a strategic foundation for the implementation of STEM-based learning (Hasani, 2020; Karimah & Wulandari, 2023). However, empirical studies indicate that such integration remains limited, largely due to the unavailability of well-structured instructional materials and student worksheets (LKPD) that promote active and reflective engagement (Rahmi et al., 2025; Unayah et al., 2025; Muna, 2024). Existing learning resources are predominantly textbook-centered, with an emphasis on rote memorization rather than inquiry-based exploration and critical thinking (Paul & Elder, 2020; Fithri et al., 2021). A preliminary needs assessment conducted at MI Baiturrahim, an Islamic elementary school in Indonesia, revealed that IPAS instruction continues to rely heavily on standardized textbooks lacking alignment with STEM principles. Teachers reported that current materials provide limited support for the development of students' critical thinking skills. This is substantiated by pre-test data, which showed that only 1 out of 28 students achieved the *Kriteria Ketuntasan Minimal (KKM)* or Minimum Competency Criteria. These local findings are consistent with national and international research, underscoring the urgent need for instructional innovation grounded in STEM. In response to these challenges, the present study seeks to integrate STEM-based approaches into the design and implementation of teaching materials and LKPD for fourth-grade IPAS instruction. Building upon prior research in educational development, the proposed materials are intended to deepen students' conceptual understanding while simultaneously fostering critical thinking.

Based on the explanation above, this study aims to answer the following research questions:

1. What is the level of critical thinking skills of fourth-grade students at MI Baiturrahim in the IPAS subject before the implementation of STEM-based teaching materials and LKPD?
2. What is the level of critical thinking skills of fourth-grade students at MI Baiturrahim in the IPAS subject after the implementation of STEM-based teaching materials and LKPD?
3. Is there a significant difference in the critical thinking skills of fourth-grade students at MI Baiturrahim before and after the implementation of STEM-based teaching materials and LKPD?

2. METHODS

The research method used in this study is an experimental method with a type of Pre-Experimental Design. The research design employed is the "One Group Pretest-Posttest" design. In this design, a pretest is administered before the treatment to accurately determine the initial condition of the participants, as it allows for comparison with the condition after the treatment. In the first meeting, the researcher administered a pretest to the students in the form of an exercise on the IPAS (Integrated Science and Social Studies) subject focusing on energy material, without using STEM-based teaching materials and student worksheets (LKPD). In the following sessions, the researcher implemented the STEM-based teaching materials and LKPD during the learning process. In the subsequent session, the researcher administered a posttest (final test). The One-Group Pretest-Posttest design can be illustrated as follows (Sugiyono, 2013).

$$O_1 \rightarrow X \rightarrow O_2$$

Figure 1. One-Group Pretest-Posttest Design

Description:
O_1 = Pretest score (before treatment)
X = Treatment
O_2 = Posttest score (after treatment)

The population in this study consisted of fourth-grade students at MI Baiturrahim, and the sample used for the study was 28 fourth-grade students. Data processing was conducted using Microsoft Excel 2016 and IBM SPSS 25. The purpose of using Microsoft Excel was to obtain a general overview of each variable based on certain categories. Meanwhile, IBM SPSS 25 was used to obtain descriptive data of each variable and perform statistical analysis to facilitate the hypothesis testing process.

3. RESULT AND DISCUSSION

Based on the results of the pretest, the lowest and highest scores were identified according to the assessment criteria. The lowest pretest score was 20, and the highest was 80, based on the evaluation of the practice questions on the Science and Social Studies (IPAS) topic of energy. From the posttest results, the lowest score was 70 and the highest was 100, indicating an improvement from the pretest scores.

3.1. Critical Thinking Skills of Grade IV Students at MI Baiturrahim Before Learning Using STEM-Based Teaching Materials and Worksheets

Based on the research conducted on 28 Grade IV students at MI Baiturrahim prior to learning with STEM-based teaching materials and student worksheets (LKPD), the data are as follows:

Table 1. Pretest Scores of Grade IV MI Baiturrahim

No.	Score Interval	Frequency
1	71 – 80	1
2	61 – 70	4
3	51 – 60	7
4	41 – 50	2
5	31 – 40	7
6	21 – 30	2
7	10 – 20	5
Total		28
Average		47,14
Standard Deviation		18,228

Table 1 presents the distribution of pretest scores for 28 fourth-grade students at MI Baiturrahim prior to the implementation of the STEM-based instructional materials and student worksheets (LKPD). The results indicate a generally low level of critical thinking skills among students before the intervention. A majority of students scored within the mid-to-low performance ranges. Specifically, 7 students (25%) scored between 51–60, and another 7 students (25%) were in the 31–40 range. An additional 5 students (17.86%) fell within the lowest score interval (10–20). Only one student (3.57%) achieved a score between 71–80, indicating that high-level performance was rare at this stage. The mean score of the group was 47.14 with a standard deviation of 18.23, reflecting a wide spread of scores and suggesting significant variability in students' initial critical thinking abilities. The score distribution is negatively skewed toward lower intervals, which implies that most students struggled with the tasks designed to assess critical thinking prior to the STEM intervention. These findings confirm the necessity of an instructional innovation, as the baseline data reveals a substantial gap in students' ability to engage in higher-order thinking processes. It also establishes a strong rationale for adopting interdisciplinary, inquiry-based learning models such as STEM to enhance cognitive development in the elementary science classroom. Figure 2 presents a bar chart illustrating the distribution of pretest scores obtained by Grade IV students. This visual representation categorizes student performance into specific score intervals, allowing for a clearer understanding of their initial level of knowledge prior to the instructional intervention

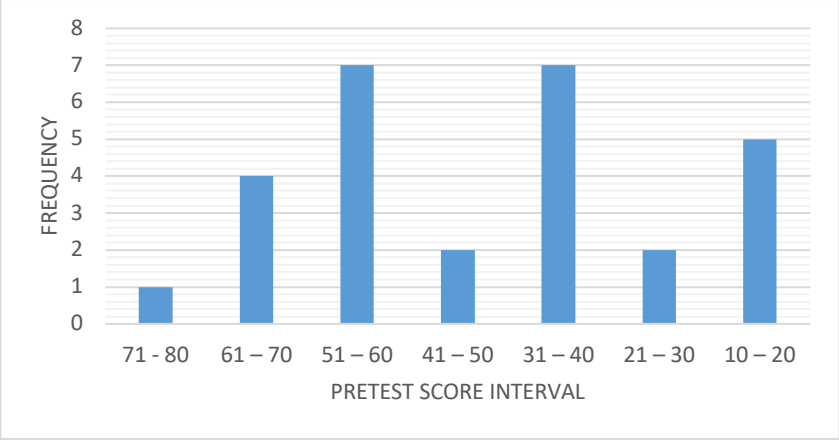

Figure 2. Bar Chart of Grade IV Pretest Scores

Figure 2 presents the distribution of pretest scores for Grade IV students at MI Baiturrahim, categorized by score intervals. The data indicates that the majority of students achieved scores in the intervals of 51–60 and 31–40, each with 7 students (25% of the sample). This concentration suggests that a significant portion of students demonstrated only moderate to low levels of initial understanding of the material prior to the intervention. Furthermore, 5 students scored in the 10–20 range, which is the second most frequent interval, reflecting a substantial number of students with very limited comprehension. Only 1 student scored in the highest interval (71–80), highlighting the rarity of high pretest performance within the sample. The overall mean score was 47.14, with a standard deviation of 18.228, indicating a wide variation in students' prior knowledge. This variation could be attributed to differences in prior learning experiences, access to learning resources, or individual cognitive readiness. The skewed distribution toward lower scores underscores the necessity of a well-designed instructional intervention to elevate students' conceptual understanding and engagement with the subject matter.

Figure 3. Administration of the Pretest for Grade IV Students at MI Baiturrahim

The pretest in Grade IV involved 28 students. The results showed that 16 students obtained scores categorized as very poor, 7 students achieved poor scores, 4 students earned scores in the sufficient category, and only 1 student attained a good score. The highest score recorded was 80, while the lowest was 20. Based on statistical analysis, the average pretest score was 47.14 with a standard deviation of 18.228.

3.2. Critical Thinking Skills After Learning with STEM-Based Teaching Materials and Worksheets

After the implementation of STEM-based instructional materials and student worksheets within the IPAS (Ilmu Pengetahuan Alam dan Sosial) learning context, a posttest was administered to the same cohort of 28 Grade IV students. The collected data revealed measurable changes in students' academic performance, indicating the potential impact of the intervention on their conceptual understanding and critical thinking skills. The detailed distribution of posttest scores is presented in Table 2 below to illustrate the extent of students' learning progression following the application of the STEM-based approach.

Table 2. Posttest Scores of Grade IV MI Baiturrahim

No.	Score Interval	Frequency
1	91 – 100	6
2	81 – 90	8
3	71 – 80	4
4	61 – 70	4
5	51 – 60	2
6	41 – 50	2
7	31 – 40	2
Total		28
Average		77,68
Standard Deviation		19,316

Based on Table 2, which presents the distribution of posttest scores for Grade IV students at MI Baiturrahim, there is a clear improvement in critical thinking skills following the implementation of STEM-based teaching materials and worksheets (LKPD). Out of 28 students who participated in the posttest, 14 students (50%) scored between 81 and 100, placing them in the "Good" to "Very Good" categories. This indicates that half of the class achieved high academic performance. In addition, 8 students (28.57%) scored between 61 and 80, demonstrating satisfactory learning outcomes. Meanwhile, only 6 students (21.43%) scored below 60, suggesting that a small portion of the class may need further support or reinforcement. The average posttest score was 77.68, reflecting a substantial improvement compared to the pretest average of 47.14. The standard deviation of 19.316 indicates a moderate level of score variation among students, showing that while most students improved, differences in individual performance still exist. Overall, the data suggests that the STEM-based instructional approach had a positive and significant impact on enhancing students' critical thinking skills in the IPAS subject.

Figure 4 presents a bar chart illustrating the distribution of posttest scores of Grade IV students at MI Baiturrahim after participating in STEM-based learning activities. The visual representation highlights a notable shift in students' critical thinking abilities, as reflected in their performance on the posttest.

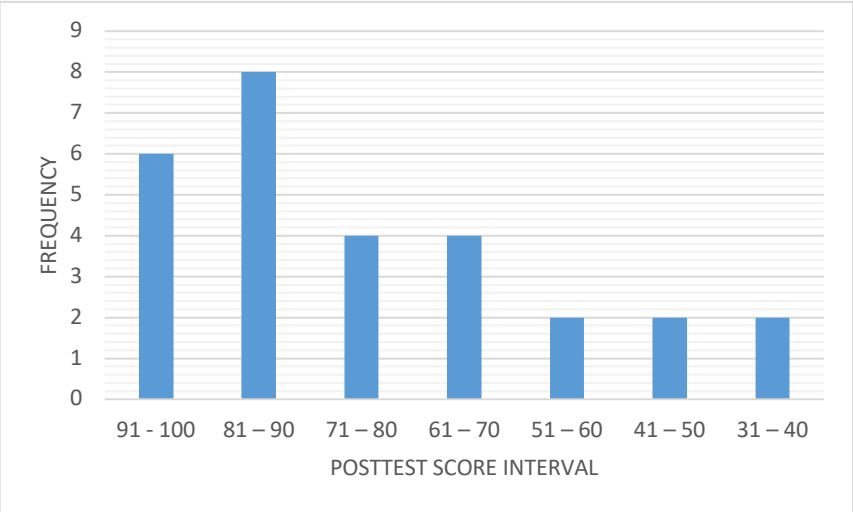

Figure 4. Bar Chart Showing the Posttest Results of Grade IV Students

Figure 4 displays the distribution of posttest scores of Grade IV students at MI Baiturrahim after the implementation of STEM-based teaching materials and student worksheets (LKPD). The chart indicates that the majority of students scored within the higher intervals, showing a positive learning outcome. The most frequent score range was 81–90, achieved by 8 students, followed by 91–100 with 6 students, and 71–80 and 61–70 intervals, each with 4 students. Fewer students scored in the lower intervals, with 2 students each in the ranges 51–60, 41–50, and 31–40. This distribution suggests that most students demonstrated high levels of critical thinking ability after the intervention, with only a small portion still needing further support. Overall, the chart illustrates a significant improvement in posttest performance, reflecting the effectiveness of the STEM-based learning approach.

Figure 5. Implementation of the Posttest for Grade IV at MI Baiturrahim

The results of the final test in this class indicate an improvement among the 28 students. Specifically, 6 students received an excellent rating, 8 students received a good rating, another 8 students received a fair rating, 4 students received a poor rating, and 2 students received a very poor rating. The highest score on this final test was 100, while the lowest was 35. Based on the statistical analysis, the mean score of the final test was 77.68, with a standard deviation of 19.316.

A normality test was conducted to determine whether the sample used in the study came from a normally distributed population. In this study, the Kolmogorov-Smirnov test was employed using IBM SPSS version 25. The normality test was applied to both the pretest and posttest scores of the Grade IV students. Accordingly, the hypotheses are as follows:

H_o: The data come from a normally distributed population
H_1: The data do not come from a normally distributed population

Table 3. Normality Test Results for Grade IV with Pretest and Posttest Scores

Test of Normality						
Result	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	,188	28	,012	,919	28	,032
Posttest	,203	28	,005	,901	28	,012

Based on the Kolmogorov-Smirnov test results shown in the table above, the pretest scores in Grade IV yielded a significance value of 0.012, with $\alpha = 0.05$ and $n = 28$. Since the

significance value is less than 0.05, the data are considered not normally distributed. Similarly, the posttest scores resulted in a significance value of 0.005, which is also less than 0.05, indicating that the data do not follow a normal distribution.

Given that the data obtained in this study are not normally distributed, subsequent statistical analysis employed a non-parametric test, specifically the Wilcoxon signed-rank test. This test was applied to the pretest and posttest scores of Grade IV students at MI Baiturrahim to determine whether there was a statistically significant difference in students' critical thinking skills after the implementation of STEM-based teaching materials and student worksheets (LKPD) in the IPAS subject. The following hypotheses were tested:

H_o: There is no significant difference in the critical thinking skills of Grade IV students in the IPAS subject after using STEM-based teaching materials and worksheets.

H_1: There is a significant difference in the critical thinking skills of Grade IV students in the IPAS subject after using STEM-based teaching materials and worksheets.

The decision rule for the Wilcoxon test is: if the Asymp. Sig. value is less than 0.05, the null hypothesis is rejected; if it is greater than 0.05, the null hypothesis is accepted. After analysis using SPSS version 25, the results were as follows:

Table 4. Wilcoxon Test Results for Students' Critical Thinking Skills

	posttest - pretest
Z	-4,669
Asymp. Sig. (2-talled)	<,001

The results in Table 4 show that the Asymp. Sig. value is 0.001, which is less than 0.05. Therefore, the null hypothesis (H_o) is rejected and the alternative hypothesis (H_1) is accepted. This indicates that there was a significant improvement in the critical thinking skills of Grade IV students in the IPAS subject after the use of STEM-based teaching materials and worksheets.

3.3. Comparison of Critical Thinking Skills of Grade IV Students at MI Baiturrahim in Pretest and Posttest

Table 1 shows that the critical thinking skills of students in the IPAS subject before the learning process, which used STEM-based teaching materials and student worksheets (LKPD), resulted in an average score of 47.14. Table 2 further indicates that after the implementation of STEM-based teaching materials and LKPD, the average score for critical thinking skills increased to 77.68. From these two tables, it can be concluded that there was an improvement in the critical thinking skills of the students in the IPAS subject after applying STEM-based teaching materials and LKPD. During the pretest, the students' critical thinking skills were categorized as very poor, with 16 students falling into this category. Seven students received a poor rating, four students received a fair rating, and one student received a good rating. In contrast, during the posttest, the students' critical thinking skills improved, with 14 students receiving excellent or good ratings, eight students received fair ratings, four students received poor ratings, and two students received very poor ratings.

Table 5. Comparison of Pretest and Posttest Scores for Grade IV Students at MI Baiturrahim

No.	Pretest		Posttest	
	Test Score Interval	Frequency	Test Score Interval	Frequency
1	71 - 80	1	91 - 100	6
2	61 – 70	4	81 – 90	8
3	51 – 60	7	71 – 80	4
4	41 – 50	2	61 – 70	4
5	31 – 40	7	51 – 60	2
6	21 – 30	2	41 – 50	2
7	10 – 20	5	31 – 40	2
Total		28	Total	28
Average		47,14	Average	77,68
Standard Deviation		18,228	Standard Deviation	19,316

Table 5 compares the pretest and posttest scores of Grade IV students at MI Baiturrahim to evaluate the effectiveness of STEM-based teaching materials and worksheets. Before the implementation of the STEM approach, the pretest scores indicate a generally low level of critical thinking skills among students, with the majority scoring within the lower intervals—7 students scored between 31–40, and 5 students scored between 10–20. The average pretest score was 47.14, with a standard deviation of 18.228, suggesting a wide variation in student performance.

In contrast, posttest results show a significant improvement. The highest frequency was recorded in the 81–90 interval (8 students), followed by 91–100 (6 students), indicating a shift toward higher achievement levels. The average posttest score increased markedly to 77.68, with a slightly higher standard deviation of 19.316, reflecting continued variation but overall improvement. These results suggest that the implementation of STEM-based instructional strategies effectively enhanced the students' critical thinking abilities, as reflected in the substantial gains from pretest to posttest performance.

Based on the improvement in the critical thinking skills of Grade IV students at MI Baiturrahim in the IPAS subject, as evidenced by the pretest and posttest results following the implementation of STEM-based teaching materials and student worksheets (LKPD), the N-gain analysis was conducted to determine the effectiveness of the intervention. The results are presented in the following Table 6.

Table 6. N-gain Test Results for Grade IV Students at MI Baiturrahim

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	28	,19	1,00	,6444	,24296
Valid N (*listwise*)	28				

Table 6 presents the results of the N-gain test, which measures the improvement in students' critical thinking skills after the implementation of STEM-based teaching materials and student worksheets (LKPD). The data shows that out of 28 students, the N-gain scores ranged from a minimum of 0.19 to a maximum of 1.00, with an average score of 0.6444 and a standard deviation of 0.24296. According to Hake's classification, an N-gain score in the range of 0.3 to 0.7 falls into the medium category. This indicates that the application of STEM-based materials had a moderate but meaningful effect in enhancing students' critical thinking

abilities. The relatively high mean score suggests that most students experienced a notable improvement in their learning outcomes following the intervention.

The application of teaching materials and LKPD has been a supporting factor for students in the learning process, as it provides evaluations and exercises beneficial for their critical thinking abilities (Novitasari et al., 2022). This is in line with studies conducted by Prasasti & Anas (2023) and Kotimah et al., (2024), which show that the application of supplementary teaching materials can enhance students' critical thinking skills. Based on the data obtained in this study, the average pretest score for Grade IV students at MI Baiturrahim was 47.14, while the average posttest score was 77.68. The data were then tested for normality using the Kolmogorov-Smirnov test, with the pretest yielding a significance value of 0.012 < 0.05, and the posttest yielding a significance value of 0.005 < 0.05, indicating that the data are not normally distributed. This suggests that non-parametric analysis is more appropriate for assessing the differences observed.

Subsequent testing was performed using the Wilcoxon test to determine whether there was a significant difference in students' critical thinking skills before and after the application of STEM-based teaching materials and LKPD in the IPAS subject. According to Sugiyono (2015), the Wilcoxon test is a non-parametric statistical test used to compare two related samples. The Asymp. Sig. obtained from this test was 0.001 < 0.05, indicating a significant difference in the students' critical thinking skills before and after the application of the teaching materials and LKPD. This result aligns with the evaluation theory presented by Arikunto (2010), which suggests that pretest and posttest evaluations provide a clear picture of the effectiveness of a teaching method in achieving the desired objectives.

The N-gain test result of 0.6444 indicates that the improvement in students' critical thinking skills from the pretest to the posttest falls into the moderate category. According to Hake (1998), the N-gain is a measure used to determine the extent of change in students' abilities after undergoing a learning process. This significant N-gain value suggests that the use of STEM-based teaching materials and LKPD has a positive impact on improving students' critical thinking skills.

The improvement in critical thinking skills, reflected in the pretest and posttest results, is crucial as it provides a clear indication of the effectiveness of STEM-based teaching materials and LKPD in enhancing students' critical thinking abilities. This aligns with Debora & Pramono, (2021), Hacıoğlu, & Gülhan (2021), Sukarma et al., (2024), dan Wahdaniyah et al., (2023) view that STEM approaches can improve critical thinking skills by encouraging students to think analytically, creatively, and systematically when solving complex problems.

The data obtained from both tests will serve as a primary reference for evaluating the teaching materials and LKPD that were applied. Additionally, the test results can be used to identify specific areas within the material that may need to be revised and adjusted to ensure that the teaching methods used achieve the learning objectives effectively. Therefore, pretest and posttest-based evaluations not only provide information about students' progress but also serve as valuable feedback for continuous improvement in the development of teaching materials and LKPD, as highlighted by Arikunto (2010) on the importance of evaluation in measuring the achievement of learning goals.

4. CONCLUSION

Based on the data obtained, it can be concluded that the application of STEM-based teaching materials and student worksheets (LKPD) has a positive impact on improving students' critical thinking skills. Before the implementation, the level of students' critical thinking skills was relatively low, as reflected by the average pretest score of only 47.14. However, after the implementation of STEM-based teaching materials and LKPD, a significant improvement was observed, with the average posttest score reaching 77.68. The results of the Wilcoxon statistical test show a significant difference in students' critical thinking skills before and after the learning process, with an Asymp. Sig value of 0.001, which is less than 0.05. This indicates that the application of the STEM approach in IPAS learning can significantly improve students' critical thinking skills.

Furthermore, the improvement falls into the moderate category, with an N-Gain score of 0.6444, indicating a meaningful progress in students' critical thinking skills after participating in STEM-based learning. Therefore, it can be concluded that the use of STEM-based teaching materials and LKPD can be an effective alternative for developing students' critical thinking skills, particularly in the IPAS subject for Grade IV students at MI Baiturrahim.

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