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The Effect of STEM-Based Discovery Learning Model on Critical Thinking Skills of Elementary School Students on Fraction Topics in the Context of Islamic Education

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ABSTRACT

This study examines the effect of the STEM-based Discovery Learning model on improving students' critical thinking skills in fraction material in the context of Islamic education. This kind of study is a mixed-method quantitative experiment with a sequential explanatory design. This study involved 4th grade students of SD Negeri 3 Karanggondang. The instruments used were tests and interviews. The results of the statistical analysis showed that the application of this model resulted in a significant increase in students' critical thinking skills, with a large effect on the aspects of concept analysis and evaluation. The implications of this study confirm that the STEM-based Discovery Learning model is not only effective in improving cognitive skills but is also in line with Islamic values that encourage curiosity, problem solving, and critical reflection. The benefit of this study for elementary education, especially in Islamic education, is in the potential of this model to help shape the critical thinking skills needed to face modern challenges. This model offers an innovative approach that aligns with the Islamic curriculum, enabling students to connect scientific concepts with Islamic values holistically.

Keywords: *Critical Thinking; Discovery Learning; STEM; Islamic Education*

ABSTRAK

Penelitian ini mengkaji pengaruh model pembelajaran Discovery Learning berbasis STEM terhadap peningkatan kemampuan berpikir kritis siswa dalam materi pecahan pada konteks pendidikan Islam. Jenis penelitian ini adalah kuantitatif eksperimen dengan menggunakan mixed method menggunakan desain sequintal explanatory. Penelitian ini melibatkan siswa kelas 4 SD Negeri 3 Karanggondang. Instrumen yang digunakan adalah tes dan wawancara. Hasil analisis statistik menunjukkan bahwa penerapan model ini menghasilkan peningkatan yang signifikan dalam kemampuan berpikir kritis siswa, dengan efek besar pada aspek analisis dan evaluasi konsep. Implikasi penelitian ini menegaskan bahwa model Discovery Learning berbasis STEM tidak hanya efektif dalam meningkatkan keterampilan kognitif tetapi juga selaras dengan nilai-nilai Islam yang mendorong keingintahuan, pemecahan masalah, dan refleksi kritis. Manfaat penelitian ini bagi pendidikan dasar, khususnya dalam pendidikan Islam, terletak pada potensi model ini untuk membantu membentuk keterampilan berpikir kritis yang diperlukan dalam menghadapi tantangan modern. Model ini menawarkan pendekatan inovatif yang relevan dengan kurikulum Islam, memungkinkan siswa menghubungkan konsep-konsep saintifik dengan nilai-nilai keislaman secara holistik.

Kata-kata Kunci: Berpikir Kritis; Discovery Learning; STEM; Pendidikan Islam

1. INTRODUCTION

The rapid advancement of science and technology requires a workforce that is competitive and can adapt to technological developments. In the era of industrial revolution 4.0, education aims to improve 21st century skills known as 4C. The 4C skills are critical thinking, communication, collaboration, and creativity (Ariyana et al., 2018). In Islamic education, to accomplish noble and admirable objectives, critical thinking must be bolstered by a systematic, directed approach that is successful and efficient (Dupni & Rosadi, 2021). Islamic education's objectives are highly relevant to critical thinking as one of the 21st century competencies since the STEM approach, which is incorporated into Islamic education as a tool to foster critical thinking, promotes moral and spiritual growth in addition to cognitive development.

Critical thinking is the mental process by which someone gathers, classifies, evaluates, and disseminates data and evidence in order to solve an issue. This includes thinking, investigating, solving problems, assessing assumptions, making judgments, and offering justifications (Amir, 2015). From the standpoint of the Qur'an, the idea of critical thinking is highly relevant to learning mathematics, particularly when it comes to comprehending fractional topic. Surah Al-Alaq (96:1-5) serve as an important basis for encouraging humanity always to learn and think. This process aligns with the growth of critical thinking skills in learning mathematics, which includes comprehending the idea of fractions as a genuine way for people to try to understand the universe that Allah SWT created. In contemporary Islamic religious education, students' comprehension of the idea of creation and their relationship with Allah is strengthened by placing a strong emphasis on critical education through Bloom's taxonomy and HOTS learning (Fikri & Munfarida, 2023)

There are five main indicators in critical thinking. 1) Elementary clarification or what can be called interpretation includes understanding questions, focusing questions, determining assumptions, determining implications, and distinguishing between facts and opinions. 2) Basic support, or analysis, includes finding evidence, assessing evidence, taking into account various information sources and viewpoints, and spotting bias. 3) Inferencing, or drawing conclusion, includes distinguishing between deductive and inductive conclusions, assessing conclusions, and identifying assumptions. 4) Clarification, Advanced clarification includes defining terms, identifying assumptions and implications, distinguishing between facts, opinions and interpretations, and assessing credibility. 5) Evaluation and problem solving, or explanation, includes evaluating arguments, identifying reasoning errors, making decisions, solving problems, and evaluating solutions (Ennis, 1985; Erlita & Hakim, 2022).

In 2022, the Program for International Student Assessment (PISA) measured students' critical thinking skills in mathematics in 78 countries. The findings showed that the average math score worldwide was 489 points, which was still less than the desired

500 points. Only about 11% of students worldwide reach level 5 (the highest level of proficiency in mathematics). With an average score of 379 points, Indonesia came up at number 67 out of 78 countries, a 13-point drop from the 2018 PISA results. Students' capacity to think critically and solve challenging mathematical problems is declining globally, as evidenced by the drop in math results (Golla & Reyes, 2022).

Based on observations and interviews with grade 4 teachers at SD Negeri 3 Karanggondang, it was found that students had difficulty in understanding fraction material. He added that in addition to using multiplication and division, which he believes are the keys to understanding fractions, he had also utilized tools like photographs of bread and items from his surroundings, like chalk, to help kids think and comprehend. However, the way the material is delivered still cannot be adequately conveyed because children's cognitive abilities differ. Up to 43.86% of participants fell into the extremely low category based on the average test results. It contradicts the research by I Made (2018), which reveals that the topic of traditional arithmetic operations falls into the good category with an average score of 82.17%.

One of the elementary school mathematics materials is recognizing fractions. The concept of fractions is also found in the Qur'an, Surah An-Nisa, verses 11 and 12, demonstrating that the science of faraidh (Islamic inheritance law) relies on the concept of fractions for accurate and precise division. Amallia & Unaenah (2018) stated that the most difficult part for students was the topic of fractions in the problem-solving section. The most common mistakes students made were mistakes when completing the final questions or filling in certain sections incorrectly, resulting in incomplete answers. According to Atiaturrahmaniah et al. (2021), students struggled to comprehend the idea of fraction and solve story problems in fraction material. Students' critical thinking skills can be enhanced by incorporating the STEM approach into the discovery learning model. In addition to offering more relevant and appropriate education, the STEM approach's conformity with Islamic values fortifies the development of a generation that is prepared to contribute positively to society and has superior personalities and talents (Anas & M, 2024).

A concrete example of a STEM approach integrated with Islamic values is in engineering projects in which Islamic values such as cooperation and responsibility can encourage students to design effective and sustainable solutions. Thus, the STEM approach forms not only cognitive skills, but also noble character. Improvements in math achievement and better understanding of math bring positive impacts to the mind. Applying Islamic values through the STEM approach can also develop social skills such as cooperation, empathy, and honesty. Students are encouraged to collaborate and learn to tolerate differences of opinion through project activities, which is one way that Islamic values are applied in the STEM method. This is consistent with Islamic principles, which advocate for brotherhood and tolerance. behavioral or affective improvements in

mathematics imply an affective effect, while an increase in pupils' creative talents indicates psychomotor benefits (Mardhiyatirrahmah et al., 2020).

The use of a STEM-based discovery learning model creates a dynamic and engaging learning environment, where students can develop 21st century skills and knowledge. It is supported by a previous study conducted by Fadlina et al., (2021), mentioning that the implementation of the STEM-based discovery learning model at MAN Kota Banda has succeeded in increasing students' critical thinking skills, indicated by the results of the n-gain test of 0.85 that shows an increase in critical thinking skills at a high level. According to (Supriaman, 2023), the application of the STEM-based discovery learning model also has an impact on the development of students' creative thinking skills. However, it needs to optimally implemented. It is in line with a study by Haeruman et al. (2017) revealing that students' critical mathematical thinking skills are better when using the discovery learning model compared to conventional learning.

Apart from its success, it is still necessary to optimize the discovery learning model in order to enhance critical thinking skills. Marisya and Sukma (2020); citing from Dari & Ahmad (2020), suggest that discovery learning model consists of six stages: (1) giving stimulation to fosters students' desire to find their self-identity (2) problem statement, where students identify the problem and create a hypothesis (3) data collection, where students collect as much information as possible (4) data processing, in which students process data to get the information they need (5) verification of evidence, in which students prove the findings from data processing (6) generalization or drawing conclusions related to what has been understood and providing reinforcement for their findings.

This study aims to answer two main questions. First, can the STEM-based discovery learning model that integrates Islamic values improve the critical thinking skills of 4th grade elementary school students in understanding the concept of fractions? Second, how do students' critical thinking skills develop before and after following the model, and to what extent do their critical thinking processes reflect Islamic values in solving mathematical problems? Answering the two questions means achieving the goal of this study which is to explore the influence of the application of the STEM-based discovery learning model on students' critical thinking skills in fraction lessons, and to examine changes in students' critical thinking skills before and after using the model. This research is important to enrich the approach to learning mathematics by combining STEM and Islamic values, which is expected to improve students' critical thinking skills in solving fraction problems. Furthermore, this study also endeavors to evaluate the efficacy of the model in enhancing critical thinking skills while including Islamic principles in the educational process.

2. METHODS

This study used mixed methods, which blend quantitative and qualitative techniques to obtain a more thorough grasp of the activities under study (Yam, 2022). The design was Sequential Explanatory, which begins with the collection and analysis of quantitative data, followed by the collection and analysis of qualitative data, and ends with drawing conclusions (Hendrayadi, Kustati, et al., 2023). Figure 1 depicts the Sequential Explanatory design, which was chosen because it is very effective for examining students' critical thinking skills in the context of Islamic education. By combining quantitative and qualitative data, this design allows for a deeper understanding of students' critical thinking skills in line with Islamic values. Combining these two data sources yields broader insights, which can boost Islamic education's applicability and efficacy and make a significant contribution to its development.

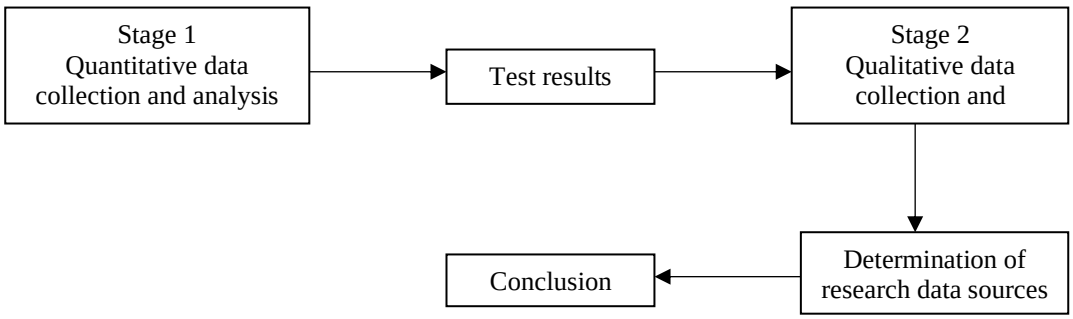

Figure 1. Sequential explanatory design

This study was conducted at SDN 3 Karanggondang, which is well-known for incorporating Islamic principles into education. Twelve children made up the research sample, which was purposively chosen based on two criteria: students without special needs and those with pretest scores greater than 25 (>25). The selection of schools and students takes into account that the curriculum of the school was relevant to the study's goals and that the students' characteristics allowed them to actively participate in learning activities that emphasized Islamic principles. Data collection technique used test instruments for quantitative data and quantitative data analysis employed the inferential statistics t-test (also known as paired sample t-test) with Jamovi software version 2.3.26 to assess the research hypothesis.

Qualitative data was collected through interviews, where one of the questions asked was about the concept of fractions, such as "Which part of the fraction do you still find confusing or difficult? Can you tell me why?" Another question is related to the relationship between fractions and Islamic values, for example "Do you see a relationship between fractions and Islamic values such as justice in the Quran?". The transcribed interview data were then analyzed thematically. In this analysis, recurring themes will be

identified, focusing on findings that support the integration of Islamic values in critical thinking as listed in Table 1. This thematic analysis aims to identify Islamic values, such as honesty, cooperation, and reflection, which are reflected in students' answers.

Table 1. Levels and characteristics based on critical thinking skill indicators

Indicator	Level 4 (very critical)	Level 3 (Critical)	Level 2 (Quite critical)	Level 1 (Less critical)	Level 0 (Not critical)
Problem Interpretation	Accurately interpreting problems by understanding Islamic values	Accurately interpreting the problem but not fully related to Islamic values	Accurately interpreting problems, but with limited understanding of Islamic values	Being able to only accurately interpret problem with minimum understanding of Islamic values	Unable to interpret problems without regard to Islamic values
Problem Analysis	Analyze problems in depth and accurately and relate them to Islamic values	Analyze the problem with several errors, with a weak link to Islamic values	Superficial analysis with errors and with minimal association of Islamic values	Superficial and inaccurate analysis, without significant linkage to Islamic values	Unable to analyze problems and without linking to Islamic values
Information Evaluation	Evaluate comprehensive and accurate information by considering Islamic values	Evaluate some information with some errors, with weak consideration of Islamic values	Evaluate some information with significant errors, with minimal consideration of Islamic values	Do not evaluate information accurately and without considering Islamic values	Unable to evaluate information without considering Islamic values
Problem Conclusion	Drawing clear, relevant and accurate conclusions reflecting Islamic values	Drawing relevant, but incomplete conclusions with little reflection of Islamic values	Drawing partial conclusions with little or no errors, without reflecting Islamic values	Cannot draw conclusions from problems, without reflecting Islamic values	Unable to draw conclusions without connection to Islamic values
Explanation of Results	Provide detailed and accurate explanations, demonstrate the application of Islamic values	Provide explanations but not in detail, with unclear application of Islamic values	Provide partial explanations with errors and minimal application of Islamic values	Do not provide accurate explanations without applying Islamic values	Do not provide explanation and without implementing Islamic values

(Erlita & Hakim, 2022; Facione et al., 2011; Sofie et al., 2023)

3. RESULTS AND DISCUSSION

Validity test analysis was conducted in class 5 of SDN 3 Karanggondang consisting of 11 students. With the reason that the fraction material has been given. Validity test analysis using the Pearson correlation method found that 14 of the 25 instrument items had a correlation above 0.60. therefore, there are 14 valid instruments. The result of the test items based on the calculated r value compared to the r table was 0.602. In the following figure 2, green dots indicate valid items, while red dots indicate invalid items. The results of the validity test can be seen in Figure 2.

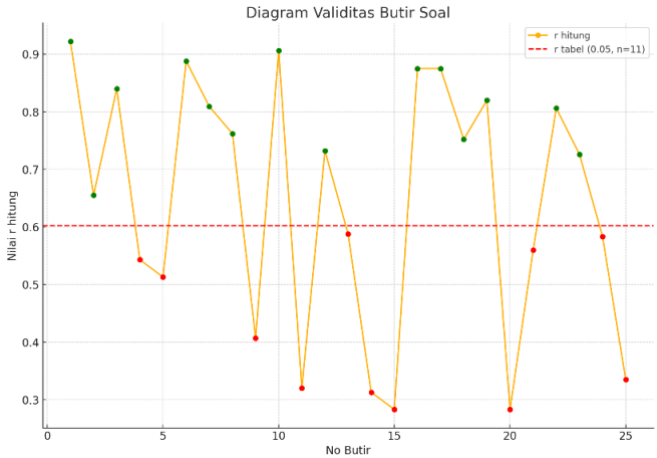

Figure 2. Diagram of the results of the validity test of question items

The Cronbach's Alpha method was then used to verify the instrument's reliability, yielding a result of 0.937. These results indicate that the instrument developed is quite reliable in measuring critical thinking values based on Islamic values which are in line with the research objectives. High reliability ensures that the instrument is able to consistently measure the aspects of critical thinking that have been established. The results of the instrument reliability test are presented in Table 2.

Table 2. Instrument reliability test

Scale Reliability Statistics

	Cronbach's α
scale	0.951

Table 2 of the instrument reliability test demonstrates the reliability prerequisite test using Cronbach's Alpha produced a value of 0.951. This value indicates that the instrument used has a perfect item reliability level because (>0.90). Therefore, this research instrument can be used and is considered reliable and accurate for use in collecting research data.

Table 3. Descriptive test

Descriptives		
	pretest	**postest**
N	12	12
Missing	0	0
Mean	33.2	66.8
Median	31	70.5
Standard deviation	7.08	11
Minimum	25	37
Maximum	45	76
Shapiro-Wilk W	0.899	0.772

Descriptive Test as shown in table 3 was conducted to provide an overview or summary of the data being analyzed. N is the number of samples, consisting of 12 4th grade students at SDN 3 Karanggondang. Descriptive analysis of the table shows the pretest and posttest scores of students. The average pretest was 33.2 and the posttest was 66.8, indicating an increase in the average score. In the pretest, the lowest score was 25, and in the posttest, it was 37. The highest value increased from 45 to 76. Given that the pretest value was 0.899 > 0.05 and the posttest value was 0.772 > 0.05, the Shapiro-Wilk W normality test indicated that the data was normally distributed. The t-test wa then conducted. The test was conducted with Paired Samples T-Test to show the difference in the average before and after the treatment was given.

Table 4. Paired samples T-Test

Paired Samples T-Test											
								95% Confidence Interval			
			statistic	**df**	**p**	**Mean difference**	**SE difference**	**Lower**	**Upper**		**Effect Size**
pretest	postest	Student's t	-13.6	11	< .001	-33.6	2.48	-39.0	-28.1	Cohen's d	-3.92

Note. H_a $\mu_{\text{Measure 1 - Measure 2}} \neq 0$

Table 4 demonstrates that there is a significant difference between the pretest-posttest averages because the results of the hypothesis test using the t-test (paired samples t-test) show a p-value (0.001) < 0.05. hence, Ho is rejected. The implementation of the Discovery Learning model not only shows a significant increase in students' critical thinking skills, but also helps students integrate critical thinking skills into Islamic values. This improvement is not only related to analytical abilities but also to moral and spiritual assessments in accordance with Islamic values, such as justice, honesty and responsibility. The average difference score was -33.6 (CI95 = [-39: -28.1]). This means that the provision of the STEM-based Discovery Learning model in critical thinking

showed a large difference between the pretest and posttest averages with an effect size of -3.92 > 0.80 Cohen's d, denoting a great effect. Increasing critical thinking in Islamic education implies that students can evaluate issues from a moral and spiritual perspective in addition to a scientific one, leading to more comprehensive and ethical decisions. Based on the data from the critical thinking ability test of students before and after the intervention, the following information data was obtained regarding the average student scores.

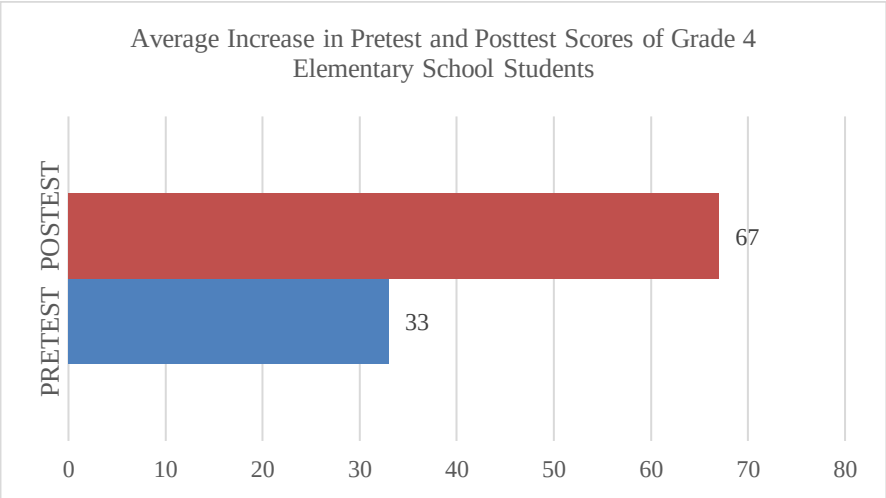

Figure 2. Average results of pretest-posttest increase

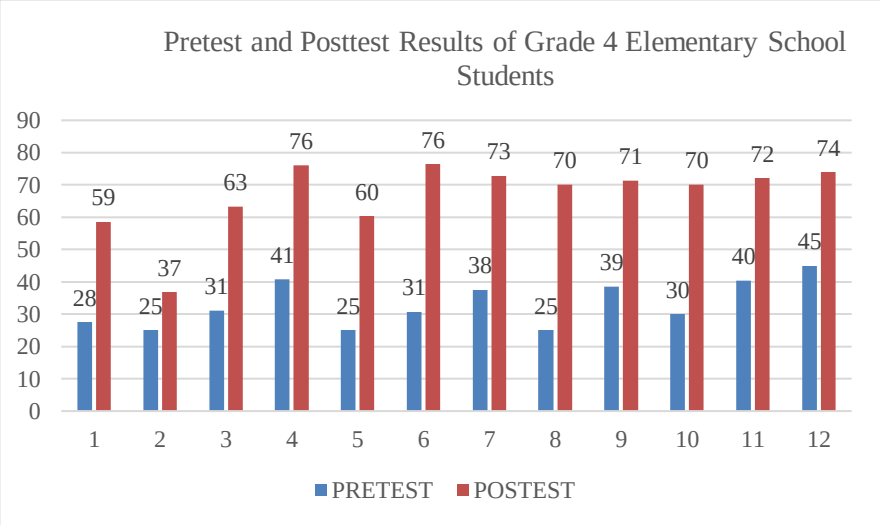

Figure 3. Pretest and posttest results of grade 4 elementary school students

Figure 4 and 5 on Average Pretest-Posttest Graphs reveal that students' critical thinking skills increased after implementing the STEM-based Discovery Learning model in mathematics lessons on fractions. Figure 4 shows an increase from 33 to 67 with an average difference of 34. This disparity in values demonstrates how using the STEM-based Discovery Learning methodology helps students become more adept at critical

thinking and problem-solving. The results of each student's test obtained different scores as shown in Figure 5. This graph displays the scores obtained by each student. The lowest pretest score was 25 and the highest score was 45. While the lowest posttest score was 37 and the highest was 76.

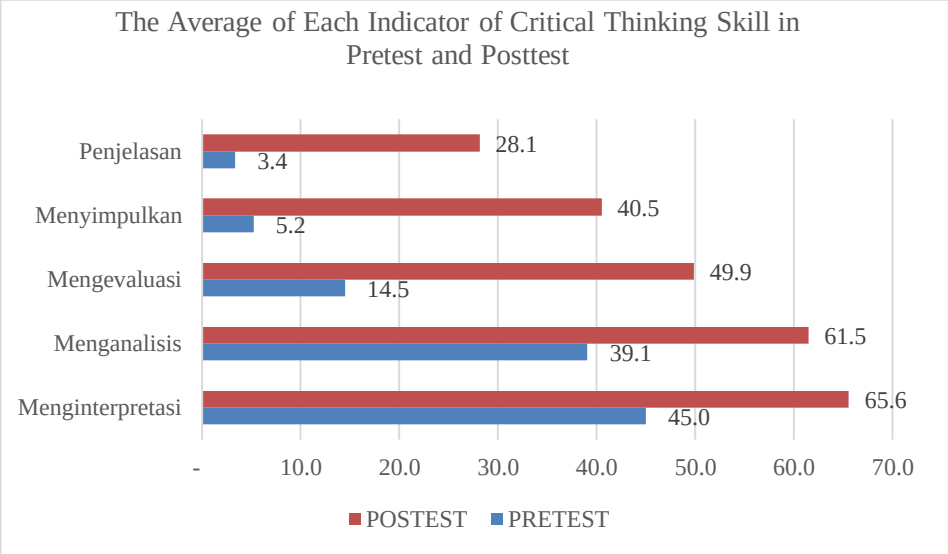

Figure 6. The average of each indicator of critical thinking skill in pretest and posttest

Figure 6 demonstrates the average of each indicator of critical thinking in the pretest and posttest. It also shows that there are five indicators of critical thinking, namely interpreting, analyzing, evaluating, concluding and explaining. In the interpretation stage, there was an average difference of 20.6 between the pretest and posttest, indicating a significant increase in students' ability to examine problems such as filtering well-presented information. The analysis stage revealed a difference of 22.4, suggesting that students are becoming more adept at assessing arguments and material in light of Islamic values of justice and truth. The evaluation stage revealed a difference of 35.4, demonstrating the students' ability to evaluate data in light of Islamic moral principles, specifically trust and integrity. Students were able to make inferences that aligned with the teachings of Islamic values, as evidenced by the significant difference in the conclusion stage of 35.3. Similarly, there was a notable shift at the explanation stage of 24.7, suggesting that students were becoming more adept at evaluating and drawing conclusions based on Islamic values, specifically honesty and responsibility. At the critical thinking stage before the intervention, students are able to interpret and analyze. However, in the next stages, which are evaluating, concluding, and explaining, students have not fully implemented the processes yet. After the intervention, in addition to the increase in interpreting and analyzing skill, there was also an increase in students' ability to evaluate, conclude, and explain.

Figure 7 and 8 show how students solve problems before and after the intervention. The questions used are as follows. ”Di toko buku terdapat diskon 25% untuk semua buku. Jika harga sebuah buku adalah Rp 5.000,00, berapa rupiah yang harus dibayar untuk membeli buku tersebut (*In the bookstore there is a 25% discount on all books. If the price of a book is Rp 5,000.00, how much rupiah must be paid to buy the book)*?” This question is relevant to measure critical thinking skills in mathematics and can be integrated with Islamic values. In this case, students are encouraged to understand the importance of honesty in transactions and asset management in accordance with the principles of Islamic economics, namely fairness and fiscal responsibility. Thus, this approach not only helps students develop their analytical abilities but also gives them moral and ethical judgments that are in line with Islamic beliefs.

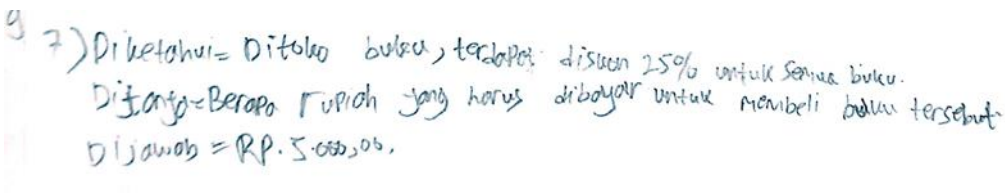

Figure 7. Student’s answer before receiving treatment

Students already have the ability to interpret and analyze the problems as shown in Figure 7. However, students are still unable to properly evaluate, conclude, and explain each problem. Students are not yet able to conduct evaluations through data collection, processing, and proof. Furthermore, students are still unable to draw correct conclusions. This shows that although students have achieved the requirements for issue analysis and interpretation, they have not been able to advance to the next level.

The interpretation of the question is to write down the information in the question, such as a 25% discount price, the price of the book is Rp. 5,000. Meanwhile, the analysis of the problem is how much the price must be paid for the book. In the next stage, students experience difficulties in operating the problem solving. In the process of solving the problem, students are confused about performing arithmetic operations of subtraction, addition, multiplication, or division.

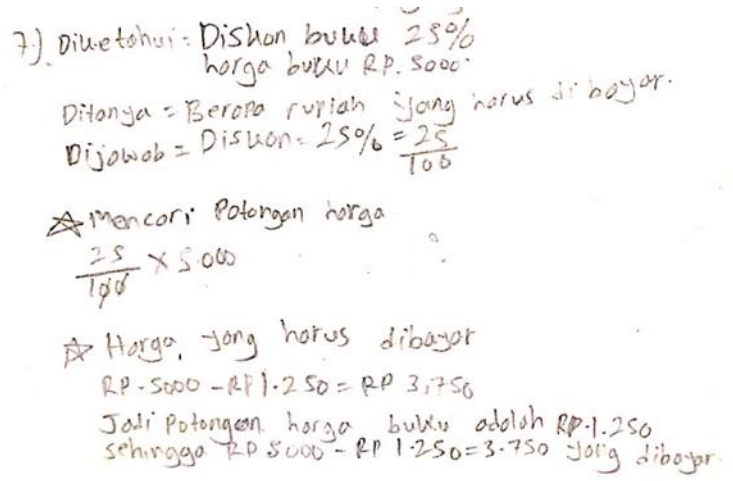

Figure 8. Student's answer after receiving treatment

Figure 8 shows the responses from students who have received treatment. The chart demonstrates the students' comprehension of the provided information, including book prices and discounts. Students are taught the virtue of honesty in business dealings within the framework of Islamic principles. Students comprehend that part of the virtue of honesty that needs to be applied is giving accurate information regarding discounts and prices. After that, the students put down their analysis of the problem, namely the amount that has to be paid. The following step asks students to consider wise money management in line with Islamic economics' tenets of justice and responsibility, which is called evaluation. Since students are not thorough in their evaluation of potential discounts, the result of calculating the amount of the discount in rupiah is not included. However, at the inference stage, students have done it correctly by reducing the price of the book with a discount. At the last stage, explanation, students are able to provide conclusions by providing an explanation.

Figure 7 and 8 demonstrate that differences were found in the process of working by students before and after the intervention. Before receiving treatment or intervention, students were only able to interpret the information obtained. For the next stage, however, students immediately wrote down the answers directly without following the procedure. Thus, students struggle to explain or make conclusions in the following step. One of the reasons is that students are not yet able to find relevant concepts. Moreover, because the learning process takes a long time, it is necessary to manage the use of time well (Priadi et al., 2021). As the result, students find difficulty in the next indicators.

By applying STEM-based discovery learning in the context of Islamic education, students are not only able to calculate the final price after the discount but also able to integrate knowledge with Islamic values. Pupils will be able to evaluate economic issues by taking into account moral and ethical considerations in addition to mathematical ones. In addition, students will learn to make fair and responsible decisions in everyday life

such as managing expenses and income according to Islamic teachings. Thus, with the STEM-based discovery learning model in the context of Islamic education, students not only improve their analytical skills but they are equipped with an understanding of Islamic values. This aids students in developing into people who align with the principles of Islamic education, which include being honest, wise, and responsible.

Qualitative data analysis from in-depth interviews with students shows their diverse experiences and perceptions of the application of the Discovery Learning method in STEM learning towards critical thinking. The following is an analysis of the themes emerging in the interview results. Before the intervention, students already had a basic understanding of the concept of fractions, but their understanding was limited to the numerator and denominator. Students did, however, demonstrate a greater comprehension of the fractions concept following the intervention, particularly with regard to operational fractions. However, there are still issues in comprehending the idea of fraction division. A Student said that, "the confusing part of learning fraction material is the division between fractions" The concept of dividing fractions is considered difficult to understand by students.

Some students have difficulty in collecting information and interpreting story problems involving fractions. However, some of them have also been able to interpret story problems. They tend to focus more on the numbers without understanding the context of the problem. Therefore, when students were asked what steps to take, they experienced difficulties. "The answering part is difficult, because the money and discount parts are made into fractions," said one of the students. Students feel enthusiastic and enjoy learning more with STEM-based discovery learning methods. They feel that learning is more interesting and helps them understand concepts better. One of the students said that he enjoyed learning about fractions because of the animated forms of fractions and fraction games “pizza-shaped fractions and playing with fractions.”

From the several themes that emerged, it can be concluded that the STEM-based discovery learning method has the potential to improve students' understanding of the concept of fractions. However, some aspects still need to be improved, such as students' ability to solve complex problems and apply concepts in different situations. Islamic education is an endeavor to equip humans through teaching, mentoring, and training to help people understand and apply the true nature of Islamic teachings in their lives as individuals and as members of society, so that they can achieve a happy life and good destiny in this world and the hereafter (Abas et al., 2024). Islamic education has evolved through several stages, beginning with the heyday of Islam, going through challenging periods, and now continuing to adjust to the demands of the contemporary world (Risdiani et al., 2023; Ulya & Tohari, 2022). As a result, Islamic education must be revived in the 21st century through advancements and modern teaching methods that enable the

development of 4C skills (communication, creativity, collaboration, and critical thinking).

The most relevant approach in the 21st century is the integration of Islamic education in STEM learning. One method that can be used in STEM integration is by using the discovery learning model. This approach focuses not only on developing critical thinking and academic skills but also on the formation of students' moral and spiritual character. Students can receive a comprehensive education by incorporating Islamic values—such as honesty, responsibility, and justice—into the educational process. Students should have both intellectual intelligence and strong moral values and good spiritual attitudes according to Islamic teachings. According to the findings of the research, students' critical thinking skills are significantly enhanced by the STEM-based discovery learning methodology.

It is in line with previous research by Zul Hanifah et al. (2022), mentioning the same result that the Discovery Learning approach to help students develop their critical mathematical thinking abilities yields superior overall results than using the conventional method. Developing critical thinking skills involves more than just cognitive abilities; it also entails knowledge of Islamic principles and morality. In the framework of Islamic education, critical thinking encompasses not only intellectual capacity but also the capacity to assess and examine moral principles, justice, and ethics in daily life. Therefore, students can make wise and responsible decisions according to Islamic teachings. This study and the current research are comparable in that they both demonstrate that students' critical thinking abilities significantly improve following the implementation of the discovery learning approach. The differences are in the sample, material, and the approach in which the previous one did not apply STEM-based learning (Imron et al., 2024).

The discovery learning model with STEM (Science, Engineering, and Mathematics) integration in the context of Islamic education, in learning provides a real effect for students to understand mathematical concepts in a more applicable way. In addition, it ensures students not only develop in science and technology aspects, but also in moral and spiritual aspects. In addition to teaching students how to create and think creatively, STEM also urges them to apply their creativity responsibly and in line with Islamic values. It is in resonance with Sofwan Mahmud's (2021) study, claiming that STEM integration in mathematics plays a significant role in boosting student interest in math classes and enhancing student achievement. It can also help students solve problems in their lives innovatively and creatively. Both of the reserch integrate STEM in the teaching method. However, the afore-mentioned study applied literature review in their study, while this current study applied experimental design. The findings of Sofwan Mahmud (2021) is supported by Saputri & Herman (2022), stating that STEM integration

in mathematics teaching can improve critical thinking skills and problem-solving skills, which are essential in modern era mathematics.

Though there are similarities with previous studies, this study differs with previous studies in some terms. Fadlina et al. (2021) show similarity in term of significant increase in the implementation of the STEM-based discovery learning model. However, it emphasizes on the material on the motor system for senior high school students. Otherwise, this study focuses on measuring critical thinking skills in the context of mathematical material in elementary school students. This research has several unique features compared to previous research. First, this study integrates STEM into the discovery learning model in mathematics subjects with fraction material which is a new approach in the context of fraction learning in elementary schools. Previously, many studies used the discovery learning model without STEM integration, or applied it at a higher level of education. STEM integration has been shown to have a more significant positive impact on students' critical thinking skills. Second, this study can contribute to the development of a curriculum that better meets the demand of 21st century students, one of which is critical thinking. This study directly measures and analyzes the impact of the model used on improving critical thinking skills. Third, the application of mixed techniques offers a more comprehensive view of the intervention's effects and a greater comprehension of students' struggles and achievements.

In light of the findings, it is becoming more and more important to make an attempt to incorporate Islamic principles into the STEM approach. According to Anas & M (2024) incorporating Islamic principles into the STEM method not only enhances the educational experience but also gives students the noble morals and skills they need to be productive members of society. Critical thinking skills through the STEM approach have very significant implications in the context of Islamic education. In this case, critical thinking skills enable students to have a deeper understanding in interpreting and building a deeper understanding of Islamic teachings. Students will be able to apply Islamic principles in their daily lives and make morally sound choices. Additionally, critical thinking can assist pupils in differentiating between correct and incorrect interpretations, allowing them to stay clear of radical or extremist ideologies (Kiki Eka putri, 2023).

The STEM method fosters critical thinking abilities that are very pertinent to Islamic education's objective of producing a generation capable of comprehending the complexity of Islamic teachings. Furthermore, the goal of critical thinking in Islamic education is to assist students in resolving difficulties in daily life by using Islamic principles. Students who practice critical thinking are more equipped to handle moral and societal dilemmas in accordance with Islamic principles, in addition to understanding religious doctrine. As a result, students are more equipped to analyze situations, evaluate information, and make wise and ethical decisions grounded in Islamic principles of honesty, justice, and accountability. Building critical and creative character is one of the

goals of Islamic education. Students that possess critical thinking abilities are better able to analyze, evaluate, and make inferences from the data they obtain. Hendrayadi, Syafrudin, et al., (2023) stated that in order to identify the truth of the solution while addressing the issues of contemporary development, extensive critical thinking skills are required. Through the STEM approach, students are encouraged to think critically and creatively in finding solutions to a problem. However, there are obstacles to overcome when incorporating STEM into Islamic education, specifically disparities in how Islamic ideals can be included in STEM learning. There are several workable ways to deal with these issues. First, educators and policymakers must have open discussions to agree on suitable interpretations. Second, integrating STEM and Islamic beliefs can be facilitated by creating a curriculum that is clear and structured. This curriculum must include guidelines and materials that contain Islamic principles of honesty, responsibility, and justice. It also must be applicable with STEM-based learning to create a balanced and holistic environment.

4. CONCLUSION

The application of the STEM-based Discovery Learning model has been proven to significantly improve students' critical thinking skills in understanding the concept of fractions in elementary schools. Quantitative research showed a significant increase in the mean score from pretest to posttest ($p < 0.001$) with a large effect size (Cohen's $d = -3.92$). Qualitative research indicates that this approach has the ability to enhance students' comprehension of the notion of fractions, but it still need improvement in terms of handling challenging problems and applying ideas in many contexts. By demonstrating how STEM-based Discovery Learning aligns with Islamic ideals, this study also advances Islamic education. This method develops students' moral and spiritual characteristics, such as the values of justice, responsibility, and wisdom, in addition to their cognitive abilities. According to Islamic teachings, the incorporation of STEM into Islamic education helps to produce a generation that is both academically and morally robust. The significance of incorporating STEM into the classroom and using technology to encourage student inquiry while reinforcing Islamic values is the practical implication for teachers. Teachers serve as facilitators who connect science with ethics of honesty, justice, and responsibility so that students can develop a well-rounded understanding. For schools, support is needed in the form of facilities and curriculum that integrate STEM with Islamic values, as well as thorough training for teachers to enable them to apply a comprehensive strategy. It is recommended that longitudinal testing be used in future studies to assess the long-term effects of implementing STEM-based Discovery Learning. In addition, research can explore supporting factors such as teacher competence, the role of parents, and the contribution of Islamic values in increasing the effectiveness of STEM

learning. It can provide deeper insight into the application of a holistic approach in Islamic education.

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