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Comparison of Inquiry and Problem Solving Approaches Towards Improving Students' Mathematical Reasoning Abilities

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ABSTRACT

The study seeks to ascertain disparities in the enhanced mathematical reasoning abilities of students instructed using inquiry-based methods versus those taught using mathematics problem-solving educational approaches. Additionally, it aims to discern variations in the increased self-assurance of students taught with inquiry-based methods compared to those taught with mathematics problem-solving educational approaches. This study falls under the category of quasi-experimental research. This study is being conducted at a Higher Secondary School in Labuhan Batu regency during the academic year 2023/2024. The research schedule is organised to align with the school's activities. The research included a cohort of 72 high school students in the X-grade. The survey results indicate that students who use inquiry approaches and problem-solving approaches demonstrate different levels of improvement in their mathematical reasoning skills. Additionally, there are variations in the level of enhanced self-confidence among students who use Inquiry and Problem Solving Approaches. Furthermore, there is a clear distinction between the effects of inquiry and problem-solving approaches on students' mathematical reasoning ability and self-confidence

A. INTRODUCTION

Mathematics as a discipline, has an important meaning in human existence, serving as a basic framework for various other fields of science, including chemistry, physics, medicine, economics, and accounting. Scientific progress relies on mathematics as a fundamental foundation. Furthermore, (Damas Sadewo et al., 2022) stated that learning mathematics has the potential to foster cognitive abilities such as logical reasoning, critical thinking, and methodical problem-solving abilities applicable to a wide range of practical contexts. Therefore, educational institutions have a duty to expand their ability to develop human resources that are competent and satisfy the expectations that are now in place.

The objective of teaching math is to provide pupils with the skills they'll need to tackle challenging mathematical issues on their own. All pupils need mathematical competence, competency, or skill when they acquire mathematics, asserts Kamarullah in Suraji et al. (2018:1). A broader variety of goals is provided by the curriculum, which students are supposed to follow.

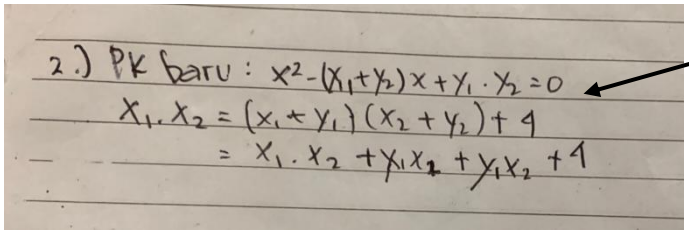
Providing pupils with the knowledge and abilities to excel in mathematical ideas is the fundamental purpose of mathematics education in schools (Rachmantika & Wardono, 2019). Math isn't only about getting the facts right; it's also about honing your analytical, critical, logical, and creative thinking abilities (Kholifah et al., 2021). This allows individuals to not only grasp mathematical ideas but also articulate those ideas' interconnections and effectively apply them to real-world challenges (Radiusman, 2020).

The primary objective of studying mathematics in high school is to enhance pupils' capacity to comprehend and use mathematical principles with thoroughness (Hartati, 2019). Students are required to possess the ability to elucidate the connections between mathematical concepts, use logical thinking to resolve issues, and effectively convey ideas using symbols or other forms of media (Rohman et al., 2021). Furthermore, the purpose of studying mathematics is to foster favourable dispositions towards the subject, such as inquisitiveness, focus, and enthusiasm for acquiring mathematical knowledge (Marfu, 2022). As a result, they are able to solve complicated problems effectively and use mathematical principles in their daily lives.

During the learning process, educators must provide a pedagogical framework that enables students to cultivate their creative thinking skills and enhance their capacity to generate novel information (Bito & Masaong, 2023). The use of the inquiry technique has the potential to enhance students' aptitude for critical thinking in comprehending and using mathematical topics (Suhendra et al., 2021). The inquiry method empowers students to independently develop and explore mathematical topics, leading to a deeper comprehension and practical application of these concepts (Sarifah & Nurita, 2023). Hence, possessing mathematical thinking is a crucial aptitude that students must possess.

Rectifying misconceptions about fundamental ideas may be particularly difficult, especially for pupils who have previously used them in mathematical reasoning and problem-solving exercises. Class X mathematics textbooks at SMA Negeri Bilah Hulu and elsewhere still lack sufficient mathematical problems; as a result, instructors who rely solely on these texts will be unable to give their students the kind of targeted practice they need to build their mathematical reasoning abilities and self-assurance. Consequently, pupils continue to lack faith in their mathematical talents. According to Napitupulu (2016:29), When pupils get questions on the skills that are being tested wrong, it means they haven't understood the topic well enough to pass. This means that children have difficulty and take a long time to understand and overcome obstacles.

Mathematical reasoning ability was still low, and students had trouble solving questions connected to reasoning ability, according to the results of the first study by researchers who administered questions measuring reasoning ability on the subject of quadratic equations to students of Bilah Hulu State High School. A student provided the following response to the question:



Students are still wrong in writing the new form of quadratic equations $x^2-(x_1+x_2)x+x_1.x_2=0$

Gambar 1. Students' Answers to Mathematical Reasoning Questions

From the student's answer process above, it can be seen that students are not yet able to write a new form of quadratic equation $x^2-(x_1+x_2)x+x_1.x_2=0$. Students' ability to draw conclusions without providing supporting evidence is evident. Out of the 36 students that were present for the examination, this particular question demonstrates that the student has not fully grasped the idea.

Based on the findings of the preliminary study conducted by researchers utilizing assessment questions that evaluate students' logical thinking skills in relation to quadratic equations, It was found that students were only able to draw conclusions without logical reasons. As many as 15 people, which is 42% of the student population, showed the ability to articulate ideas using mathematical equations. Of these students, 14 people or 39% were able to provide satisfactory explanations regarding the sufficiency of data to answer the problem. In addition, only 7 people or 19% were able to draw logical conclusions. These results suggest that pupils' mathematical thinking skills are still below average.

This study shows that students' mathematical reasoning ability is lacking because they are not used to using logical thinking to understand the topic. This shows that students continue to struggle to understand the questions asked. Additionally, in the context of classroom learning, pupils exhibit less engagement when it comes to responding to inquiries posed by the teacher. When teachers give the class the option to ask questions, no one takes advantage of the opportunity, leading the teacher to believe that students have mastered the material, as the instructor is really helping the class grasp the material and develop their reasoning and critical thinking skills via the use of practice problems.

When dealing with real-world events, pupils need to hone their mathematical reasoning abilities. A teacher should also think about ways to help their students develop these abilities. Teachers play a crucial role in fostering an optimal learning environment, enabling children to engage actively and use mathematical reasoning to solve problems. In addition, a teacher should possess the ability to develop a comprehensive instructional strategy that optimizes the capabilities of every student.

Inquiry learning involves an approach to teaching in which the teacher refrains from providing direct explanations of the content of the lesson. Students are presented with challenges and then conduct investigations, allowing them to discover anticipated concepts independently. Menurut Huda (2014), Students in a guided inquiry classroom actively participate in the learning process by identifying and analyzing topics, issues, and events outlined in the lesson plan. With the teacher's help, pupils are encouraged to put what they've learned into practice. At now, being examined.

According to Hendriana (2017), students may hone their thinking abilities using the guided inquiry paradigm by generating questions, making hypotheses, gathering information, and drawing conclusions. Students work together to investigate topics via guided inquiry learning. As a group, students will use the inquiry method to identify relevant prior knowledge and make connections between it and the issue at hand. Finding solutions to the problems presented here relies heavily on the students' cognitive processes. Students' mathematical reasoning abilities may be enhanced via guided inquiry learning as it enables them to comprehend and assess challenges, justify several answers, and obtain logical consequences from the solutions provided.

Inquiry and problem solving approaches are effective strategies that are beneficial for students to understand and retain information, as they help in long-term memory retention. By using inquiry-based and problem-solving strategies, educators can develop a more targeted teaching curriculum. This in turn allows them to enhance students' mathematical thinking and strengthen their confidence in the subject matter during the teaching and learning process.

The quality of learning may be enhanced by activating the learning components effectively using innovative methods, such as examining the disparity in mathematical reasoning skills between the inquiry technique and the problem-solving strategy.

B. RESEARCH METHODS

This study is categorized as quasi-experimental research. The methodology used in this research consists of three distinct stages: The tasks included in this project include: 1) assembling research instruments, 2) evaluating the effectiveness of research instruments, and 3) carrying out experiments. Each step is designed to guarantee the accuracy of the data collected, taking into account the peculiarities of the variables and the study's aims. The variables in this research are divided into two categories: independent variables and dependent variables.

The independent factors in this study are the inquiry strategy and the problem solution approach, whereas the dependent variable is the students' mathematical reasoning ability. This research was conducted at SMA Negeri 1 Bilah Hulu in the 2023/2024 academic year. The population in this study were all 72 students of class X of SMA Negeri 1 Bilah Hulu divided into 2 classes. The following is the form of research design presented in Figure 2.

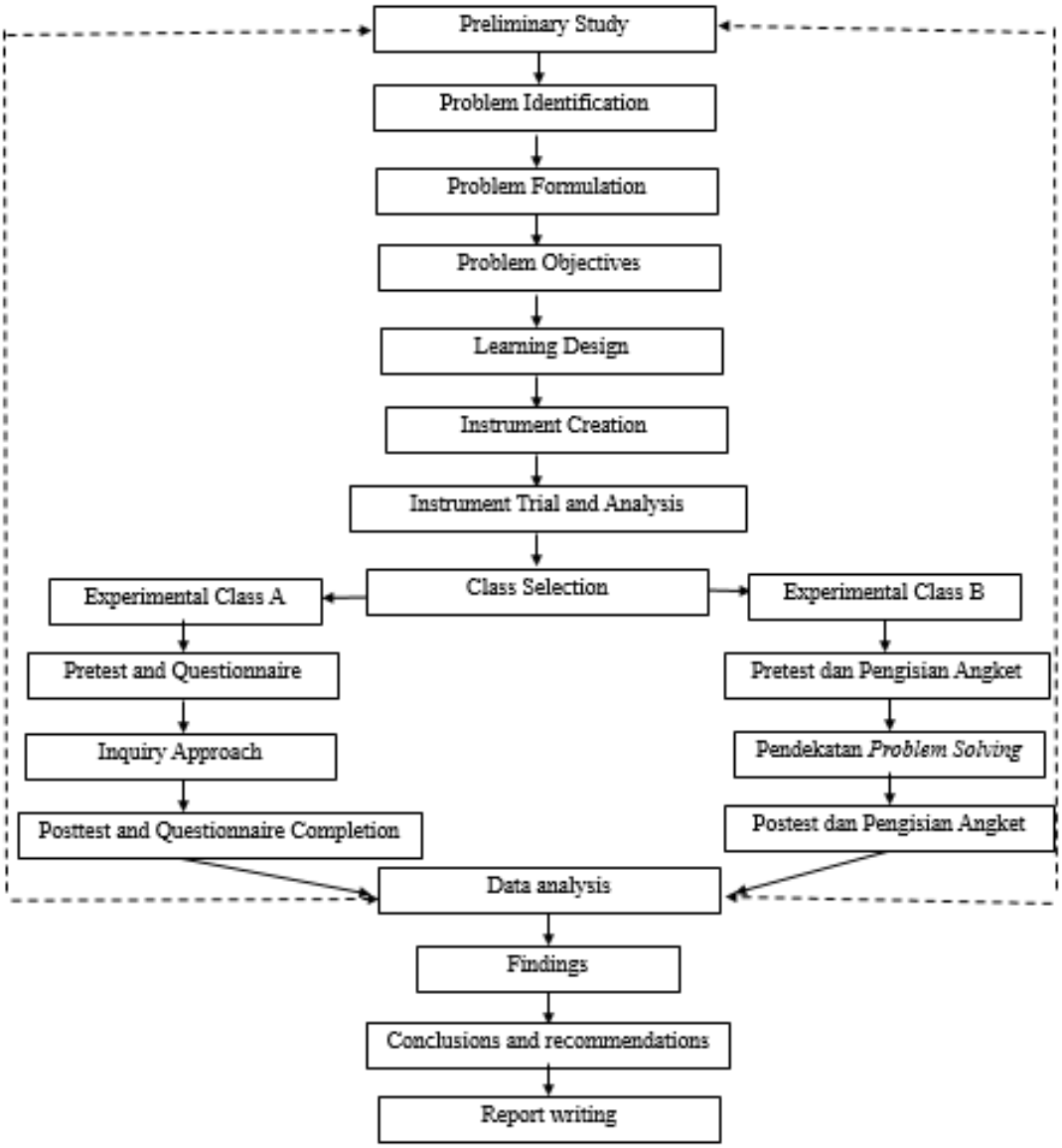


Figure 2. Research design

In Figure 2. is a research design that takes a sample of grade 10 and uses a mathematical reasoning ability test with an inquiry and problem solving approach. The sample method used in this investigation was complete sampling. This comprises of two classes: X-1 and X-2. Then, class X-1 was designated as experimental class A, and class X-2 as experimental class B.

This study used a pre-test-post-test control group design for its investigation. The plan calls for administering a pre-test to two sets of students to gauge their level of preparedness for introductory trigonometry classes.

C. RESULTS AND DISCUSSION

The data provided will be quantitative in nature. This investigation yielded several data points, including: 1) The appearance of a preliminary test of mathematical reasoning skills. 2) The administration of a test to assess pupils' critical thinking skills. 3) Developing a test for pupils' mathematical thinking abilities. Students of SMA Negeri 1 Bilah Hulu totaled 72 people. Based on the data obtained from the research results, it will be determined whether the formulation of the problem or research questions given in the previous section have been answered. The findings of the data analysis revealed:

Table 1. Description of the results of the pre-test of students' mathematical reasoning abilities

Statistik	Kelas Eksperimen	
	A (In)	B (PS)
N	35	35
Rata-Rata	65,17	63,05714
Standard Deviasi (SD)	9,963	8,025

According to the data in table 1, the average score for the Inquiry Approach in experimental class A was 65.17, while the average score for the Problem Solving Approach in experimental class B was 63.05714. The normalcy of the average results achieved by the Inquiry and Problem Solving courses was further examined.

Table 2. Normality Test of Pre-test Results of Students' Mathematical Reasoning Ability Based on Class

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Metode Belajar	Statistic	df	Sig.	Statistic	df	Sig.
Kemampuan Penalaran Matematis	Inkuiri	,102	35	,200*	,972	35	,489
	Problem Solving	,128	35	,155	,962	35	,259

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The data presented in table 2 indicates that the significance value for the inquiry class is 0.489, while the significance value for the Problem Solving class is 0.259. Since the significance value for both groups is more than 0.05.

Table 3. Independent T Test of Students' Mathematical Reasoning Ability Based on Class

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
KPM	Equal variances assumed	.510	.478	3.372	68	.001	7.571	2.246	3.091	12.052
	Equal variances not assumed			3.372	66.902	.001	7.571	2.246	3.089	12.054

According to the information provided in table 3, the Levene's Test for Equality of Variances yielded a significant value of 0.478, which is more than 0.05. Therefore, we may infer that the variances of the data from class A and class B are equal or homogenous. Additionally, the two-tailed significant value is 0.001, which is less than 0.05.

Summary of Differences in Mathematical Instructing Ability Improvement for Each Indicator
As for the division of N-gain value categories, we can see it in the following table.

Table 4. Gain score distribution

Nilai N-Gain	Kategori
$g > 0{,}7$	Tinggi
$0{,}3 \leq g \leq 0{,}7$	Sedang
$g < 0{,}3$	Rendah

Source : Farrel, 2021 : 1188

From the table above, the N-gain score can be determined based on the N-gain value or from the N-gain value in the form of a percentage (%). The following are the results of the N-gain value:

The next section will provide a summary of the analysis to answer the third problem formulation, namely the differences in reasoning ability improvement based on indicators presented through investigation techniques and problem-solving strategies. The N-Gain score for each indication is used in the test, which measures the improvement before and after the recognition, the data will be displayed in table 6.

Table 5. Summary of Differences in Reasoning Ability Improvement

Class	N-Gain Skor			
	Indicator 1	**Indicator 2**	**Indicator 3**	**Indicator 4**
Inkuiri	0,47	0,34	0,85	0,34
Problem Solving	0,37	0,19	0,60	0,15
Sig (2-tailed)	0,362	0,133	0,205	0,046

As shown in Table 5, the N-Gain score for indication 1 corresponds to the N-Gain score for Experimental Class A of $0{,}3 \leq 0{,}47 \leq 0{,}7$ The N-Gain value of experimental class A $0{,}3 \leq 0{,}47 \leq 0{,}7$ is higher than experimental class B's N-increase value of 0.37, showing that the inquiry technique produces a modest increase in indicator 1, which generates logical conclusions about students' mathematical reasoning skills.

$0{,}3 \leq 0{,}37 \leq 0{,}7$ demonstrates that the problem solving strategy improves students' mathematical reasoning ability by increasing the logical conclusion indicator somewhat. Subsequently, indicator 1 crucial value is $0{,}36 > 0{,}05$ When it comes to the strengthening of mathematical reasoning skills, the findings of the research indicate that there is no significant difference between students who get teaching using an inquiry-based approach and those who are taught using a problem-solving strategy. Specifically, this conclusion pertains to the capability of providing explanations for models, facts, qualities, connections, or patterns that already exist.

In indication 2, Experimental Class A has a higher N-Gain score is 0.34 than Experimental Class B 0,19 Experimental class N-Gain value A $0{,}3 \leq 0{,}34 \leq 0{,}7$ demonstrates that the inquiry technique has a modest effect on indicator 2 using relationship patterns to examine circumstances, or creating comparisons or generalizations about students' mathematical reasoning ability.

Meanwhile, the N-Gain Value of the experimental class B $0{,}3 \leq 0{,}19 \leq 0{,}7$ demonstrates that the problem-solving strategy has a modest effect on indication 2 employing relationship patterns to understand circumstances or creating analogies or generalizations on students' mathematical reasoning skills. Then from the significance value of indication 2, which is $0{,}133 > 0{,}05$ This indicates that there is no substantial (actual) difference in the rise in students taught using connection patterns to evaluate circumstances, or creating analogies or generalizations, which is higher than students taught using the problem-solving strategy.

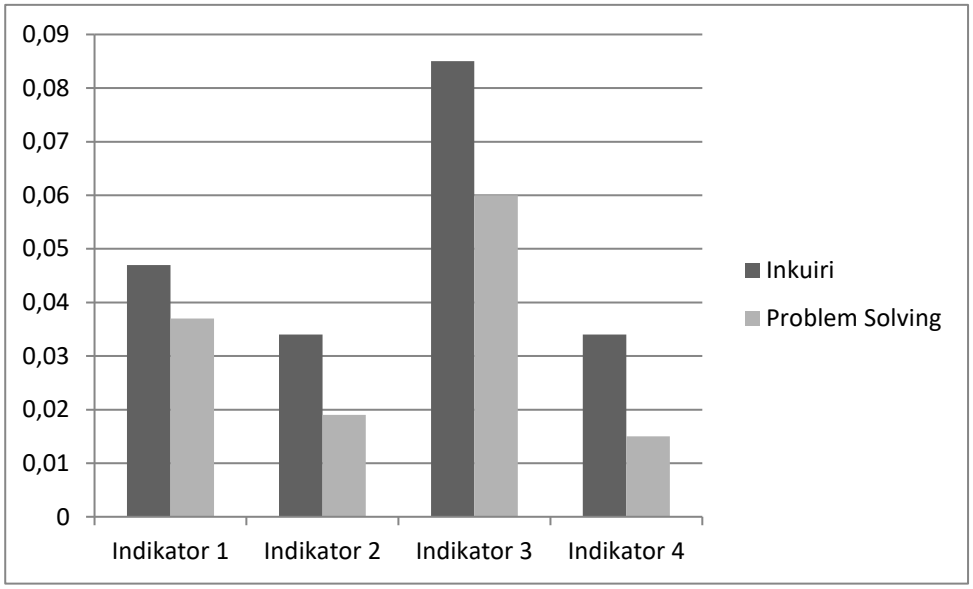
With an N-Gain score of 0.85 in indication 3, Experimental Class A outperforms Experimental Class B, which only managed a 0.60. N-Gain analysis shows that experimental group A achieved a result of $0{,}85 > 0{,}7$ shows that the investigational approach yields an improvement with a high category, and the experimental class B's N-Gain value is $0{,}3 \leq 0{,}60 \leq 0{,}7$ demonstrates that the problem-solving strategy gives a modest category rise in the indicator of establishing assumptions and gathering evidence because 0.60 and 0.85. The significance value for indicator 3 is 0.205, which exceeds the threshold of 0.05. This suggests that there is no

statistically significant difference in the improvement of mathematical reasoning ability between students taught using the inquiry approach and those taught using the problem solving approach, in terms of making guesses and compiling evidence.

In indication 4, the N-Gain score for Experimental Class A is 0.34, greater than the N-Gain score for Experimental Class B, which is 0.15. However, based on the N-Gain category, experimental class A and experimental class B produce a medium and low category gain for indication 4 utilizing logical conclusions since $0{,}3 \leq 0{,}34 \leq 0{,}7$ dan $0{,}19 < 0{,}3$.

The significance value for indication 4 is 0,046 < 0,05, This analysis demonstrates a significant disparity in the development of mathematical reasoning abilities as measured by the indicator. Establishing causal relationships between pupils instructed using an inquiry-based technique and those instructed through a problem-solving approach.

In Figure 1 below, the difference in N-Gain scores for each indicator will be shown to see which N-Gain score is higher for each class.



Picture 3. N-Gain Mathematical Reasoning Ability Score in Both Sample Classes for Each Indicator

Figure 1 clearly shows that experimental class A, which was taught using the inquiry approach, outperformed class A, as seen by the growth in mathematical reasoning ability in indicators 1, 2, 4, and 4.

D. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of data analysis and subsequent discussion in this research, numerous conclusions are presented as follows:

1. There is a disparity in the growth of pupils' mathematical reasoning skills when using the inquiry technique compared to the problem solution strategy. The Independent T Test Score analysis yielded a significance value of 0.001. Since the significance threshold is less than 0.05, the null hypothesis H_0 is rejected and the alternative hypothesis H_1 is accepted.
2. There is a notable disparity in the improvement of mathematical reasoning skills across indicators 2, 3, and indication 4. There is no statistically significant difference in the improvement of mathematical reasoning abilities between students who were taught using the inquiry approach and those who were taught using the problem-solving approach in indicator 1.

CONFESSION

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