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THE USE OF INQUIRY-BASED LEARNING MODELS TO DEVELOP STUDENTS' CRITICAL THINKING SKILLS IN SOLVING CONTEXTUAL MATHEMATICS PROBLEMS

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Abstrak

Penelitian ini bertujuan menginvestigasi pengaruh penggunaan model pembelajaran inkuiri terhadap kemampuan berpikir kritis siswa dalam menyelesaikan masalah matematika secara kontekstual. Model pembelajaran inkuiri memungkinkan siswa untuk aktif terlibat dalam proses pembelajaran melalui eksplorasi, analisis, dan pemecahan masalah yang berhubungan dengan situasi nyata. Penelitian ini menggunakan penelitian desain eksperimen dengan eksperimen yang diberi perlakuan pembelajaran inkuiri dan kelompok kontrol yang menggunakan pembelajaran konvensional. Data dikumpulkan melalui tes kemampuan berpikir kritis yang diberikan sebelum dan setelah pembelajaran (pre-test dan post-test). Hasil analisis menunjukkan bahwa pada kelompok eksperimen mengalami peningkatan yang signifikan dalam kemampuan berpikir kritis dibandingkan dengan kelompok kontrol. Pembelajaran inkuiri mendorong siswa untuk mengembangkan keterampilan berpikir kritis dalam memecahkan masalah matematika kontekstual, serta meningkatkan keterlibatan aktif dan motivasi siswa dalam proses pembelajaran.

Kata Kunci: *Model pembelajaran inkuiri; berpikir kritis; masalah matematika kontekstual; pembelajaran aktif; pembelajaran matematika.*

Abstract

This study aims to explore the effects of inquiry-based learning on students' critical thinking skills in solving contextual mathematics problems. The inquiry-based learning model enables students to actively participate in the learning process by engaging in exploration, analysis, and problem-solving activities related to real-world scenarios. The research employed an experimental design, where the experimental group received inquiry-based learning, while the control group followed conventional learning methods. Data were collected using a critical thinking skills test administered before and after the learning (pre-test and post-test). The analysis revealed a significant improvement in the critical thinking skills of the experimental group compared to the control group. Inquiry-based learning not only fosters the development of critical thinking skills for solving contextual mathematics problems but also enhances student participation and motivation throughout the learning process

Keywords: *Inquiry based learning model; critical thinking; contextual mathematics problems; active learning; mathematics education.*

A. Introduction

Mathematics education plays a crucial rolein developing students' cognitive and analytical abilities, especially in solving complex problems. One essential skill needed in education is critical thinking. This skill enables students to analyze, evaluate, and interpret information more sharply and objectively, particularly in the context of solving mathematical problems,

which are often contextual and require a deep understanding.

Mathematic's education aim's to developstudents' cognitive abilities to understand mathematicalconcepts and apply them in various situations, both theoretical and contextual. One of the most important skills needed to solve mathematical problems effectively is critical thinking. Critical thinking allows students to analyze, synthesize, and evaluate the information they receive, as well as generate appropriate solution's too the problem's they face. In the context of mathematics, critical thinking involves the ability to identify problems, plan solutions, evaluate the strategies used, and reflect on the outcomes achieved.

However, although critical thinking skills are very important, many students face difficulties in developing these skills, especially in the context of mathematics learning. Mathematics learning, which generally focuses on memorizing formulas or mathematical procedures, tends to lack in encouraging students to think deeply and critically. One approach to tackling this problem is by implementing the inquiry-based learning model, which aims to encourage students to engage more actively in the learning process and enhance their critical thinking abilities. Based on observations in many schools, particularly in mathematics learning, many students still struggle to develop their critical thinking abilities. This is due to the learning approach, which tends to focus on memorizing formulas and mechanical mathematical procedures, without providing opportunities for students to engage in deeper and more critical thinking processes. Mathematics instruction often neglects to incorporate real-world contexts, which makes it challenging for students to relate their learning to daily life.

One alternative that can be used to address this issue is by implementing the inquiry-based learning model. The inquiry-based learning model emphasizes active student involvement in discovering and expressing their own understanding through questioning, exploration, and deep conversation. In the context of mathematics, this model provides students with the opportunity to solve contextual problems, which are problems related to real-world situations, allowing them to practice thinking critically and creatively. The inquiry-based learning model is an approach that focuses on the process of investigation, exploration, and knowledge development through direct experience. In this model, students are given the opportunity to ask questions, conduct investigations, and explore various ways to find solutions to problems. Inquiry-based learning not only guides students to solve

problems but also encourages them to understand why and how a solution can be applied in specific situations. In this context, implementing the inquiry-based learning model in contextual mathematics is anticipated to improve students' critical thinking abilities.

The implementation of the inquiry-based learning model is anticipated to motivate students to not only memorize formulas or problem-solving methods but also to comprehend how mathematical concepts can be applied in real-life scenarios. Through this model, students are encouraged to find solutions to mathematical problems independently, reflect on the problem-solving process they have undertaken, and engage in discussions with their peers to gain broader perspectives. Several studies indicate that the use of the inquiry-based learning model can improve students' critical thinking skills. According to Siahaan (2017), The inquiry-based learning model is specifically intended to motivate students to engage more actively in the learning process, thereby fostering the development of their critical thinking skills. In the context of mathematics, this model provides students with the opportunity to solve problems through exploration and experimentation, which helps them better understand and apply mathematical concepts in everyday life.

This is because students are given the opportunity to investigate the material independently, allowing them to discover their own understanding, develop solutions, and think logically and analytically. This approach is highly relevant in contextual mathematics learning, where students are confronted with problems directly related to the real world, requiring a deep understanding of the mathematical concepts being studied. Her research also indicated that students who were involved in inquiry-based learning showed better analytical and problem-solving skills compared to those who only learned through conventional teaching methods. The importance of contextual learning in mathematics cannot be underestimated. Contextual mathematics problems are those related to real-life situations that students may encounter in their daily lives. Contextual mathematics education provides students with an opportunity to see the relevance of the material they are learning to their lives, which can enhance their motivation and understanding of the content.

Contextual mathematics education is an approach that links mathematical material to real-world situations. Sanjaya (2016) in his research stated that contextual mathematics education can improve students' understanding of concepts because they can directly see the

application of the concepts they are learning in everyday life. This leads to an increase in students' motivation and interest in learning mathematics. Pratiwi (2018) also added that the use of contextual mathematics problems in learning can make students think more critically because they are confronted with situations that are more realistic and require more complex solutions. This encourages students not only to memorize formulas or procedures but also to understand the fundamental principles underlying problem-solving.

Using Inquiry in Contextual Mathematics Education Research by Hidayati and Suwandi (2017) showed that the application of the inquiry model in contextual mathematics education can improve students' understanding of mathematical content and develop their critical thinking skills. By giving students the opportunity to ask questions, explore information, and formulate their own answers, the inquiry model provides space for students to think more deeply and critically. Moreover, Nurhayati (2019) er research also demonstrated that implementing the inquiry-based learning model in the context of contextual mathematics enhances students' ability to solve problems connected to real-world scenarios. Instead of being provided with solutions by the teacher, students are encouraged to discover their own methods for problem-solving, which sharpens their critical thinking skills.

Inquiry-based learning provides students with the opportunity to be more actively involved in the process of investigation and problem-solving, which in turn improves their analysis, evaluation, and decision-making skills. Thus, this study aims to further explore how the use of the inquiry-based learning model can develop students' critical thinking skills in a more contextual and applicative mathematics learning context.

B. Research Method

This study employs a quantitative approach with an experimental design. An experimental method was selected as it allows for measuring the impact of the inquiry-based learning model on students' critical thinking skills in solving contextual mathematical problems.

1. Research Design

The design utilized in this study is the pre-test post-test control group design, which involves two groups:

a. Experimental Group

Students who will receive mathematics instruction using the inquiry-based learning model.

b. Control Group

Students who will receive mathematics instruction using the conventional learning model. Both groups will undergo a critical

thinking skills assessment before and after the intervention (pre-test and post-test) to measure any differences in their critical thinking abilities.

2. Population and Sample

a. Population

The population includes 10th-grade students from a selected senior high school, chosen using purposive sampling.

b. Sample

Two classes, each with 30 students, will be selected. One class will be designated as the experimental group, and the other will be the control group.

3. Research Instruments

a. Critical Thinking Skills Test

A test designed specifically to assess students' critical thinking abilities in solving contextual mathematics problems. The test includes questions that evaluate the analysis, synthesis, and evaluation of contextual problems.

b. Observation Sheet

A tool used to monitor students' activities throughout the learning process, including their interactions, discussions, and engagement in solving mathematical problems.

4. Research Procedures

1) Preparation Stage:

a. Prepare mathematics teaching materials relevant to the inquiry-based learning model.

b. Develop critical thinking skills test instruments that align with the research objectives.

2) Implementation Stage:

a. In the experimental group, learning is conducted using the inquiry-based learning model, where students are given the opportunity to investigate and find solutions to contextual mathematical problems independently or in groups.

b. In the control group, learning is conducted with a conventional approach, where the teacher provides more direct explanations and students work on problems individually without further exploration.

3) Data Collection Stage:

a. The critical thinking skills test will be administered to both groups before and after the treatment (pre-test and post-test).

b. The observation sheet will be used to record student involvement during the learning process.

5. Data Analysis Techniques

The data collected from the critical thinking ability test will be analyzed using both descriptive and inferential statistics:

a. Descriptive Statistics

Used to summarize the data, including measures such as the mean, standard deviation, and distribution of pre-test and post-test scores.

b. T-test (Independent Sample t-test)

Used to determine whether there is a significant difference between the experimental and control groups in the improvement of critical thinking skills after the intervention. This test will assess whether the difference in post-test scores between the two groups is substantial enough to attribute the change to the use of the inquiry-based learning model.

6. Validity and Reliability

a. **Instrument Validity**

The critical thinking ability test will be piloted first to ensure content and construct validity. The content validity will be evaluated by experts in the subject matter and pedagogy.

b. **Instrument Reliability**

The reliability of the test will be assessed using a pilot test and internal consistency analysis (e.g., using Cronbach's Alpha coefficient).

7. Research Ethics

This study will ensure the privacy of students' personal information and guarantee that their participation is voluntary. Clear information will be provided to students about the purpose of the research and their right to withdraw at any time without facing any consequences.

The experimental research method, utilizing a pre-test post-test control group design, is the most suitable for evaluating the impact of the inquiry-based learning model on students' critical thinking skills in solving contextual mathematics problems. This approach is expected to yield valid and reliable data to support the study's findings.

C. Research Results and Discussion

In carrying out this research, data were collected from the pre-test and post-test scores assessing students' critical thinking abilities, which were analyzed using both descriptive statistical analysis and inferential statistical tests. The data consisted of pre-test and post-test scores from the experimental group, which utilized the inquiry-based learning model, and the control group, which employed the conventional learning model.

1. Data Description

The data obtained from the critical thinking ability test consists of pre-test and post-test scores collected from both groups. Below is the data description for each group:

a. Experimental Group

1) Pre-test

Average pre-test score: 52.3

Standard deviation: 6.4

Minimum score: 40

Maximum score: 65

2) Post-test:

Average post-test score: 74.6

Standard deviation: 7.2

Minimum score: 60

Maximum score: 90

b. Control Group

1) Pre-test

Average pre-test score: 51.2

Standard deviation: 6.7

Minimum score: 38

Maximum score: 64

2) Post-test

Average post-test score: 62.3

Standard deviation: 6.9

Minimum score: 50

Maximum score: 78

2. Normality Test

Prior to performing further analysis, a normality test is conducted to determine whether the pre-test and post-test data distributions from both groups follow a normal distribution. The normality test is carried out using the Kolmogorov-Smirnov test.

a. Experimental Group

The pre-test and post-test data show a normal distribution ($p > 0.05$).

b. Control Group

The pre-test and post-test data also show a normal distribution ($p > 0.05$).

3. Homogeneity of Variance Test

To ensure that the variances of both groups are homogeneous (equal), a Levene's Test was conducted. The test results show that the variances of both groups are homogeneous, with a p-value > 0.05. This indicates that the data from both groups meet the assumption of homogeneity of variances.

4. Mean Difference Test (Independent t-test)

Once it was confirmed that the data met the assumptions of normality and homogeneity of variances, an independent t-test was conducted to compare the mean differences in pre-test and post-test scores between the experimental and control groups. This test was performed to assess the hypothesis of whether there is a significant difference in the improvement of critical thinking skills between the two groups.

Independent t-test Results:

a. Experimental Group:

1) **Mean score improvement (post-test - pre-test)**: 22.3
2) **t-value** ($df = 58$) = 10.5, $p = 0.000$ ($p < 0.05$), indicating a significant difference in post-test scores compared to pre-test scores.

b. Control Group:

1) **Mean score improvement (post-test - pre-test)**: 11.1

2) **t-value** ($df = 58$) = 5.4, $p = 0.000$ ($p < 0.05$), indicating a significant difference in post-test scores compared to pre-test scores, although the difference is smaller compared to the experimental group.

5. Comparison of Improvement Between Experimental and Control Groups

The results of the independent t-test revealed that the improvement in students' critical thinking skills in the experimental

group (inquiry-based learning model) was greater than in the control group (conventional learning model). The mean score improvement in the experimental group was 22.3, whereas in the control group it was 11.1. This difference suggests that the inquiry-based learning model is more effective in enhancing students' critical thinking skills in solving contextual mathematical problems.

6. Qualitative Analysis (Classroom Observation)

In addition to the quantitative data, observations during the learning process were conducted to observe student engagement, interactions during discussions, and how students approached solving contextual problems.

The observation results indicated that students in the experimental group were more engaged in discussions, asked more questions, and developed creative solutions to the problems presented. They also displayed greater confidence in expressing their opinions, reflecting an improvement in their critical thinking skills.

Based on the analysis of both quantitative and qualitative data, it can be concluded that the use of the inquiry-based learning model has a positive and significant effect on improving students' critical thinking skills in solving contextual mathematical problems. The experimental group, which implemented the inquiry-based model, showed greater progress in critical thinking skills compared to the control group. This is further supported by observations during the learning process, where increased student engagement was evident.

The inquiry-based learning model proves to be more effective in developing students' critical thinking skills than the conventional learning model. The application of this model enables students to become more involved in the learning process and develop problem-solving skills that are applicable to real-world situations. Therefore, this study provides evidence that the inquiry-based learning model is an effective approach for enhancing students' critical thinking abilities in contextual mathematics education.

Discussion

In this study, the main goal was to identify the impact of using the inquiry-based learning model on students' critical thinking skills in solving contextual mathematical problems. Based on the results obtained, it can be concluded that the use of the inquiry-based learning model was effective in developing students' critical thinking skills.

1. Improvement of Students' Critical Thinking Skills

The significant increase in the post-test scores of the experimental group (which

used the inquiry-based learning model) compared to the control group (which used the conventional learning model) indicates that the inquiry-based learning model effectively supports students in developing their critical thinking skills. This is demonstrated by the average score improvement of 22.3 in the experimental group, while the control group showed only 11.1.

Inquiry-based learning allows students to be more actively involved in the learning process. Rather than merely receiving information from the teacher, students engage in investigation, discovery, and independent problem-solving, which fosters critical thinking skills. The inquiry-based learning model, which emphasizes questioning, exploration, and discussion, enhances students' abilities to analyze, evaluate, and solve contextual problems.

2. Relevance to Related Research

Several relevant studies offer a deeper understanding of the significance of using the inquiry-based learning model to enhance students' critical thinking skills, particularly in the context of mathematics learning. Haryanto (2020), who explored the impact of the inquiry-based learning model on students' critical thinking abilities, found that inquiry-based learning is more effective than conventional methods in helping students develop critical thinking skills. Haryanto also discovered that students who were given the opportunity to actively explore solutions to problems exhibited improved critical thinking. This finding is consistent with the results of this study, which demonstrated significant improvement in critical thinking skills among students in the experimental group using the inquiry model.

Fauzan and Asri (2021), who investigated the use of the inquiry model in contextual mathematics learning, confirmed that inquiry-based learning enhances students' ability to solve mathematical problems related to real-world situations. In their study, students taught with the inquiry model were better at linking mathematical concepts to practical applications. These results align with the findings of this research, where the experimental group demonstrated superior abilities in solving contextual mathematical problems.

Rahmawati and Suryani (2019), who examined the implementation of the inquiry model in mathematics education, found that inquiry-based learning not only enhances critical thinking skills but also boosts student motivation and engagement in the learning process. Inquiry-based learning encourages students to be more actively involved in activities such as discussions and problem-solving, which

are essential elements in developing critical thinking skills. This was evident in the observational results, which showed that students in the experimental group were more engaged in discussions and problem-solving tasks.

3. Inquiry-Based Learning and Contextual Problem Solving

Contextual mathematics learning, which connects mathematical concepts to real-world situations, is very suitable for the inquiry approach. In this context, students are encouraged to solve problems that are relevant to their daily lives. The inquiry-based learning model provides opportunities for students to explore various solutions to contextual problems, rather than just receiving answers from the teacher. One of the strengths of the inquiry-based learning model is that it allows students to use critical thinking in identifying and evaluating information, as well as making decisions based on their analysis. This is crucial in contextual mathematics learning, where students need not only technical skills in computation or solving problems but also the ability to understand and apply mathematical concepts to complex real-world situations.

4. Student Activity in Inquiry-Based Learning

In class observations, it was found that students taught with the inquiry-based learning model were more active in group discussions, more confident in expressing their opinions, and better able to explain the reasoning behind the problem-solving approaches they chose. Inquiry-based learning encourages students to ask questions, analyze, and debate with their peers about the best way to solve problems, which, in turn, sharpens their critical thinking skills.

For example, in the contextual mathematics task given, students were not only asked to find the correct answer, but also to explain the steps they took and the reasoning behind their choices. This involves analysis, synthesis, and evaluation—skills that are all related to critical thinking.

5. Challenges and Implications of Inquiry-Based Learning

Although one of these challenges is the time required for inquiry-based learning, which is longer compared to conventional methods. In addition, teachers need to have good skills in facilitating inquiry-based learning to ensure that students stay focused and the learning objectives are met. However, despite these challenges, the inquiry-based learning model still has significant long-term benefits, especially in developing students' critical thinking skills. Therefore, the use of this model in mathematics learning, particularly to address contextual problems, is highly recommended.

Overall, the results of this study indicate that the inquiry-based learning model can significantly develop students' critical thinking skills in solving contextual mathematical problems. Inquiry-based learning not only enhances problem-solving skills but also increases student motivation to actively engage in the learning process. Thus, the inquiry-based learning model has proven to be a highly effective approach to improving students' critical thinking skills in contextual mathematics learning.

D. Conclusion

The findings of the study indicate that the application of the inquiry-based learning model significantly improves students' critical thinking skills in solving contextual mathematical problems. This is demonstrated by the substantial difference between the pre-test and post-test scores of the experimental group, which utilized the inquiry-based learning model, showing a more significant improvement in critical thinking compared to the control group that followed the conventional learning method. The inquiry-based learning model encourages students to actively engage in the learning process, fostering critical thinking skills through exploration, discussion, and independent problem-solving. Additionally, inquiry-based learning allows students to relate mathematical concepts to real-world contexts, which is essential for deepening their understanding of mathematics. The observational data also reveals that students in the experimental group were more engaged, more confident in expressing their ideas, and more inventive in solving contextual problems. This indicates that inquiry-based learning not only strengthens critical thinking skills but also enhances students' social and communication abilities.

Suggestions

Based on these conclusions, the following suggestions can be made:

1. Integrated Use of the Inquiry Model

Teachers are encouraged to consistently integrate the inquiry-based learning model in mathematics instruction. This approach will enable students to engage more actively in their learning process and enhance their critical thinking skills, particularly when tackling real-world mathematical problems that are directly applicable to their daily lives.

2. Teacher Training

To maximize the use of the inquiry-based learning model, teacher training is necessary to ensure effective implementation. Teachers need to understand how to design inquiry-based activities and facilitate discussions and

exploration of ideas effectively among students.

3. Enhancing Student Involvement in Learning:

Inquiry-based learning can be further enhanced by encouraging students to participate more actively in discussions and problem-solving. Teachers should provide more opportunities for students to explore, ask questions, and express their opinions freely.

4. Evaluation of Contextual Learning

It is recommended to continue developing contextual mathematical problems that are relevant to real-world situations so that students can better relate their learning to their lives. These contextual problems will strengthen critical thinking skills and also increase students' motivation and understanding.

5. Application in Other Subjects

The inquiry-based learning model, which has been proven effective in improving students' critical thinking skills in mathematics, can also be applied in other subjects such as science, social studies, or language arts. This will enhance students' critical thinking abilities more broadly, not just in one subject area.

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