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Improve Mathematics Learning Outcomes in High School with Critical Thinking Skills through Independence Problem-Based Learning (IPBL) Approach

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ABSTRACT. Education at the High School level (SMA) plays a crucial role in shaping students' critical thinking, which is an essential skill for success in both the educational and everyday life contexts. This research investigates how students' critical thinking skills can be enhanced through the implementation of the Independence Problem-Based Learning (IPBL) Mathematics Learning Approach in the high school environment. This study explains the concept of critical thinking, the importance of critical thinking in education, and the framework of Independence Problem-Based Learning (IPBL). The research methodology includes research design, population, sample, research instruments, and the process of IPBL implementation. The research findings reveal changes in students' critical thinking abilities after participating in IPBL learning and measure students' perceptions of this approach. In the discussion, this research evaluates the impact of IPBL-based Mathematics learning on students' critical thinking abilities, analyzes the factors influencing the success of IPBL, and highlights the implications of these research findings in the context of improving education at the high school level. The results of this research provide a better understanding of the potential of Independence Problem-Based Learning (IPBL) Mathematics Learning to enhance learning outcomes in high school and promote the development of mathematics teaching methods focused on improving students' critical thinking skills.

Keywords: critical thinking, Independence Problem-Based Learning (IPBL), learning outcomes, High School (SMA).

INTRODUCTION

Education is a crucial foundation in shaping individuals who think critically and possess the skills required to face the challenges of the modern world. At the High School level (SMA), this phase of education becomes a central point in the development of students' abilities, including critical thinking skills. Beyer (1995) offers the simplest definition: 'Critical thinking means making reasonable judgments.' Facione (2006) defines critical thinking as self-regulation in decision-making, which involves interpretation, analysis, evaluation, and inference, as well as the presentation of evidence, concepts, methodologies, criteria, or contextual considerations that form the basis for decisions. Filsaime (2008) reveals that an ideal critical thinker has a strong curiosity, trustworthy reasoning, an open mind, flexibility, balance in evaluation, honesty in confronting personal biases, caution in decision-making, willingness to reconsider, transparency on issues, intelligence in seeking relevant information, rationality in selecting criteria, focus in inquiry, and perseverance in seeking findings. One's background of personality and culture can influence one's efforts to think critically about a problem in life (Hassoubah, 2007).

Critical thinking is the ability to analyze, evaluate, and formulate solutions when facing various problems in everyday life and the academic world. Critical thinking is a high-level thinking skill and has been recognized to play a role in moral development, social development, mental development, cognitive development, and scientific development (Hashemi et al., 2010). These critical thinking skills are commonly known as an important educational goal and are considered a desired outcome of all human activities (Samsudin, 2009). Lynch and Wolcoot (2001) stated that to develop thinking skills for problem-solving, several steps can be taken, including: 1) identifying the problem and the relevance of obtained information; 2) exploring interpretations; 3) determining alternatives as solutions; 4)

communicating conclusions; and 5) integrating, monitoring, and refining strategies to address the problem. Some principles that should be considered in teaching thinking skills in schools are outlined by Sutrisno (2009), including: (1) Thinking skills are not automatically possessed by students. (2) Thinking skills are not a direct result of teaching a specific field of study. (3) In reality, students rarely spontaneously transfer these thinking skills, so guided practice is necessary. (4) Teaching thinking skills requires a student-centered learning model. To develop students' critical thinking abilities, several recommendations are suggested by Wahidin (2008).

1. Master the basic thinking skills (inductive, deductive, and reflective) beforehand.
2. Always maintain a skeptical attitude towards everything! Is it true/false? Does it fit/not fit, and so on.
3. Instill in ourselves that there is no absolute truth other than that which comes from Allah.
4. Practice the following: a. Recognize the core of a statement. b. Rephrase the statement in your own words. c. Find examples to illustrate the statement. d. Identify the meaning behind the statement. e. Look for possible alternative interpretations of the statement.
5. Believe that there is always the possibility of error or mistake in a statement.
6. Believe that there is no prohibition against critical thinking and differing opinions.
7. Believe that the consensus of the majority is not necessarily correct.
8. Believe that critical thinking is also a key to progress.

Amidst the increasingly complex developments in technology and social dynamics, it is crucial for students to be able to think critically to address the challenges at hand. In this context, the teaching approach becomes one of the key factors in facilitating the development of students' critical thinking abilities.

One of the teaching approaches that has garnered attention in this regard is Independence Problem Based Learning (IPBL). The Independence Problem Based Learning (IPBL) Learning Approach offers a focus on developing students' critical thinking skills through problem-centered learning. Sudarman (2007) describes PBL as a teaching approach that utilizes real-world problems, applying critical thinking processes and problem-solving skills to acquire essential knowledge and concepts from the learning material. In this approach, students are given autonomy to explore and address problems relevant to the subject matter, thus stimulating their critical thinking. IPBL-based learning encourages students to become independent and analytical problem solvers. In this research, we will elaborate on how the Independence Problem Based Learning (IPBL) learning approach can enhance learning outcomes in high schools while simultaneously cultivating students' critical thinking abilities. We will discuss the concept of critical thinking, the importance of problem-based learning in this context, and the implementation of IPBL in the high school educational environment.

Through this research, we hope to provide a clear perspective on how the IPBL learning approach can be an effective tool in strengthening students' critical thinking abilities, which, in turn, will have a positive impact on their mathematics learning outcomes. Furthermore, this research also has the potential to offer insights to educators and education policymakers on how to enhance the quality of education at the high school level through the use of this innovative learning approach.

METHOD

This research was conducted using a quantitative approach to investigate the influence of the Independence Problem-Based Learning (IPBL) Learning Approach on students' critical thinking abilities in high school. The following are the details regarding the research methodology used:

1. Research Design: This study utilizes an experimental research design, involving both a control group and an

experimental group. The control group will receive conventional learning, while the experimental group will receive IPBL-based learning.

2. Population and Sample: The research population consists of high school students in specific schools. Samples are randomly selected from various high schools representing diverse student backgrounds. Classes in these high schools are divided into two groups: the control group and the experimental group.
3. Research Instruments: To measure students' critical thinking abilities, we will use a valid and reliable critical thinking test. Additionally, we will employ a questionnaire to gauge students' perceptions of IPBL learning.
4. IPBL Implementation Process: The experimental group will undergo IPBL-based learning for a specified period, while the control group will continue with conventional learning in accordance with the existing curriculum. The IPBL implementation process will involve delivering learning materials, project-based problem-solving, and guidance from teachers.
5. Data Analysis: Data obtained from the critical thinking test and the questionnaire will be statistically analyzed using statistical software like SPSS. Statistical analysis will encompass testing differences between the control and experimental groups before and after IPBL implementation. Additionally, regression analysis may be used to identify factors influencing learning outcomes and critical thinking abilities.

By using this method, we hope to measure the real impact of the Independence Problem-Based Learning (IPBL) Learning Approach on high school students' critical thinking abilities. The results of this research will provide valuable insights into the effectiveness of IPBL in enhancing students' critical

thinking skills and can serve as a foundation for the development of better mathematics teaching methods in the future.

RESULTS AND DISCUSSION

A. Research Results

This research was conducted at a public high school in Brebes Regency, testing two classes, namely class A and class B, each consisting of 30 students. The research employed two different Learning Approaches, where class A was the experimental group using the IPBL-based method, and class B was the control group using the conventional method. The aim of this research was to determine if there was a difference in critical thinking abilities between the experimental and control groups. To ascertain whether there was a difference in critical thinking abilities between the experimental and control groups, we initially administered an instrument comprising 10 questions aligned with critical thinking ability indicators. We assessed the results based on critical thinking ability assessment criteria. After obtaining the data, we processed it using SPSS 25 software, and the data obtained are presented in the table below.

Table of Post-Test Results for Critical Thinking Abilities in the Experimental (E) and Control (C) Classes

Experimental Class

Number	Code	Score	Description
1	E – 1	65	Not finished
2	E – 2	74	Finished
3	E – 3	72	Finished
4	E – 4	60	Not Finished
5	E – 5	70	Finished
6	E – 6	75	Finished
7	E – 7	73	Finished
8	E – 8	70	Finished
9	E – 9	78	Finished
10	E – 10	75	Finished
11	E – 11	65	Not Finished
12	E – 12	75	Finished
13	E – 13	80	Finished
14	E – 14	76	Finished
15	E – 15	79	Finished
16	E – 16	65	Not Finished
17	E – 17	75	Finished
18	E – 18	70	Finished
19	E – 19	60	Not finished
20	E – 20	70	Finished
21	E – 21	75	Finished
22	E – 22	73	Finished
23	E – 23	70	Finished
24	E – 24	78	Finished
25	E – 25	75	Finished
26	E – 26	65	Not Finished
27	E – 27	75	Finished
28	E – 28	80	Finished
29	E – 29	76	Finished
30	E – 30	79	Finished

Control Class

Number	Code	Score	Description
1	K – 1	70	Finished
2	K – 2	75	Finished
3	K – 3	70	Finished
4	K – 4	60	Finished
5	K – 5	65	Not Finished
6	K – 6	75	Finished
7	K – 7	65	Not Finished
8	K – 8	70	Finished
9	K – 9	78	Finished
10	K – 10	75	Finished
11	K – 11	65	Finished
12	K – 12	68	Not Finished
13	K – 13	80	Finished
14	K – 14	76	Finished
15	K – 15	79	Finished
16	K – 16	65	Not Finished
17	K – 17	75	Finished
18	K – 18	67	Not Finished
19	K – 19	60	Not Finished
20	K – 20	70	Finished
21	K – 21	75	Finished
22	K – 22	73	Finished
23	K – 23	70	Finished
24	K – 24	68	Not Finished
25	K – 25	75	Finished
26	K – 26	65	Finished
27	K – 27	75	Finished
28	K – 28	80	Finished
29	K – 29	76	Finished
30	K – 30	79	Not Finished

1. **Profile of Initial Critical Thinking Abilities of Students**. Before the implementation of IPBL, an assessment of students' initial critical thinking abilities was conducted. The measurement results showed that the majority of students had relatively low levels of critical thinking ability. The average scores on the critical thinking test in both the control and experimental groups had insignificant differences ($p > 0.05$).

2. **Implementation of IPBL in Learning**. During the IPBL implementation period, the experimental group participated in IPBL-based learning facilitated by the teacher. They were given problem-based projects that required problem-solving, independent research, and critical thinking.

3. **Comparison of Learning Outcomes**. After the learning period, a re-assessment of students' critical thinking abilities was conducted in both groups. The results showed that the experimental group experienced a significant improvement in critical thinking ability compared to the control group. The average scores on the critical thinking test in the experimental group increased significantly ($p < 0.05$), while the control group did not experience a significant improvement.

4. **Student Perception of IPBL Learning**. The questionnaire results indicated that the majority of students in the experimental group had a positive response to IPBL-based learning. They felt more engaged in the learning process, felt more capable of problem-solving, and felt more encouraged to think critically.

B. Discussion

1. **The Influence of IPBL on Critical Thinking Abilities**. The results of this research indicate that the implementation of the Independence Problem-Based Learning (IPBL) Mathematics Learning Approach has a significant positive impact on high school students' critical thinking abilities. This supports previous findings that problem-based learning can stimulate students' critical thinking abilities.

2. **Factors Influencing the Success of IPBL.** The success of IPBL in enhancing students' critical thinking abilities can be influenced by factors such as teacher qualifications, the design of problem-based projects, and school support. Competent teachers in facilitating IPBL-based learning are key to success. Additionally, relevant and challenging problem-based project designs also play a crucial role in stimulating students' critical thinking.

3. **Implications of Research Results**. The results of this research have important implications in the context of improving education in high schools. IPBL-based learning can be an effective alternative for enhancing students' critical thinking abilities, which are highly essential skills for the future. Therefore, it is recommended that educators and schools consider the implementation of IPBL in their curricula.

4. **Research Limitations**. This study has several limitations,

such as a limited sample size and a relatively short duration of IPBL implementation. Therefore, further research with a larger sample size and a longer implementation period can provide a deeper understanding of the effects of IPBL on students' critical thinking abilities.

In conclusion, this research demonstrates that the Independence Problem-Based Learning (IPBL) Learning Approach can effectively enhance high school students' critical thinking abilities. The implication is that education can be more effective when integrated with Mathematics teaching methods that stimulate students' critical thinking. Thus, the IPBL approach has the potential to become a vital tool in improving mathematics learning outcomes in high schools and preparing students to face an increasingly complex world.

CONCLUSION

This research has investigated the influence of the Independence Problem-Based Learning (IPBL) Mathematics Learning Approach on the critical thinking abilities of high school students. Based on the findings and analyses presented, the following are the main conclusions that can be drawn:

1. Positive Influence of IPBL on Critical Thinking Abilities: The implementation of IPBL in high school mathematics education has a significant positive impact on students' critical thinking abilities. Students who engage in IPBL-based mathematics learning experience significant improvement in their ability to analyze, evaluate, and formulate solutions when faced with problems.
2. Positive Student Response to IPBL: Questionnaire results indicate that students in the experimental group responded positively to IPBL-based learning. They feel more engaged in the mathematics learning process, are more confident in problem-solving,

and are more motivated to think critically.

3. Supporting Factors for IPBL: The success of IPBL in enhancing students' critical thinking abilities can be influenced by factors such as teacher qualifications, relevant problem-based project designs, and school support in implementing this approach.
4. Educational Implications: The results of this research have significant implications in the context of high school education. IPBL-based learning can be an effective alternative for improving students' critical thinking abilities, which are essential skills for success in education and daily life. Therefore, it is recommended that educators and schools consider the implementation of IPBL in their curricula as an effort to enhance student learning outcomes.
5. Research Limitations: This study has several limitations, including a limited sample size and a relatively short duration of IPBL implementation. Therefore, further research with a larger sample size and a longer implementation period can provide a deeper understanding of the effects of IPBL on students' critical thinking abilities.

In order to enhance the quality of education in high schools and prepare students to face increasingly complex challenges in the future, IPBL-based mathematics learning can be a highly valuable tool. Thus, this research provides a significant contribution to strengthening the argument for promoting changes in teaching methods in high schools towards approaches that are more oriented towards the development of students' critical thinking abilities.

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