

ASSESSING THE EFFECT OF INQUIRY-BASED LEARNING ON MATHEMATICS UNDERSTANDING AT JUNIOR HIGH SCHOOL LEVEL

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ABSTRACT

This study aims to evaluate the impact of the Inquiry-Based Learning (IBL) approach on students' understanding, motivation, and engagement in mathematics at junior high school level. IBL is a learning method that emphasizes the active involvement of students through questioning, investigation, and problem-solving, which is based on the theory of constructivism developed by Piaget and Vygotsky. This study used a descriptive quantitative survey method involving 39 junior high school students as respondents, using a questionnaire as a data collection instrument distributed online through Google Forms. The analysis showed that most students gave a "Strongly Agree" response to the effectiveness of IBL, especially in facilitating understanding of mathematical concepts, increasing participation in group discussions, and motivating them to learn. 97.3% of students stated that it was easier to understand mathematics material after participating in experimental or investigative activities. In addition, this approach was also proven to encourage increased self-confidence, independent learning ability, and critical thinking and problem-solving skills. These findings confirm that IBL is a practical approach relevant to constructivist learning principles. Therefore, it is recommended that mathematics teachers apply IBL in teaching and learning activities with appropriate assistance and integrate it consistently into the learning process.

Keywords: Inquiry-Based Learning; mathematics education; constructivism; student engagement; junior high school.

INTRODUCTION

Inquiry-Based Learning (IBL) is a student-centred learning approach emphasising exploration and active participation, significantly improving students' understanding of mathematical concepts. According to Kotsis (2025), inquiry-based learning (IBL) is a student-centred instructional strategy emphasising active student participation through questioning, research, and problem-solving, promoting deeper knowledge retention and critical thinking. In mathematics education, this approach encourages learners to construct their understanding of abstract concepts through hands-on investigation and logical reasoning. A recent meta-analysis further confirms the effectiveness of IBL, showing a substantial positive impact ($g = 1.191$) on students' conceptual understanding of mathematics, particularly when open inquiry strategies are employed ($g = 1.530$) (Mediana, Funa, & Dio, 2025). Given the challenges posed by conventional, teacher-centred instruction—such as passive learning and lack of engagement—IBL offers an effective alternative to foster deeper conceptual understanding and higher-order thinking skills.

A low understanding of mathematics concepts among junior high school students is the main reason for innovation in learning methods. Because the level of students' interest in learning greatly influences their understanding of mathematical materials, enthusiastic students more readily master concepts. In contrast, less interested students experience difficulties, and conventional teaching methods must be replaced with more interesting new ways (Kariimah & Fatikhah, 2024). In addition, a lack of direct involvement and learning activity between educators and students is a significant obstacle to the instructional process, which has the potential to reduce the effectiveness of understanding math concepts, so an alternative learning approach that encourages student activity is needed to overcome this barrier (Maulina et al., 2024). As evidence, low math ability results in poor academic performance, as seen by only 48% of students reaching targets in the early stages of research. However, this figure rises to 78% after applying a scientifically based method that effectively improves understanding (Silvia, Fitrianna, & Hendriana, 2023) Thus, creative teaching and the participative approach must help students be more motivated and understand mathematical concepts more optimally.

Junior high school students often do not actively participate in the learning process, which causes them to not understand math concepts well. As shown by research, students' low interest in engaging in math learning has been proven to reduce their ability to clearly understand concepts, as those who are less enthusiastic tend to experience difficulties; however, on the other hand, curious learners can process problems more deeply (Kariimah & Fatikhah, 2024). In addition, research shows that high school students do not participate in learning activities, with evidence that a lack of participation among students has been found to hinder their understanding of advanced mathematical concepts, mainly when instruction relies on memorizing formulas rather than conceptual analysis, which limits their ability to apply mathematics in real-world situations (Tata & Haerudin, 2022). Therefore, students' lack of motivation and engagement in learning significantly hinders their conceptual understanding and math application skills. These two factors are the most important.

The application of inquiry-based mathematical learning can increase students' understanding. Investigative-based approaches are particularly related ($r = 0.904$) to significant improvements in student academic performance (Guterres, 2024). In addition,

inquiry-based learning strategies encourage the development of fundamental analytical skills in mathematics, as evidenced by research showing a significant improvement in students' critical thinking skills after using an investigative approach (Mujtahid et al., 2023). Furthermore, applying an investigative approach to mathematical learning has increased learning outcomes because students' direct involvement and exploration help strengthen their understanding and memory of mathematical concepts (Chusna et al., 2020). Thus, the investigative approach in teaching mathematics is powerful in developing concepts, enhancing logical thinking skills, and improving student learning outcomes.

The inquiry learning approach allows students to explore and understand concepts independently through an active process. Using this method, various possible solutions can be sought out and concepts understood through logical thought and personal experience, not just by receiving passive explanations from teachers (Qablan et al., 2024). In addition, investigative methods encourage active participation in the learning process because the focus of learning shifts to the learners, allowing teaching materials to be presented in a more relevant way, resulting in a better understanding of ideas (Shanmugavelu et al., 2020). Thus, inquiry-based approaches increase students' participation and encourage more meaningful knowledge through personal experience and reflection.

This study aims to assess the effect of inquiry-based learning on junior high school students' understanding of mathematics concepts. Specifically, it investigates how this approach contributes to increasing student participation and improving learning outcomes by emphasizing student-centred exploration and active engagement during the learning process.

The construction approach and inquiry became the basis for mathematical learning theory. Both emphasize mental processes and psychological aspects, encouraging students to think analytically and evaluate their learning experiences, along with systematic literature reviews highlighting cognitive activity's key role in evaluating scientific exploration (Vo & Simmie, 2024). Viewed constructively, learning occurs when students build knowledge through experiences and reflections, where the students are encouraged to examine concepts and solve problems independently in a mathematical context rather than passively receiving information (Nurhuda et al., 2023). In other words, a constructive theory suggests that students build their knowledge from their experience, so in learning mathematics, they are encouraged to associate new ideas with previous understanding to create a more profound and meaningful learning process (Sugrah, 2020). Thus, a constructive and path-based study model is a solid basis for facilitating students to develop knowledge independently through direct interaction, reflective thinking, and intense mental activity.

The constructivism theory, the Bruner theory, and the inquiry study model become the theoretical basis for the approach to learning used. According to Bruner, effective learning is learning that involves intuitive understanding and not just mere memorization of information. He believes that ideal learning occurs through active social interaction, where students' thinking abilities can develop more deeply (as quoted in Tohari & Rahman, 2024). Jerome Bruner also positively contributed by emphasizing the importance of the surrounding environment and direct experience in learning. He instructed students to conclude their ideas through investigative methods. He highlighted that learning becomes

more relevant when students actively engage in critical thinking and problem-solving (as cited in Mulyadi, 2022). Thus, these three theoretical fundamentals complement each other in shaping an active, collaborative, and cognitive development approach for students.

This research is expected to make a meaningful contribution by improving the learning experience to be more engaging and contextual, encouraging students' intellectual independence to develop mathematics education at the junior high school level. This research aims to promote the overall quality of mathematics learning by adjusting classroom activities to real-life contexts and encouraging learning that positions students as the leading actors and emphasizes the process of independent inquiry.

Additionally, the results of this study also have the potential to be used by educators as practical references in designing dynamic and innovative learning scenarios. Curriculum designers also have the opportunity to be encouraged to expand the implementation of an exploration-based approach. In addition, teacher training programs can gain essential insights that support the preparation of prospective educators with adaptive and reflective teaching approaches. Overall, this research is expected to encourage long-term improvements in mathematical thinking skills and student engagement through a learning process that is more contextual and tailored to individual needs.

RESEARCH METHODS

This study used a descriptive quantitative survey design. The research participants were 39 students selected from junior high school. The research instrument was a questionnaire designed to analyze the effect of inquiry-based learning on mathematics learning at the junior high school level. Descriptive quantitative research aims to collect and analyze numerical data in a structured manner to explain a phenomenon without looking for cause-and-effect relationships. It is usually conducted through surveys, questionnaires, or observations (Barella et al., 2024).

The data collection procedure involves many stages. First, the researcher created questions related to the research objectives. Next, the questionnaire was sent to the participants via Google Forms. Participants were asked to fill out the questionnaire based on their experience learning math. Descriptive statistics were used to analyze the data. The data will be collected from April 14 to April 29, 2025.

The data obtained from filling out the questionnaire were analyzed descriptively using simple statistics: frequency and percentage. This analysis aims to describe the tendency of student responses to statements related to inquiry-based learning in mathematics subjects. Each response is classified into the categories "Agree" and "Disagree," and then the number and percentage are calculated to determine the general pattern of student attitudes toward applying the approach. The analysis results are presented in tabular form to facilitate interpretation and conclusion.

RESULT AND FINDING

Category	Agree	Disagree
Understanding Mathematical Concept	90,24%	9,76%
Discussion and Collaboration Activities	89,75%	10,25%
Motivation and Interest	88,7%	11,3%
Confidence and Readiness	85,64%	14,36%
Engagement and Independent	84,65%	15,35%
Application to Real Life	87,17%	12,83%
Critical Thinking and Problem Solving	89,75%	10.25%

Table 1. Data analysis results

Inquiry-based learning methods improve students' understanding of mathematical concepts. Many students reported that this approach helped them understand the material better, especially after conducting experiments and having the opportunity to explore problems independently. Students also stated that the inquiry-based learning approach helped them understand complex topics and made it easier to follow each step in solving mathematical problems. In addition, they also felt that this approach made them more aware of the importance of mathematical concepts, indicating that inquiry-based learning not only supports conceptual mastery but also increases understanding of the relevance of mathematics in everyday life.

The inquiry-based method also has a positive impact on students' social interaction. Students are more engaged in learning through group discussions and talking with friends and teachers. This discussion encourages closer collaboration between students and educators, while deepening understanding of learning materials. Through active interaction, students gain various benefits, such as ease in understanding complex concepts and broadening horizons through various perspectives.

This study also showed that the inquiry-based method increased students' interest and attraction to mathematics. Many students enjoyed completing the tasks because they were more interested and motivated to learn more about math. Independent learning, focusing on exploration and discovery, makes learning more interesting and fun. Therefore, students become more excited during the learning process.

In addition to deepening understanding of the material, the inquiry-based approach also positively impacts students' confidence, especially when facing math problems and exams. Many students feel more confident in their mathematics abilities after applying this approach. This increase in confidence is essential to help students face academic challenges more optimistically, which can positively affect their learning outcomes.

The inquiry-based approach has increased students' interest in what they are studying. Students' interest in mathematics learning seems to increase along with their

active participation in every stage of learning activities. Interaction in groups becomes more lively because students work together more often and exchange ideas compared to regular learning in class. They also seem to ask questions more often and are interested in trying different approaches in solving problems, which indicates a deeper curiosity and involvement in the learning process.

Additionally, students stated that they could better apply the mathematical ideas they had learned to real-world scenarios. Thanks to the inquiry-based method, lessons feel more worthwhile and applicable when students can use their mathematics knowledge in a more practical setting. This shows how important it is to provide context in mathematics learning so that students can directly benefit from what they learn.

Some pupils felt unprepared to learn independently despite the favorable reaction. This suggests that the inquiry-based method could be implemented better by providing more initial assistance to help students become more independent. A guided inquiry approach, which initially provides more intensive guidance, may be a solution to ensure that all students feel more prepared to innovate and learn independently (Vygotsky 1978:56).

Based on these findings, inquiry-based learning significantly impacts mathematics learning regarding concept understanding, motivation, confidence, engagement, and critical thinking skills. These results confirm the importance of incorporating inquiry-based approaches into the mathematics curriculum with appropriate modifications to meet students' needs. This approach can promote the achievement of 21st century educational goals for creative, critical and independent students (Darling-Hammond, 2008:188).

This study revealed that inquiry-based learning approach has a significant and positive impact on mathematics learning. This impact is very visible, especially in increasing students' understanding of the material, enthusiasm in learning, self-confidence, active participation in learning activities, and critical thinking skills. The shift from passive to active learning not only enhances understanding but also fosters a more enjoyable learning experience, in line with the creative nature of mathematics (Capaldi, 2015). The study shows that the Inquiry-Based Learning (IBL) model positively influences mathematics learning outcomes for junior high school students, indicating that IBL enhances their comprehension of mathematical concepts compared to conventional teaching methods (Baeti & Mikrayanti, n.d.).

Problem-solving and higher-order thinking skills, both of which are very important mathematical proficiencies, are developed through this learning strategy. As a number of empirical studies have shown, these benefits improve student learning outcomes (Simarmata et al., 2024). These findings address the issues raised in the research questions concerning how this approach influences different dimensions of mathematics learning. Most students stated that they found it easier to understand mathematical concepts after engaging in experimental or investigative activities, which reinforces the view that this strategy allows learners to deepen their understanding through independent exploration and discovery (Bransford, Brown, & Cocking, 2000:26).

Furthermore, the findings showing increased discussion and cooperation activities indicate that inquiry-based learning supports more intensive communication between students and both their classmates and teachers. IBL fosters an active learning environment, as demonstrated by a study in which students showed increased

participation and engagement in math classes following the introduction of the IBL method (Neang et al., 2023). These findings also align with Vygotsky's theory on the importance of social interaction in learning, where discussions between students and teachers enhance both understanding and student motivation (Vygotsky, 1978).

This approach promotes a collaborative learning environment that supports problem-solving and critical thinking through exploration and higher-order questioning (Gillies, 2023). Group discussions play an important role in learning because they can help students understand more complex concepts through brainstorming with their peers. In addition, the results of this study indicate that there is an increase in students' motivation and interest in learning mathematics. This is shown by the increased enthusiasm of students to complete classroom tasks and learn mathematical concepts. When compared to conventional approaches, inquiry-based learning has been shown to be more interesting and enjoyable (Jonassen, 1999:262). In addition, this study also found a significant increase in students' self-confidence when solving math problems or facing exams. Self-efficacy affects students' mathematics learning outcomes by 33.9%. Research shows that using an inquiry-based approach to instruction is essential for improving conceptual knowledge and increasing students' academic and conceptual self-confidence (Isyana et al., 2024). These findings indicate that the inquiry-based learning model improves students' conceptual understanding and increases their academic self-confidence. Although not all learners were prepared for autonomous learning, the inquiry approach proved effective in maintaining students' focus and promoting active classroom involvement (Hattie, 2009:2000).

This study supports the principles of constructivist learning theory, which states that deep understanding is formed when students actively construct knowledge through direct experience and inquiry processes. Student engagement increases when they are involved in investigative activities, which in turn creates a more positive and enjoyable learning experience (Osman, 2009). Linking learning to real-life problems makes the material feel more relevant and interesting to students, thereby increasing their curiosity and enthusiasm (Qablan et al., 2024). The inquiry-based learning paradigm encourages active participation of students in the learning process and helps them apply the concepts they have learned in practical situations by placing a strong emphasis on active experimentation and the investigation process. This paradigm encourages active participation of students in the learning process and helps them apply the concepts they have learned in practical situations by placing a strong emphasis on active experimentation and the investigation process.

Based on the findings, the inquiry approach can be adjusted to a gradual inquiry model, by providing intensive guidance at the beginning of the learning process, then slowly reduced according to the level of readiness of each student. This approach broadens the scope of the traditional inquiry model which generally assumes that students are ready to learn independently from the start. Moreover, the findings also show that the combination of inquiry and social interaction supports conceptual understanding and accelerates the development of academic self-confidence, which has not been widely emphasized in previous inquiry theories (Vygotsky, 1978:56; Hattie, 2009:89).

CONCLUSION

Inquiry-based learning has improved students' mathematical understanding, motivation, and participation. Research findings show that this method helps most students understand math concepts more easily after participating in experimental or inquiry-based activities. Students were also more involved in the learning process and more active in group discussions. With IBL, students gained a deeper understanding of math concepts and were trained to think critically and solve problems independently.

Using IBL in math learning increases students' confidence and enthusiasm to learn. After participating in inquiry-based learning, students showed increased confidence in solving math problems and the ability to learn independently. This approach successfully encouraged a deeper understanding of math concepts, increased student engagement in learning activities, and developed social and collaborative skills in group discussions. Overall, the Inquiry-Based Learning (IBL) approach is in line with the principles of constructivism because it provides opportunities for students to be directly involved in the process of building knowledge through interaction, exploration, and reflection. Thus, the learning they experience becomes more meaningful and has an effective impact.

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