THE EFFECT OF THE GUIDED INQUIRY LEARNING MODEL ON STUDENTS' MATHEMATICAL REPRESENTATION ABILITY

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ABSTRACT Mathematical representation ability is an important skill for students to transform complex problems into simpler forms. However, field observations based on the pretest results of mathematical representation ability conducted at SMP Negeri 18 Bandarlampung show that many students have not yet mastered this skill. This is supported by the 2022 PISA results, which indicate that students' mathematical representation ability is still categorized as low. Therefore, it is necessary to apply a learning model that can help students improve their mathematical representation skills. This study aims to determine the effect of the guided inquiry learning model on students' mathematical representation ability. The population in this study consisted of all eighth-grade students at SMP Negeri 18 Bandarlampung in the odd semester of the 2024/2025 academic year, totaling 174 students distributed across six classes. Sampling was conducted using the cluster random sampling technique, selecting class VIII B (28 students) as the experimental class and class VIII D (29 students) as the control class. The research design used was the pretest-posttest control group design. The data in this study are quantitative data obtained from the students' mathematical representation ability test. Based on data analysis using the Mann-Whitney U test, it was found that the improvement in mathematical representation ability of students who participated in guided inquiry learning was higher than that of students who followed conventional learning. Thus, the guided inquiry learning model has an effect on improving students' mathematical representation ability.

Keywords: mathematical representation ability, guided inquiry learning, learning model

ABSTRAK Kemampuan representasi matematis merupakan keterampilan penting bagi siswa dalam menyederhanakan permasalahan kompleks menjadi lebih mudah untuk diselesaikan. Namun, fakta di lapangan berdasarkan hasil pretest kemampuan representasi matematis yang dilakukan di SMP Negeri 18 Bandarlampung menunjukkan bahwa masih banyak siswa yang belum menguasai kemampuan tersebut. Hal ini diperkuat oleh hasil PISA tahun 2022 yang menunjukkan bahwa kemampuan representasi matematis siswa masih tergolong rendah. Oleh karena itu, diperlukan model pembelajaran yang dapat membantu siswa meningkatkan kemampuan representasi matematis mereka. Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran *guided inquiry* terhadap kemampuan representasi matematis siswa. Populasi dalam penelitian ini adalah seluruh siswa kelas VIII

SMP Negeri 18 Bandarlampung semester ganjil tahun pelajaran 2024/2025 yang berjumlah 174 siswa dan terdistribusi dalam enam kelas. Pengambilan sampel dilakukan menggunakan teknik *cluster random sampling*, dengan terpilihnya kelas VIII B sebanyak 28 siswa sebagai kelas eksperimen dan kelas VIII D sebanyak 29 siswa sebagai kelas kontrol. Desain penelitian yang digunakan adalah *pretest-posttest control group design*. Data penelitian berupa data kuantitatif yang diperoleh melalui tes kemampuan representasi matematis siswa. Berdasarkan analisis data menggunakan uji Mann–Whitney U, diperoleh hasil bahwa peningkatan kemampuan representasi matematis siswa yang mengikuti pembelajaran dengan model *guided inquiry* lebih tinggi dibandingkan dengan siswa yang mengikuti pembelajaran konvensional. Dengan demikian, model pembelajaran *guided inquiry* berpengaruh dalam meningkatkan kemampuan representasi matematis siswa.

Kata-kata kunci: kemampuan representasi matematis, pembelajaran inkuiri terbimbing, model pembelajaran

INTRODUCTION

Education plays a vital role in the advancement of a nation. The higher the quality of education in a country, the more progressive the nation becomes (Wahyudi et al., 2022). In support of this, the Indonesian government mandates compulsory education for all citizens, as stated in Article 6 of Law Number 20 of 2003 of the Republic of Indonesia, which requires all citizens aged seven to fifteen to complete basic education.

The importance and obligation of national education as outlined in Law Number 20 of 2003 align with the overarching goals of national education. According to the National Education Standards, Curriculum, and Assessment Agency, the purpose of national education is to develop students' potential so they become individuals who are faithful and devoted to God Almighty, possess noble character, are healthy, knowledgeable, capable, creative, and independent, and who act as democratic and responsible citizens. Ideally, these goals encompass the cognitive, affective, and psychomotor domains. Among school subjects, mathematics plays a central role in fostering logical, analytical, critical, and creative thinking, thereby strengthening the cognitive aspect of learning.

Mathematics is introduced from early education due to its essential role in various disciplines and its contribution to developing human thinking abilities (Noer, 2017). One fundamental aspect of mathematical proficiency is mathematical representation, which refers to the ability to interpret mathematical ideas or concepts through various formats such as diagrams, tables, graphs, and symbols (Sahbirin, 2014). This skill aids students in simplifying and solving complex problems more effectively (Noer & Gunowibowo, 2018; Irwan et al., 2023). Key indicators of mathematical representation include visual, symbolic, and verbal representations.

However, numerous studies have reported that Indonesian students' mathematical representation skills remain relatively low (Mulyaningsih et al., 2020; Septian et al., 2023; Hidayati et al., 2024). This concern is further validated by the results of international assessments such as TIMSS and PISA, which show that the average mathematics score of Indonesian students consistently falls below the global standard (OECD, 2023). For instance, Indonesia's average mathematics score in PISA 2022 was only 366, compared to the international average of 468.

The issue of low mathematical representation skills is also evident at the local level, including at SMP Negeri 18 Bandarlampung. Preliminary research conducted at the school revealed that many students struggled to interpret mathematical problems into diagrams or models accurately. One of the main contributing factors is the predominance of conventional teaching methods that fail to actively engage students in the learning process (Ikhsan et al., 2024; Satriaman et al., 2018). Teaching is still largely teacher-centered, characterized by direct instruction and mechanical problem-solving, with limited opportunities for students to explore and construct mathematical understanding independently.

Addressing this issue requires the implementation of instructional models that promote student engagement in problem-solving and provide opportunities to express mathematical ideas meaningfully. One promising approach is the guided inquiry learning model, which emphasizes active student participation in constructing knowledge with support from the teacher through open-ended questions and collaborative discussions (Khoimaidah & Koeswanti, 2020). This model encourages students to think critically, communicate their ideas effectively, and develop various forms of mathematical representation (Prasetiyo, 2021).

Despite its potential, research on the impact of the guided inquiry model on mathematical representation skills has not yet been conducted at SMP Negeri 18 Bandarlampung. Therefore, this study aims to examine the effect of the guided inquiry learning model on the mathematical representation skills of eighth-grade students at SMP Negeri 18 Bandarlampung in the 2024/2025 academic year.

METHODS

This research was conducted at SMP Negeri 18 Bandar Lampung during the even semester of the 2024/2025 academic year. The population of this study consisted of all eighth-grade students at the school, totaling 174 students distributed across six classes (VIII A to VIII F). The sampling technique employed was cluster random sampling, which involves randomly selecting intact groups rather than individuals. Two classes were chosen as samples: one class was designated as the experimental group and the other as the control group.

This study employed a quantitative approach with a pretest-posttest control group design, which is a type of quasi-experimental research. The dependent variable was students' mathematical representation ability, while the independent variable was the learning model implemented in each group. According to Siyoto and Sodik (2015), the structure of this research design is presented in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O	X	O
Control	O	C	O

Description:
O : Students' mathematical representation ability score
X : Learning using the guided inquiry learning model
C : Learning using the conventional learning model

The instrument used in this study was an essay-type test based on the indicators of mathematical representation ability. The same test was administered to both the experimental and control groups. These tests were conducted individually to assess students' mathematical representation skills in alignment with the corresponding competency indicators. Before the test items were developed, a test blueprint was prepared based on the dimensions of mathematical representation. Each item was designed to assess one or more of the following forms of representation: symbolic, visual, and verbal.

To ensure the accuracy and reliability of the data collected, the test instruments were required to meet specific validity criteria. A valid instrument is one that is not only both valid and reliable, but also demonstrates an appropriate level of item difficulty and discriminatory power. All test items used in this study were validated to meet these psychometric properties.

The data analysis procedure was aimed at testing the hypotheses and supporting evidence-based conclusions. The quantitative data consisted of pretest and posttest scores. To evaluate improvement, gain scores were calculated and analyzed statistically to determine the effect of the guided inquiry learning model on students' mathematical representation abilities. Prior to the hypothesis testing, assumption tests were conducted, including normality and homogeneity tests. The normality test was used to verify whether the data were drawn from a normally distributed population, while the homogeneity test assessed the equality of variance across groups.

Following the assumption tests, hypothesis testing was carried out to compare the performance of the two groups. The goal was to determine whether students taught using the guided inquiry learning model demonstrated significantly higher mathematical representation abilities than those taught using the conventional learning model. Based on the results of the normality tests, it was found that the gain scores from the experimental group were not normally distributed, while those from the control group were normally distributed. Consequently, the appropriate statistical test used was a non-parametric test, specifically the Mann–Whitney U test.

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FINDING AND DISCUSSION

Data on mathematical representation ability were obtained from pretest and posttest scores in both the experimental and control classes. After processing the data, the gain scores in students' representation ability are summarized in Table 2.

Table 2. Research Result Data

Class	Experiment	Control
Number of students	28	29
Mean	0.65	0.32
Standard deviation	0.27	0.17
Lowest Score	0.12	0.00
Highest Score	0.93	0.64

Based on Table 2, the average gain in mathematical representation ability in the experimental class is higher than in the control class, with a mean difference of 0.33. Furthermore, the standard deviation in the experimental class is also higher than in the control class, with a difference of 0.10, indicating a wider range of gain scores among students in the experimental group.

The achievement of mathematical representation indicators was analyzed based on pretest and posttest results. The pretest results reflect students' initial achievement levels, while the posttest results show final outcomes in both classes. This data is presented in Table 3.

Table 3. Achievement of Students' Mathematical Representation Skill Indicators

No	Indicators	Experiment Class		Control Class	
		Pretest	Posttest	Pretest	Posttest
1	Visual	0,00%	45,84%	0,86%	8,05%
2	Symbolic	17,39%	83,62%	18,25%	63,65%
3	Verbal	1,72%	47,70%	4,31%	19,54%
	Average	6,37%	59,05%	7,81%	30,41%

Based on Table 3, the difference in pretest averages between the experimental and control classes is 1.44%, showing that both groups had similar initial abilities. After instruction, the average posttest difference increased to 28.64%, indicating a greater improvement in the experimental group. The average indicator improvement in the experimental class was 52.68%, compared to 22.60% in the control class. The highest increase in the experimental class occurred in the symbolic indicator (66.23%), while the visual indicator showed the smallest gain (45.84%). In the control class, the symbolic indicator also showed the highest increase (45.40%), and the visual indicator the lowest (7.19%).

Based on the assumption tests, the gain score data for the experimental group was not normally distributed. Therefore, a non-parametric test, the Mann–Whitney U test, was used. At a significance level of $\alpha = 0.05$, the results show $Z_{count} = -4.21$ and $Z_{table} = -1.64$, so $-4.21 < -1.64$. Thus, the null hypothesis H_0 is rejected, and the alternative hypothesis H_1 is accepted. This means that the median gain in mathematical representation ability of students who received guided inquiry instruction is significantly higher than that of students who received conventional instruction.

Based on the descriptive analysis results, students in the guided inquiry class demonstrated greater improvement in mathematical representation ability compared to those in the conventional class. This suggests that the guided inquiry model effectively supports the development of representation skills by encouraging students to construct conceptual understanding independently. In contrast, conventional instruction, which is more teacher-centered, limited students' opportunities to construct understanding, resulting in lower gains in representation skills. This finding aligns with Dira (2023), who found that guided inquiry learning more effectively improves mathematical representation ability than traditional teaching.

The guided inquiry learning process was conducted over five meetings. It began with group formation (4–5 students per group) and the presentation of initial problems connecting prior knowledge to new material. Students were then guided to interpret the problems into mathematical statements. According to Fauzy et al. (2019), a key role of the teacher in this phase is to foster a responsive learning atmosphere that stimulates students to think critically and explore solutions.

In the next phase—problem formulation—students received worksheets containing structured problems covering the differences between linear equations and systems of linear equations in two variables (*systems of linear equations in two variables*), as well as methods such as graphing, substitution, elimination, and mixed techniques. Students began by identifying known and unknown elements of the problems and translating them using their own language and mathematical symbols. This aligns with Agustinsa et al. (2022), who noted that teachers should encourage students to engage with texts and exploratory activities in preparation for solving problems.

The third phase was hypothesis formulation, where students proposed initial answers to the problems in their worksheets. They expressed their reasoning in their own language and discussed multiple hypotheses within their groups before agreeing on the most appropriate mathematical explanation. This step reflects the view of Putra and Hervian (2015), who emphasized the importance of teacher-guided hypothesis development.

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In the data collection phase, students actively gathered information from books and online sources to support their hypotheses. They represented data in symbolic forms, tables, and diagrams. According to Juliawati et al. (2018), this phase is critical for students to express concepts in their own terms and distinguish between examples and non-examples, ensuring the evidence they gather is meaningful for hypothesis validation.

Next, in the hypothesis testing stage, students analyzed the collected data to evaluate their proposed answers. They compared their conclusions with initial hypotheses and discussed the best solutions using appropriate mathematical models. Juliawati et al. (2018) emphasized that this phase involves careful investigation and the articulation of ideas using precise examples and non-examples—key components in developing symbolic, visual, and verbal representation skills.

The final phase involved drawing conclusions. Students summarized their findings from the worksheets and shared them during class presentations. They actively responded to peers' questions and clarified points of confusion. The teacher then guided students in synthesizing the learning material and formulating conclusions in their own words. As Ratnawati et al. (2020) noted, this stage promotes consensus-building and enhances the learning experience through reflection and open discussion.

In general, the guided inquiry learning process was carried out successfully. Students responded with enthusiasm and engagement. However, some challenges were encountered. In the first session, students were unfamiliar with the learning model, and each group initially received only one worksheet, which slowed discussion. In subsequent meetings, the teacher addressed this by providing two worksheets per group and allocating time limits for each stage. The teacher also circulated among the groups to provide guidance. These strategies align with Amsari et al. (2023), who emphasized that group collaboration fosters student interaction and problem-solving in mathematics.

A second obstacle occurred during the second meeting, when students struggled with the graphical method for solving systems of linear equations in two variables. The slow pace of discussion was attributed to difficulty in translating symbolic forms into graphs. Maryani & Setiawan (2021) similarly reported that 80% of students had trouble understanding the graphical approach to finding solutions for such systems.

In conclusion, despite some challenges in the learning process, the guided inquiry learning model positively impacted students' mathematical representation skills, as demonstrated by the data and analysis presented above.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research findings and discussion, it can be concluded that the guided inquiry learning model is effective in enhancing students' mathematical representation skills. This model encourages active participation, fosters student motivation, and supports the achievement of learning objectives by guiding students through structured, student-centered learning experiences. Therefore, mathematics teachers are encouraged to implement the guided inquiry model as an alternative to conventional instruction, particularly to improve students' ability to represent mathematical ideas in visual, symbolic, and verbal forms. For future researchers, it is important to consider classroom conditions and student engagement to ensure the successful application of this model. Providing at least two copies of the same worksheet for each group can facilitate more efficient group work and better comprehension of the problems. Additionally, establishing time limits for each phase of learning will help maintain classroom pacing, and extra attention should be given to subtopics such as solving systems of linear equations in two variables using the graphical method, which students often find challenging.

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