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Students' Responses to 7E Learning Cycle and Inquiring Minds Want to Know for Developing Mathematical Representation Ability

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ABSTRACT

This study aims to analyze student responses to the implementation of the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy, and to descriptively examine the alignment between these responses and the post-test results regarding students' mathematical representation abilities. Data were derived from a quasi-experimental study involving two Grade 8 classes at a public junior high school in Bandung, Indonesia, with the analysis focusing on the 29 students in the experimental class. Student responses were collected through questionnaires and analyzed descriptively, while post-test scores served as supporting data to identify patterns aligned with student responses. The results indicate that most students responded positively to the instruction. The activities within the 7E Learning Cycle stages and the Inquiring Minds Want to Know strategy gave students opportunities to express ideas, explore concepts, and use various forms of mathematical representation. Overall, the positive student responses showed a pattern consistent with the post-test results. Although a few students showed a discrepancy between their overall response scores and post-test results, their responses to questionnaire indicators related to mathematical representation abilities aligned with the post-test outcomes. These findings suggest that the instruction generally elicited a positive response and fostered student engagement in mathematical representation activities.

Keywords: 7E Learning Cycle; Inquiring Minds Want to Know; mathematical representation ability; students' responses

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INTRODUCTION

Mathematical representation ability is essential for students to solve problems, including those encountered in everyday life. This ability also helps students understand higher-level mathematical concepts (Hariyani et al., 2023). From the moment students begin reading and understanding a problem, they need mathematical representation ability to interpret the information provided, determine appropriate solution strategies, and communicate their reasoning. Therefore, mathematics learning should provide opportunities for students to develop this ability continuously.

However, various studies have found that students still have insufficiently developed mathematical representation ability (Mataheru et al., 2021; Yuhasriati et al., 2022). Students are also not yet accustomed to using this ability, particularly in geometry. Geometry requires students to translate information among verbal, visual, and symbolic representations. For example, to solve problems related to the Pythagorean Theorem, students must identify the dimensions of a right triangle, construct an appropriate diagram, express the relationships among its sides symbolically, and explain the solution. This illustrates the close relationship between geometry learning and mathematical representation ability.

Therefore, a learning model is needed that supports the development of mathematical representation ability. One such model is the 7E Learning Cycle model. The 7E Learning Cycle consists of seven phases: Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate (Musfiroh et al., 2024). In the Elicit phase, students activate and express their prior knowledge as a basis for understanding new concepts and solving problems related to prerequisite knowledge. In the Engage phase, students are encouraged to use their mathematical representation ability by responding to teacher-posed questions. Similarly, the Explore, Explain, Elaborate, Extend, and Evaluate phases give students opportunities to use and communicate mathematical representations through different learning activities.

One learning strategy that can be integrated into the 7E Learning Cycle model is the Inquiring Minds Want to Know strategy. This strategy emphasizes using questions as triggers to arouse student interest and motivation to participate in the lesson (Resweda et al., 2025). At the beginning of the lesson, the teacher presents thought-provoking questions, and students then discuss and propose initial answers in groups. Rather than immediately confirming whether the answers are correct or incorrect, the teacher collects students' ideas and allows them to reconsider and discuss which responses are most appropriate. This implementation aligns well with the Elicit and Engage phases of the 7E Learning Cycle because these phases emphasize students' prior knowledge, curiosity, and active engagement at the beginning of the learning process.

Previous studies have discussed the 7E Learning Cycle in relation to various learning outcomes and mathematical competencies (Cherono et al., 2021; Nurochmah et al., 2021; Komariah et al., 2021; Rofiq et al., 2021). Research by Nurochmah et al. (2021) examined the application of the 7E Learning Cycle to students' mathematical communication ability, while Cherono et al. (2021) investigated its application to students' learning outcomes in biology. Komariah et al. (2021) examined the 7E Learning Cycle combined with PowerPoint, GeoGebra, and guided student worksheets in relation to junior high school students' mathematical representation ability. Collectively, these studies have primarily focused on students' learning outcomes or mathematical competencies. However, relatively little attention has been given to how students respond to integrating the 7E Learning Cycle model with the Inquiring

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Minds Want to Know strategy, particularly in learning designed to support mathematical representation ability.

Students' responses matter because they reveal how students perceive and experience an instructional approach. Positive responses may indicate students' interest, engagement, and acceptance of the learning activities. However, positive perceptions of learning do not necessarily correspond directly to students' academic performance. Therefore, examining the correspondence between students' responses and their mathematical representation performance may provide a more comprehensive understanding of their learning experiences.

Based on this gap, this study aims to analyze students' responses to mathematics learning through the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy and to descriptively examine the correspondence between students' responses and their mathematical representation posttest performance. The response indicators examined in this study include students' interest and engagement in the learning process, their perceptions of the benefits of the learning activities, and their participation during mathematics learning. Rather than re-examining the instructional model's effectiveness in improving mathematical representation ability, this study focuses on students' perceptions of the learning experience and the correspondence between their responses and posttest performance. This focus offers an additional perspective on implementing the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy, beyond analysis of learning outcomes alone.

METHOD

Research Design and Setting

This study used a descriptive research approach based on data from a quasi-experimental study with a nonequivalent pretest–posttest control group design. The original study involved an experimental class and a control class; however, the present study focused specifically on students in the experimental class who received mathematics instruction through the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy. The analysis aimed to examine students' responses to the learning process and to descriptively explore the correspondence between their responses and mathematical representation posttest performance.

Participants, Instruments, and Procedures

The participants were 29 eighth-grade students from a public junior high school in Bandung, Indonesia. In the original study, two classes were selected using purposive sampling, with one class serving as the experimental group and the other as the control group. For the present analysis, researchers included only students from the experimental class because the response questionnaire was administered to students who experienced the instructional intervention.

This analysis used two instruments: a mathematical representation test and a student response questionnaire. The mathematical representation test consisted of items on the Pythagorean Theorem designed to assess students' mathematical representation ability. Although the original study administered the test as both a pretest and posttest, the present analysis used only posttest scores. Before administration, researchers' pilot-tested the items and analyzed their validity, reliability, difficulty level, and discriminatory power; the results indicated that the items were suitable for the study.

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Researchers administered the student response questionnaire after the intervention to identify students' perceptions of mathematics learning through the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy. The questionnaire measured students' responses toward various aspects of the learning process, including their interest and engagement, perceived benefits of the learning activities, and participation during mathematics learning.

Data Analysis

Researchers analyzed the questionnaire data descriptively using response scores, frequencies, percentages, and response categories. To examine the correspondence between students' responses and mathematical representation performance, researchers compared each student's questionnaire score with their posttest score. The analysis identified both corresponding patterns and cases in which response scores differed from posttest performance. Researchers then examined the discrepant cases descriptively at the individual level to provide a more detailed interpretation of the relationship between students' perceptions of the learning experience and their mathematical representation performance.

RESULTS

Table 1 shows the number of students in the experimental class for each response category to the learning process. This categorization is part of the analysis of the experimental class student response questionnaire results regarding mathematics learning using the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy. Each category was created within a specific range, based on the maximum score (100), minimum score (25,276), range (74,724), and difference score (14,945) from the student response questionnaire. Previously, the ordinal student response questionnaire data was transformed into interval data using the Method of Successive Intervals (MSI) with Microsoft Excel 2013 and stat97.xla. The questionnaire data was then processed to obtain the data shown in Table 1.

Table 1 shows that students in the experimental class provided diverse responses to the learning process. The number of students who responded to the learning process was approximately equal, ranging from 4 to 6. Furthermore, no student responded negatively. In fact, 14 students in the experimental class responded positively to the mathematics learning. This figure nearly exceeded half of the total number of students in the experimental class. Furthermore, the number of students who responded very positively and positively exceeded half of the total number of students in the experimental class. This indicates that most students in the experimental class responded very positively and positively to the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy.

Table 1. Categorization of Student Responses

No	Range (%)		Student Response Category	Number of Students
1	85,055	100,000	Very Positive	6
2	70,110	85,055	Positive	14
3	55,166	70,110	Moderately Positive	5
4	40,221	55,166	Negative	4
5	25,276	40,221	Very Negative	0

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Table 2 presents the descriptive statistics of students' mathematical representation posttest scores after participating in mathematics learning through the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy. The 29 students' scores ranged from 59 to 100, with a mean of 89.03 and a standard deviation of 13.33. At the group level, this posttest performance shows a general pattern broadly consistent with the predominantly positive student responses presented in **Table 1**.

Table 2. Descriptive Statistics of Students' Mathematical Representation Posttest Score

N	Minimum	Maximum	Mean	Standard Deviation
29	59	100	8903	13,327

DISCUSSION

Further analysis in **Table 1** identified the students with very positive responses as A1, A9, A16, A19, A21, and A26. These six students stated that the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy made mathematics learning more engaging and less boring. Although mathematics is a compulsory subject, they do not view it as a burden or a compulsion; instead, they enjoy participating in mathematics lessons. They also feel that learning mathematics not only provides new knowledge and fosters conceptual understanding, but also offers tangible benefits for solving everyday problems. Research shows that one underlying factor behind students' high interest in learning is the perceived benefit of the learning process and their satisfaction with the activities and knowledge gained during lessons (Harefa, 2023). Furthermore, they feel increasingly motivated to participate in group discussions, complete worksheets (LKPD), and actively engage in the learning process. This is not solely due to the teacher's supervision, but also because they enjoy participating in mathematics lessons using the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy. Student interest and motivation are among the most important factors influencing student learning outcomes (Inganah et al., 2023).

Students generally responded positively to the learning activities and obtained an average posttest score relatively close to the maximum possible score. However, this general pattern at the group level does not necessarily indicate that each student's response corresponded with their posttest performance. **Table 3** examines this individual-level correspondence further. This general pattern may be understood in relation to the learning activities provided during the intervention. During the learning activities, students were encouraged to express mathematical ideas in various forms. For example, they responded to questions related to the Pythagorean Theorem, interpreted information presented through PowerPoint, and represented mathematical concepts verbally, visually, and symbolically. The tasks also required students to transform contextual problems into diagrams or mathematical models and, conversely, interpret mathematical representations in contextual forms. These findings align with Harahap et al. (2018), who reported that the 7E Learning Cycle supported students' mathematical representation, particularly in visual and written forms. Similarly, Komariah et al. (2021) found that integrating the 7E Learning Cycle with PowerPoint-based learning activities supported students' mathematical representation ability and participation in the learning process.

The Inquiring Minds Want to Know strategy also gave students opportunities to express their initial ideas in response to stimulating questions at the beginning of the lesson. These activities may help explain why students generally perceived the learning activities positively and why the instructional process provided opportunities for them to engage in mathematical representation. The stigma

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surrounding mathematics is not solely due to the difficulty of the subject matter; rather, it is more significantly influenced by the teaching models and strategies employed by the instructor, as well as how the instructor structures the learning process to make it feel relatable to students and centered on student activity (Supriyatna, 2026).

Table 3 compares posttest scores with each student's responses to learning using the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy. Overall, the researchers found good alignment between the posttest results and student responses. These findings are consistent with several recent studies on mathematics education, which report that improvements in posttest results are accompanied by positive to very positive student responses (Daulay & Siregar, 2026; Isma et al., 2026; Rainuny et al., 2026). Theoretically, students' learning interest is directly proportional to their learning outcomes. This is supported by Harefa (2023) and Hany and Setyaningsih (2021), which found a significant relationship between learning interest and student learning outcomes and showed that learning interest significantly influences learning outcomes.

However, researchers also found a possible discrepancy between posttest scores and response categories for some students. One student, coded A9, responded positively with a posttest score below the Minimum Competency (KKM), or 59. A student, coded A8, responded positively with a posttest score below the Minimum Competency (KKM), or 59. Two students, coded A10 and A22, responded negatively with posttest scores above 90 and 80, respectively. This discrepancy raises further questions about why posttest scores reflect students' representational ability achievement, which may not align with their responses to the lesson. Possible causes may be internal or external. For example, students may not yet have developed the critical thinking ability to assess or evaluate mathematics learning, leading to inappropriate questionnaire responses (Sachdeva & Eggen, 2021). Alternatively, further examination may reveal a discrepancy for each indicator.

Table 3. Comparative Data of Posttest Scores and Response Categories for Each Student

No	Student	Posttest Score	Student Response Category	No	Student	Posttest Score	Student Response Category
1	A1	100	Very Positive	16	A14	91	Positive
2	A21	100	Very Positive	17	A15	91	Positive
3	A26	100	Very Positive	18	A11	84	Positive
4	A19	88	Very Positive	19	A29	78	Positive
5	A16	81	Very Positive	20	A8	59	Positive
6	A9	59	Very Positive	21	A5	100	Moderately Positive
7	A3	100	Positive	22	A2	94	Moderately Positive
8	A7	100	Positive	23	A18	91	Moderately Positive
9	A13	100	Positive	24	A6	88	Moderately Positive
10	A20	100	Positive	25	A27	84	Moderately Positive
11	A23	100	Positive	26	A10	94	Negative
12	A24	100	Positive	27	A22	84	Negative
13	A28	100	Positive	28	A25	66	Negative
14	A4	97	Positive	29	A12	59	Negative
15	A17	94	Positive				

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Table 4 shows the student response scores from the student response questionnaire results for the learning, where the questionnaire results were suspected to be inconsistent with the posttest results. The scores have been adjusted based on the positive and negative statements. Although student A8 obtained an unsatisfactory posttest score, the student's responses were very good, with scores of 4 and 5 for almost all statements. Based on the student response questionnaire indicators, student A8 shows high interest and sincerity in participating in mathematics learning. In addition, learning with the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy provides high benefits to the student. Student A8 also feels more active in participating in the learning process. After further review, the posttest results align with the questionnaire results for indicators related to the effect of learning on mathematical representation ability. Student A8 feels that the mathematics learning has not significantly influenced his mathematical representation ability. This is evident from the score for statement number 12, where student A8 gave a score of 3. Thus, upon further examination, the posttest score was actually appropriate for the questionnaire indicators related to mathematical representation ability itself.

Student A9's situation was quite different from student A8's: student A9 gave a score of 5 for almost all statements and only a score of 1 for statement number 8. This indicates that student A9 has a very high interest and commitment in participating in mathematics learning, and that the 7E Learning Cycle model and the Inquiring Minds Want to Know strategy provided significant benefits for him. However, student A9 felt that the mathematics learning activities were still not optimal for his mathematical representation ability. This answers the researcher's follow-up question about the discrepancy between the questionnaire and posttest results, as activities related to mathematical representation ability were not implemented optimally, which impacted student A9's achievement.

In student A10, researchers indicated that their interest in participating in mathematics learning was high. However, their commitment and activity, as well as the benefits of mathematics learning, both in general and in improving mathematical representation ability, were still considered lacking. In contrast, for student A22, researchers indicated that the benefits of mathematics learning were clearly felt overall but had not significantly affected their mathematical representation ability. Similar to student A9, further analysis of the questionnaire results revealed concordance between the questionnaire results and posttest scores when examining the questionnaire indicators related to the benefits of mathematics learning through the application of the 7E Learning Cycle learning model and the Inquiring Minds Want to Know strategy in improving students' mathematical representation ability.

In one study, one factor contributing to the discrepancy between the questionnaire results and posttest scores was students' lack of seriousness when completing the questionnaire (Harefa, 2023). However, further analysis revealed that all four students (A8, A9, A10, and A22) were serious in completing the student response questionnaire. Furthermore, the researchers structured the questionnaire optimally, including a predefined grid and both positive and negative statements. This structure, which wasn't entirely positive or entirely negative, helped prevent students from completing it haphazardly (Nurfallah & Pradipta, 2021). Another possible reason is that students are not always accurate in assessing their own abilities. Students with lower ability tend to rate themselves higher than their actual test results (Leon & Lipnevich, 2026), and students' self-assessments are less effective at predicting achievement compared to objective measures (Raemy et al., 2026).

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Table 4. Questionnaire Response Scores for Students Who Experienced a Discrepancy Between Their Questionnaire Scores and Their Posttest Scores

No	Student	Statement Number											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	A8	5	4	4	4	4	4	4	4	4	5	4	3
2	A9	5	5	5	5	5	5	5	1	5	5	5	5
3	A10	4	3	3	4	3	3	3	4	3	3	4	3
4	A22	3	3	2	5	4	3	3	2	3	3	4	4

CONCLUSION

This study concludes that most students in the experimental class responded positively to the learning process, and that students demonstrated relatively high mathematical representation posttest performance after receiving the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy, with a mean score of 89.03. This is supported by the stages of the 7E Learning Cycle model and the activities corresponding to the Inquiring Minds Want to Know strategy, both of which provide opportunities for students to use their mathematical representation ability in various ways. However, there were four students whose questionnaire scores did not match the overall posttest results. However, they did match indicators related to mathematical representation ability. This study suggests that the 7E Learning Cycle model integrated with the Inquiring Minds Want to Know strategy was generally well received by students and provided supportive learning experiences for developing mathematical representation ability. The few discrepant cases highlight the importance of considering individual differences in students' responses and performance. Recommendations for further research include further statistical analysis of the relationship between questionnaire response data and student posttest scores.

DECLARATIONS

Author Contributions: NSP: Conceptualization, Methodology, Writing – original draft. DSH: Data curation, Formal analysis, Visualization, Writing – review & editing. Both authors contributed equally to the preparation of this manuscript and have approved the final version.

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Data Availability: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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