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The Effect of Mind Map-Assisted Guided Inquiry on Students' Critical Thinking in Earth Science

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ABSTRACT
Students at SMPN 2 Pariaman demonstrate relatively low critical thinking skills, mainly due to teacher-centered instructional practices that limit students' active participation and the limited use of innovative learning models and instructional media, particularly in teaching abstract science concepts. This study aimed to investigate the effect of the Guided Inquiry learning model supported by Mind Map media on the critical thinking skills of eighth-grade students studying Earth's Structure and Its Development. A quasi-experimental method with a Nonequivalent Control Group Design was employed. The sample consisted of 62 students selected through purposive sampling and divided into an experimental group, which received Guided Inquiry instruction assisted by Mind Map media, and a control group, which received conventional instruction. Data were collected using a validated critical thinking test, observation sheets, and a student response questionnaire and were analyzed using descriptive and inferential statistical techniques. The findings revealed that students taught through the Guided Inquiry model integrated with Mind Map media demonstrated significantly better critical thinking skills than those who experienced conventional learning. Furthermore, the implementation of the learning model and students' responses were categorized as good, indicating that the approach was effectively implemented and positively accepted. These findings suggest that integrating Guided Inquiry with Mind Map media is an effective strategy for fostering students' critical thinking skills in science learning, particularly on the topic of Earth's Structure and Its Development.

1. INTRODUCTION

The current era is often referred to as the 21st century, characterized by rapid advancements in technology, communication, and information. These changes have not only impacted daily life but have also transformed the educational landscape, resulting in increasingly complex demands regarding learner competencies (Rosnaeni, 2021), specifically the necessity for students to develop robust digital literacy and technology readiness to engage optimally and prepare themselves for future educational ecosystems (Firdaus & Nurohman, 2025). Mastery of academic content alone is no longer sufficient, as learners are also required to possess a range of skills aligned with 21st-century needs (Srirahmawati et al., 2024). In response to this context, a 21st-century skills framework known as the 6Cs has emerged. These six aspects comprise: critical thinking and problem-solving, creativity, character building, civic awareness, collaboration, and communication (Srirahmawati et al., 2024). Consequently, learners must be equipped with these competencies to enable them to compete and adapt in the future.

These 21st-century skills are essential for success in both professional and daily life; consequently, efforts must be made to enhance them within the educational sphere. Such

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skills are fundamental for learners to improve their ability to communicate effectively, collaborate productively, develop a critical mindset for addressing and solving problems, whether individually or in groups, and foster an innovative and creative spirit across various aspects of life (Srirahmawati et al., 2024). These skills equip learners with the necessary tools to navigate life's challenges, the demands of the workforce, and the ever-evolving landscape of technology (Rosnaeni, 2021).

One concrete manifestation of the Indonesian government's efforts to enhance the quality of national education is the transition from the 2013 Curriculum to the Merdeka Curriculum. The Merdeka Curriculum prioritizes learner-centered learning principles. In practice, this curriculum affords greater flexibility in both designing and conducting classroom learning activities; it also grants educators increased autonomy to design and develop learning experiences aligned with the specific needs, potential, and characteristics of individual students, as well as the freedom to structure instruction that is relevant to the conditions and characteristics of students at each respective school (Neliwati et al., 2023).

The Merdeka Curriculum serves as a solution to strengthen 21st-century skills by offering learning flexibility and fostering student character development through project-based learning (Mongkau et al., 2024). Critical thinking is a fundamental competency that every student must possess (Priadi et al., 2021). Critical thinking skills are essential for shaping students into individuals capable of adapting to and overcoming the complex challenges of today's world. The Merdeka Curriculum emerges as an innovative approach that positions the student as the central subject of the learning process (Kollo & Suciptaningsih, 2024). Critical thinking ability is crucial for global competitiveness in an increasingly interconnected era of globalization. A student's capacity for critical thinking implies an ability to consider various factors and make active, rational decisions (Yuniati et al., 2024). including the vital capacity to develop critical ecological awareness to solve complex environmental issues facing society today (Firdaus, 2025).

Findings from observations and interviews with science teachers at SMPN 2 Pariaman indicate that this situation also applies to eighth-grade students. Several issues were identified, including students' limited ability to analyze various phenomena, a lack of questioning activity, and a learning process still dominated by the teacher. Science instruction in the classroom tends to be one-way, with the teacher retaining primary control. Consequently, active student participation in learning activities is low, resulting in a lack of motivation to develop critical thinking skills when grasping the subject matter. This is particularly evident when teachers pose questions requiring reasoning or in-depth analysis; most students provide only brief responses and tend to simply mimic solution examples previously presented. These conditions suggest that opportunities to foster critical thinking skills through scientific inquiry have not been fully optimized. This condition is consistent with recent findings indicating that teachers often face substantial institutional barriers, limited practical training, and a lack of support systems when attempting to implement inquiry-based approaches in the classroom, which ultimately hinders students' active participation (Winarto et al., 2026).

Efforts to realize science instruction that emphasizes inquiry activities and the development of critical thinking skills highlight an urgent need for an ideal learning model, one that affords students ample opportunity to construct and discover concepts for themselves through scientific processes. With such a model, students no longer act merely as passive recipients of information from the teacher. Guided inquiry is considered a suitable model to meet these needs. It serves as an approach capable of enhancing students' critical thinking skills by emphasizing the process of discovering concepts and the relationships between them through systematic stages: formulating a problem, proposing a hypothesis, collecting data, analyzing data, and drawing conclusions (Cahyani et al., 2025).

This approach is grounded in constructivism, emphasizing active learner participation in the process of discovering concepts, as well as ideas and scientific principles, under the guidance and facilitation of a teacher. This process unfolds through a series of stages, including posing questions, conducting observations, performing experiments, and engaging in discussions directed by the educator. The educator plays a role in providing a structured and purposeful inquiry framework while allowing learners the flexibility to actively construct their own knowledge (Fitriani et al., 2024). This model was selected for its ability to engage learners through a coherent and directed sequence of investigation. Through this process, learners not only gain a theoretical understanding of concepts but also develop the ability to think scientifically in a more systematic manner (Rambe et al, 2020). The primary reason for employing guided inquiry in science education is that learning science extends beyond the mere memorization of concepts; the model aims to foster structured scientific thinking processes, thereby supporting the overall enhancement of learners' critical thinking skills.

Critical thinking is an intellectual ability that enables individuals to carefully and objectively examine and evaluate the veracity of information, identify the underlying assumptions behind thoughts or actions, and formulate valid conclusions based on empirical evidence and deep, comprehensive analysis (Abrami et al., 2008). According to Facione (2015), the scope of critical thinking encompasses various cognitive processes, ranging from interpreting data, breaking down information, and evaluating evidence to drawing conclusions and articulating arguments. Furthermore, this skill is linked to the ability to make decisions and apply newly acquired knowledge. In other words, critical thinking goes beyond the mere accumulation or memorization of knowledge, placing greater emphasis on the learning process itself (Pradana et al., 2020).

The abstract nature of the subject matter regarding Earth's structure and its evolution, specifically geological objects and processes that cannot be directly observed by students, necessitates a structured learning model. Such a model enables students to logically and systematically connect real-world geological phenomena with scientific concepts. This approach is considered effective for honing students' critical thinking skills, as it provides ample opportunity for them to actively engage in formulating problems, designing experimental procedures, processing and interpreting data, and drawing conclusions independently, all while remaining under the guidance and direction of the educator. However, to optimize this model for abstract topics concerning Earth's structure, visual media capable of simplifying complex concepts are required. Previous studies highlight that providing or developing cognitive stimulus media for abstract and complex materials is a significant challenge for educators, yet it is crucial because appropriate media can drastically improve conceptual understanding, metacognition, and student engagement (Djara et al., 2026). Field observations indicate that the use of visual learning media at the school remains very limited and lacks variety. As a solution, the use of mind maps offers an effective alternative.

A mind map is a visual learning tool used to help students organize and map out instructional material, thereby making the content easier to comprehend and analyze in depth. As an information-organizing tool, the mind map falls into the category of "cognitive organizers." Its function is to stimulate brain activity, enabling the thinking process to operate more effectively and efficiently (Chen & Jeng-Fung, 2014). Mind maps have not yet been implemented in science lessons at the school in question; this is despite the fact that this tool, which relies on graphics, colors, and keywords, plays a crucial role in helping students systematically and structurally map the interrelationships between geological concepts. According to Syawaluddin et al. (2021), the use of mind maps has been shown to contribute positively to enhancing students' critical thinking skills. This occurs because students gain a learning experience that is more meaningful, organized, and systematically structured.

Various prior studies have demonstrated that the guided inquiry learning model and mind mapping media are each capable of enhancing students' critical thinking skills. These findings indicate that both approaches hold the potential to improve the quality of science education. However, most research has examined guided inquiry and mind mapping as separate, independent entities.

Studies on guided inquiry tend to focus on the process of scientific investigation, whereas research on mind mapping generally emphasizes conceptual mastery. Consequently, the mechanisms by which the integration of these two approaches might complement each other in fostering students' critical thinking skills remain insufficiently explained through empirical evidence. Furthermore, previous studies have not clarified how mind maps can serve as cognitive scaffolding to support the various stages of inquiry. As a result, the conceptual relationship between the inquiry process and visual representation in the development of critical thinking skills has not yet been fully elucidated. Research integrating the guided inquiry model with mind mapping, particularly regarding the topic of Earth's structure and its evolution at the junior high school level, remains relatively limited, failing to provide a comprehensive picture. Most prior studies have focused primarily on conceptual mastery, whereas research analyzing how the integration of guided inquiry and mind mapping facilitates the development of specific critical thinking skill indicators remains scarce. Therefore, this study aims to address this gap by examining the impact of a guided inquiry learning model supported by mind mapping on students' critical thinking skills regarding the topic of Earth's structure and its evolution.

The novelty of this research lies in the development of an integrated approach that positions mind maps as cognitive scaffolding within the stages of inquiry. In this study, mind maps serve not merely as a tool for summarizing content but as a means to help students organize information derived from investigations, link evidence to scientific concepts, construct arguments, and draw conclusions systematically.This research offers a conceptual model illustrating how visual representations can reinforce the inquiry process to foster the development of students' critical thinking skills. Unlike previous studies that tended to examine these elements in isolation, this research makes both conceptual and empirical contributions by explaining how integrating guided inquiry syntax with mind mapping functions as a learning mechanism that supports the development of critical thinking indicators within the abstract context of Earth's structure and its evolution.

2. METHODOLOGY

This study employs a quantitative approach using a quasi-experimental design. This design involves dividing the subjects into two groups: an experimental group that receives the treatment and a control group that does not. In the control group, there is no full control over the variables influencing the conduct of the experiment. The design employed in this study is the Nonequivalent Control Group Design (Sugiyono, 2022; 2024). Sampling is conducted when the population is too large to be studied in its entirety (Sonia et al., 2023). In this design, the assignment of experimental and control classes is not determined through a lottery or random selection. The two groups subsequently receive different treatments: the experimental class undergoes instruction using the guided inquiry model, while the control class participates in learning activities using a conventional, lecture-based method.

The research was conducted in three stages: preparation, implementation, and completion. The preparation stage involved developing instruments based on critical thinking skill indicators, namely interpretation, analysis, evaluation, inference, and explanation. The implementation stage began with administering a pretest to both the experimental and control classes; subsequently, the experimental class underwent instruction using a guided inquiry model supported by mind-mapping media, while the control class received instruction via a conventional lecture-based method. Throughout the learning process, observations were made regarding the implementation of the lesson in accordance with the stages of the guided inquiry model utilizing mind-mapping media. Upon completion of all instructional activities, both classes took a posttest, and students in the experimental class filled out a response questionnaire. The completion stage involved processing and analyzing the research data to arrive at the study's conclusions.

The study population consisted of all Grade VIII students at SMPN 2 Pariaman during the 2025/2026 academic year. Sampling is employed when the population is too large to be studied in its entirety (Sonia et al., 2023). The sample was selected using a purposive sampling technique based on comparable academic abilities, as evidenced by the daily Science assessment (PH) scores from the previous semester. The research sample comprised 31 students from class VIII.1 (the experimental group) and 31 students from class VIII.2 (the control group).

Research data were collected using test instruments, observation sheets, and questionnaires. The instruments were developed based on critical thinking skill indicators, including interpretation, analysis, evaluation, inference, and explanation. The test instrument consisted of essay questions designed to assess students' critical thinking skills in depth and comprehensively. An instructional implementation observation sheet was used to evaluate the degree of alignment between actual classroom practice and the planned stages of the guided inquiry model supported by mind-map media. Additionally, a student response questionnaire was used to gather data regarding students' reactions, perceptions, and learning experiences during the instruction.

The first step in data analysis involves conducting prerequisite tests. These include a normality test, performed using the Lilliefors technique to verify the distribution of the obtained data, and a homogeneity test, conducted using the F-test (Fisher's test) to ensure the equality of variances among the data groups being compared. Once these analytical prerequisites are met, the subsequent stage is hypothesis testing via a t-test; this aims to determine whether there is a significant difference in students' critical thinking skills between the experimental group (using the guided inquiry model assisted by mind maps) and the control group (using conventional instruction).

The research instrument, consisting of an essay test, underwent validity and reliability testing prior to its use in the study. Validity was assessed using the Pearson Product Moment correlation on the instrument's trial results, while reliability was calculated using the Cronbach's Alpha coefficient to ensure the instrument's consistency in measuring students' critical thinking skills. Finally, the research data were analyzed using a series of statistical procedures carried out in a structured, step-by-step manner.

Table 1. Validity and Reliability Test Results

Instrument	Validity	Reliability
Essay Test	12 Valid Questions and 3 Invalid Questions	0.7895 (High)

The test instrument was first pilot-tested on students outside the research sample. Validity testing using the Pearson Product-Moment correlation showed that all test items had correlation coefficients exceeding the r-table value, thereby confirming their validity. Furthermore, the reliability test yielded a Cronbach's Alpha value of 0.7895, falling into the high category, indicating that the instrument was suitable for use in the study.

3. RESULTS AND DISCUSSION

3.1 Students' Critical Thinking Skills

3.1.1. Descriptive Analysis

Table 2. Descriptive Analysis of Pretest and Posttest

Data	Number of Students	The highest score	Lowest Value	Average
Experimental Pretest	31	40	17	27,88

Data	Number of Students	The highest score	Lowest Value	Average
Control pretest	31	40	19	29,30
Experimental post-test	31	83	60	78,09
Control post-test	31	73	50	57,52

Research results indicate that the initial abilities of students in both the experimental and control classes were relatively comparable prior to the intervention. This suggests that the two groups started from a similar baseline, meaning that any differences observed at the end of the instruction could be more reasonably attributed to the applied intervention rather than to pre-existing disparities in student ability. Although the initial abilities of both groups were relatively equal, the average pretest scores were low relative to the maximum possible score. This indicates that the students' critical thinking skills had not yet optimally developed prior to the intervention. This low level of initial ability is likely linked to an instructional process dominated by a teacher-centered approach, wherein students primarily received information rather than engaging in inquiry and problem-solving activities. Furthermore, a lack of variety in instructional models and media meant that students were unaccustomed to developing skills such as interpreting information, analyzing problems, evaluating evidence, drawing inferences, and articulating logical explanations. These findings align with the study's initial observations and are supported by Priadi et al. (2021) and Fitriani et al. (2024), who state that conventional teaching methods tend to limit the development of students' critical thinking skills.

Following the instructional process, the class taught using the Guided Inquiry model supported by mind-mapping media demonstrated a greater improvement in critical thinking skills compared to the class receiving conventional instruction. These findings indicate that implementing this learning model fosters a more active learning process through activities involving inquiry, information analysis, and the formulation of conclusions based on gathered evidence. Such activities provide students with opportunities to develop various indicators of critical thinking, including interpreting information, analyzing problems, evaluating evidence, drawing inferences, and providing logical explanations.

These research findings align with the study by Fitriani et al. (2024), which demonstrates that the Guided Inquiry model is effective in enhancing critical thinking skills by encouraging students to actively engage in the process of scientific inquiry. These results are further supported by Syawaluddin et al. (2021), who state that mind maps assist students in organizing concepts and clarifying the relationships between them, thereby making the process of understanding the material more systematic. By combining the Guided Inquiry model with mind maps, students not only gain learning experience through the independent discovery of concepts but also develop the ability to organize and connect the information they acquire into a more structured framework. This approach renders the learning process more meaningful and contributes to the improvement of students' critical thinking skills regarding the topic of Earth's Structure and Its Evolution.

3.2 Data on Students' Initial Abilities (Pre-test and Post-test)

3.2.1 Normality test

A normality test was conducted to determine whether the sample data followed a normal distribution pattern. This test is a key prerequisite for selecting the appropriate statistical technique for subsequent data analysis. In this study, the normality test was performed using the Lilliefors test at a 5% significance level. Data are considered normally distributed if the maximum calculated L-value is less than the L-table value. The normality test results for the pretest and posttest data, for both the experimental and control classes, are presented in Table 3.

Table 3. Pretest Normality Test Results

	Pretest	
	Experiment	Control
L max	0,132	0,126
L table	0,159	
Description	Normally Distributed Data	
	Posttest	
	Experiment	Control
L-Max	0,142	0,128
L table	0,159	
information	Normally Distributed Data	

Based on the table, the normality test results indicate that the maximum calculated L-values (L-count) for the experimental class were 0.132 for the pretest data and 0.142 for the posttest data, respectively. These results demonstrate that the research data met the assumption of normality, making them suitable for parametric statistical analysis, specifically the independent samples t-test, to examine the difference in critical thinking skills between the experimental and control classes.

3.2.2 Homogeneity Test

The homogeneity test aims to determine whether the variances of the sample data are equal or homogeneous. In this study, the Fisher (F) test was used to assess homogeneity at a 5% significance level. The decision was based on a comparison between the calculated F-value and the F-table value. If the calculated F-value is less than or equal to the F-table value, the data variances are considered homogeneous; conversely, if the calculated F-value is greater than or equal to the F-table value, the variances are considered non-homogeneous. The results of the homogeneity test for this study are presented in Table 4.

Table 4. Pretest Homogeneity Test

	Pretest	
	Experiment	Control
F count	0,87	
F table	1,84	
information	Homogeneous Variances	

Based on Table 4, the homogeneity test results indicate that the calculated F-value of 0.87 is lower than the F-table value of 1.84. These results demonstrate that the variances of the pretest data for the experimental and control classes are homogeneous.

Table 5. Posttest Homogeneity Test

	Posttest	
	Experiment	Control
F count	1,78	
F table	1,84	
information	Homogeneous Variances	

Based on Table 5, the homogeneity test results indicate that the calculated F-value of 1.78 is lower than the critical F-value of 1.84. Thus, the data meet the assumption of homogeneity, making them suitable for parametric statistical analysis during the hypothesis testing stage.

3.2.3 Hypothesis Testing

Hypothesis testing was conducted to determine whether the research hypothesis was accepted or rejected. This test aimed to examine the effect of a mind-map-assisted guided inquiry model on students' critical thinking skills regarding the topic of Earth's structure and its evolution. Since the prerequisite test results indicated that the data were normally distributed and variances were homogeneous, the analysis proceeded with a t-test. The decision-making criteria used were as follows:

If t-calculated ≤ t-table: There is no significant difference.
If t-calculated > t-table: There is a significant difference.
The complete t-test results are presented in Table 6 below.

Table 6. Pretest Hypothesis Test Results

	Pretest	
	Experiment	Control
t count	0,868	
t table	2,00	
information	There Is No Difference	

Based on Table 6, the independent samples t-test results for the pretest data show that the calculated t-value (0.868) is lower than the critical t-value (2.00). Thus, the two groups possessed relatively equivalent initial abilities, meaning that any difference in results observed after the treatment could be attributed to the implementation of the learning model. Consequently, the subsequent hypothesis testing was conducted using the posttest data.

Table 7. Posttest Hypothesis Test Results

	Posttest	
	Experiment	Control
t-count	14,01	
t-table	2,00	
information	There Are Differences	

Based on Table 7, the independent samples t-test results for the post-test data show that the calculated t-value (14.01) is greater than the t-table value (2.00). These results indicate a significant difference in students' critical thinking skills between the experimental and control classes following the intervention. Thus, the implementation of the Guided Inquiry learning model assisted by mind map media is proven to have a significant impact on improving students' critical thinking skills regarding the topic of Earth's Structure and Its Evolution. The data on achievement levels for each critical thinking indicator are presented below.

Table 8. Achievement of Critical Thinking Indicators

Critical Thinking Skill Indicators (Experiment)	% *Pretest*	% *Posttest*
Interpretation	32%	66%
Analysis	30%	85%
Evaluation	27%	80%
Inference	17%	76%
Explanation	6%	84%
Average	23%	77%

Based on the pretest and posttest results, students' creative thinking abilities improved across all indicators. The average achievement rose from 23% in the pretest to 77% in the posttest, representing a 54% increase. This improvement indicates that the implemented instructional process effectively facilitated the development of students' critical thinking skills. The gain occurred because the learning process provided students with more active learning experiences, offering opportunities to explore ideas, solve problems, engage in discussions, and communicate their thoughts. The experimentation indicator rose from 32% to 66%, an increase of 34%. This improvement demonstrates that students were becoming capable of designing or conducting experiments to find solutions to problems. This progress resulted from opportunities during the lesson to engage in exploration and directly test various alternative problem-solving approaches. Nevertheless, this indicator showed the lowest posttest achievement compared to the others. This may be attributed to the fact that designing experiments requires more complex skills, such as identifying variables, formulating procedures, and predicting experimental outcomes. Since such abilities typically develop through repeated practice, the improvement in this area was not as pronounced as in the other indicators.

The analysis indicator rose from 30% to 85%, representing a 55% increase. These results indicate that students became increasingly capable of identifying key information, discovering relationships between concepts, and breaking down problems into simpler components. This improvement is likely attributable to learning activities that required students to analyze phenomena, identify the causes of problems, and discuss various potential solutions. Such activities trained students to think systematically, leading to a significant development in their analytical skills.

The evaluation indicator rose from 27% to 80%, a 53% increase. These results show that students became more adept at assessing the quality of ideas, comparing alternative solutions, and making decisions based on logical reasoning. This improvement is thought to stem from learning activities where students were frequently asked to respond to discussion outcomes, evaluate proposed solutions, and defend their opinions using relevant evidence. These activities fostered reflective and critical thinking skills, thereby enhancing evaluative capabilities.

The inference indicator rose from 17% to 76%, a 59% increase. This improvement demonstrates that students became increasingly capable of drawing conclusions based on data, facts, or information gathered during the learning process. This gain was likely influenced by learning activities that provided opportunities for students to interpret observations, connect various pieces of information, and independently formulate conclusions. This process helped students develop the ability to make more accurate inferences.

The explanation indicator showed the highest increase, rising from 6% to 84%, a gain of 78 percentage points. This substantial increase indicates that students made significant progress in explaining ideas, providing reasons, and logically communicating their thought processes. The low pre-test scores suggest that, prior to instruction, students struggled to articulate reasons or explain their thinking. Post-instruction, these abilities improved as students engaged more frequently in presentations, group discussions, question-and-answer sessions, and the sharing of problem-solving results. Such activities encouraged students to organize their ideas and present arguments more clearly.

Overall, all indicators showed improvement, albeit to varying degrees. The order of improvement, from highest to lowest, was: explanation (78%), inference (59%), analysis (55%), evaluation (53%), and experimentation (34%). The disparity in improvement across indicators suggests that the instruction was more effective at developing students' abilities to explain ideas, draw conclusions, analyze information, and evaluate solutions than at fostering skills in designing or conducting experiments. This may be attributed to the fact that the learning activities provided more opportunities for discussion, expressing opinions, and problem-solving than for independently designing experiments.

The findings of this study align with the research of Fitriani et al. (2024), which states that the Guided Inquiry model enhances critical thinking skills through structured inquiry activities. These results are also supported by Syawaluddin et al. (2021), who demonstrated that the use of mind maps helps learners organize concepts more systematically, thereby facilitating the processes of analysis, drawing conclusions, and formulating explanations. Integrating these two approaches fosters a learning experience that is more active and meaningful than conventional instruction.

3.3 Implementation of the Guided Inquiry Syntax

The learning model employed in this study is guided inquiry, based on Hanson's (2005) syntax. This syntax comprises five stages: orientation, exploration, concept formation, application, and closure. Generally, all five stages were implemented in every lesson. However, an adjustment was made to the concept formation stage during the third lesson. This adjustment was necessary because the material covered in the third lesson involved a relatively limited scope of concepts and was closely linked to the material in the fourth lesson. Although the material still required independent instruction, due to distinct learning objectives and competency achievement indicators, the concepts acquired by students during the third lesson were insufficient for constructing a complete and comprehensive mind map. Furthermore, the instruction was aligned with four Learning Objectives (LOs) regarding the structure of the Earth and its evolution; each LO was treated as a single learning cycle encompassing the stages of orientation, exploration, concept formation, application, and closure.

In light of this, the concept-formation activity involving mind map creation was not conducted separately during the third meeting; instead, it was integrated with the concept-formation activity of the fourth meeting. This integration aimed to enable students to connect concepts derived from both topics, thereby producing a more comprehensive mind map that clearly illustrates the interrelationships between concepts and fosters a more meaningful understanding. Consequently, the concept-formation phase was not omitted but rather carried out in the subsequent meeting as part of the overall learning sequence. This adjustment did not compromise the implementation of the guided inquiry model's procedural steps, as all stages were fully executed throughout the research process.

Table 7. Analysis of the Observation Sheet on the Implementation of the Guided Inquiry Model (Teacher)

Stages/Syntax	Percentage
Syntax 1: Orientation	87%
Syntax 2: Exploration	81%
Syntax 3: Concept Formation	81%
Syntax 4: Application	75%
Syntax 5: Closing	78%
Overall Percentage	81%

Based on Table 7, the average implementation rate of the guided inquiry model by the teacher was 81%. The highest implementation percentage was observed in the orientation phase (87%), while the lowest was in the application phase (75%). These findings indicate that the teacher implemented instruction according to the five stages of the guided inquiry model, orientation, exploration, concept formation, application, and closure, achieving a "good" implementation category. Implementation of the model from the students' perspective was measured using an observation sheet completed by an observer during the lesson. Observations were conducted to assess the extent of student engagement at each stage of the guided inquiry model in the experimental class. The observational data were then processed to determine the percentage of student activity implementation, as summarized in Table 8.

Table 8. Analysis of the Observation Sheet on the Implementation of the Guided Inquiry Model (Students)

Stages/Syntax	Percentage
Syntax 1: Orientation	86%
Syntax 2: Exploration	75%
Syntax 3: Concept Formation	78%
Syntax 4: Application	75%
Syntax 5: Closing	78%
Overall Percentage	78%

Based on Table 8, the average implementation rate of the Guided Inquiry model by students was 78%. The highest implementation rate was observed in the orientation phase (86%), while the lowest rates were found in the exploration and application phases (75%). These results indicate that students followed all stages of the Guided Inquiry model with a level of achievement classified as "good." Thus, the students demonstrated active participation throughout the entire sequence of learning activities, ranging from orientation, exploration, and concept formation to application and the concluding phase. Observations regarding the implementation of instruction revealed an average implementation rate of 81% for the teacher and 78% for the students. These findings indicate that all stages of the Guided Inquiry model, supported by the use of mind maps, were successfully implemented during the learning process.

3.4 Student Response to the Guided Inquiry Model Assisted by Mind Map Media

Based on the results of the student response questionnaire regarding the implementation of guided inquiry assisted by mind-map media, data indicate that students responded positively to the instruction. The graph of the questionnaire results is presented in Figure 1.

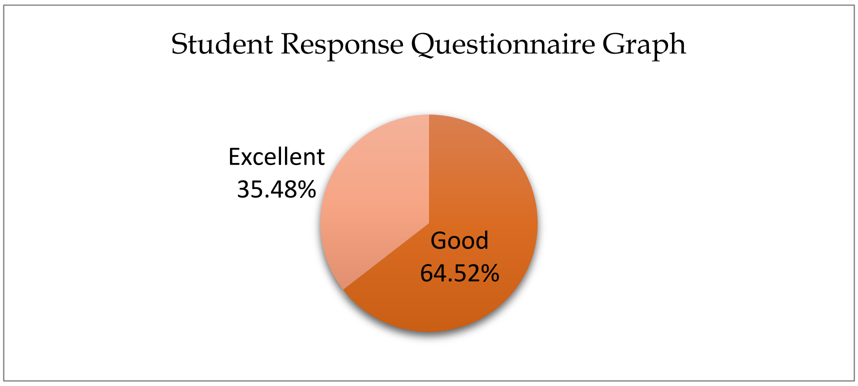

Figure 1. Pie Chart of Student Responses

The student response questionnaire consists of 15 items categorized into three main aspects: general aspects, critical thinking processes, and understanding gained through guided inquiry assisted by mind maps. A Likert scale was used for the assessment, with responses collected from 31 students. As shown in Figure 1, the majority of students responded positively to the instruction provided. Of the 31 students, 20 (64.52%) fell into the "good" category, while the remaining 11 (35.48%) fell into the "very good" category. No students fell into the "fair," "poor," or "very poor" categories. These data indicate that the mind map-assisted guided inquiry model elicited a positive response from the students.

Research conducted at SMPN 2 Pariaman using this model showed that student responses fell within the "good" category. The questionnaire results reveal that instruction utilizing the mind map-assisted guided inquiry model received positive feedback from the majority of students in the experimental class, as reflected in the student response summary table. Analysis of the questionnaire data confirms that responses were obtained from 31 students. The novelty of this study lies in the integration of the guided inquiry model with mind maps to teach the topic of Earth's structure and its evolution within the context of the Merdeka Curriculum implementation. This integration offers an instructional alternative capable of fostering students' critical thinking skills through inquiry activities supported by the visual organization of concepts.

4. CONCLUSION

Research findings indicate that the implementation of the guided inquiry model has a positive and significant impact on students. This is supported by hypothesis test results demonstrating that the model significantly influences the critical thinking skills of eighth-grade students at SMPN 2 Pariaman. The study shows that implementing the guided inquiry learning model, supported by mind-mapping tools, enhances students' critical thinking skills regarding the topic of Earth's Structure and Its Evolution. This improvement is evident in the students' ability to interpret information, analyze problems, evaluate evidence, draw inferences, and articulate explanations more systematically compared to students undergoing conventional instruction.

These findings suggest that integrating the guided inquiry model with mind-mapping tools offers an alternative science teaching strategy capable of fostering student-centered learning. Through structured inquiry activities and the visual mapping of conceptual relationships, students gain greater opportunities to develop critical thinking skills in alignment with the requirements of the Merdeka Curriculum.

This study has limitations, as it was conducted at a single school with a relatively small sample size and focused solely on the topic of Earth's Structure and Its Evolution. Consequently, the findings cannot be generalized to other science topics or different educational levels. Future research is recommended to evaluate the implementation of the Guided Inquiry model, supported by mind-mapping tools, across other science topics or educational levels with larger sample sizes. Additionally, future studies could examine the model's impact on other 21st-century skills, such as creativity, problem-solving abilities, or collaboration.

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