

Initial Study of Students' Critical Thinking Ability Level and Concept Mastery on Earth Structure Material

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Abstract: Critical thinking and concept mastery is an important ability for every student to have. So, educators need to get information about the level of skills possessed by student. This study aims to describe the initial level of critical thinking skills and mastery of students' concepts, as well as the relationship between critical thinking skills and mastery of students' concepts on earth structure material in class VIII at SMP Negeri 2 Namang. The methodology used in the research is descriptive quantitative, using a critical thinking ability test and concept mastery test, and qualitative, using interviews. Students' critical thinking and concept mastery tests showed an average score of 43.78 and 55.94, with a fairly low category. The average value of the inference indicator was 25.97, and the indicator of making further explanations was 37.01. Both are the lowest indicators that still need to be improved. In contrast, the average value of the strategy and tactics indicator is 73.95, which is in the high category. The significance value obtained is <0.001 , which indicates that there is a strong, significant, and directly proportional relationship between critical thinking skills and concept mastery, with a correlation coefficient value of 0.803. The results of the interview show the low enthusiasm of students in learning the structure of the earth due to the lack of a variety of media used and test questions that are not used to being done.

Keywords: Critical Thinking Ability; Concept Mastery; Earth Structure

Introduction

In the world of education that continues to develop, critical thinking skills are one of the important aspects that students must have (Retno Winarti & Waluya, 2018). Critical thinking ability is an ability that has meaning as a result of types of skills, types of knowledge, affective, and behavior (Aswanti & Isnaeni, 2023). The literature review explains that critical thinking has the power to help improve various other skills and abilities that create positive habits and change risky behavior into positive actions (Potter, 2022).

Critical thinking skills not only help students understand the concepts taught at school but also apply the knowledge in everyday life (Widodo & Syazali, 2023). Critical thinking can help students understand

and master concepts, especially in abstract material in the classroom (Simanjuntak & Sudibjo, 2019). In addition, students gain a deep understanding and are able to solve problems with well-conceptualized steps (Faiziyah & Priyambodho, 2022).

Critical thinking in science learning is related to the process of explicitly discovering natural phenomena, so the learning process emphasizes real experiences to develop scientific behavior skills and critical thinking as one of the aspects needed in life skills (Arini & Juliadi, 2018). Science learning is closely related to analytical competence and critical thinking, so there needs to be an effort to improve mastery of concepts through meaningful learning with critical thinking skills (Arisanti et al., 2017) (Simbolon & --, 2015).

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Earth structure is one of the essential materials in the science curriculum, but often, the concepts are considered abstract and difficult for students to understand, so additional media is needed to help explain the concept (Syawaludin et al., 2019). In this case, critical thinking becomes an impetus in the cognitive, affective, and psychomotor domains to solve problems and explain the concepts of the media in the science material (Ariyana et al., 2018). Critical thinking can draw rational conclusions from the results of analysis and evaluation of observations, communication, and reasoning in a simple way (Gaol et al., 2022); (Angraeni et al., 2021). As an integration method, critical thinking is a beginning that means accepting evidence, assumptions, logic, and language that accommodate the role of thinking (Putra & Sudarti, 2015).

Critical thinking is done consciously when students take responsibility related to metacognition in an effort to evaluate the assessment of the accuracy of decisions and information (Gurcay & Ferah, 2018). The concept of critical thinking includes all thinking activities that can be developed through the application of learning, such as concept mastery (Rahardhian, 2022). In problem-solving in the classroom, students need critical thinking skills to conceptualize material related to the problem (Fatimah et al., 2017).

In the revision of Bloom's taxonomy, the dimensions of cognitive processes become remembering, understanding, applying, analyzing, evaluating, and creating, which refers to higher-level thinking, namely analyzing and evaluating concepts (Nafiati, 2021). By mastering the right concepts, students already have a strong foundation to succeed in the next material (Saputra, 2020). Mastering the right concepts about science learning materials can help students understand the material and apply it in everyday life (Astuti, 2017). With concept mastery, it allows students to gain unlimited new knowledge (Syaharani, 2018).

From the results of interviews conducted with 35 junior high school science teachers in Central Bangka Regency, it was found that critical thinking skills and concept mastery are important for every student. Critical thinking skills and concept mastery must be present in every lesson as the beginning of scientific thinking, especially in complex science material contained in the education curriculum (Ilkorucu et al., 2022); (Bahatæg, 2019). In understanding science, high-level thinking skills (HOTS) are needed, which include the ability to think systemically and understand the relationship between concepts and the hierarchical level of a concept (Dwijayanti, 2021). Students can develop psychomotor skills and scientific attitudes through concept search to improve learning outcomes (Hikmawati et al., 2020).

Based on the above discussion, it is important to conduct this research in Central Bangka Regency,

precisely at SMP Negeri 2 Namang, with the aim of obtaining an initial description and relationship between the level of critical thinking ability and students' concept mastery on earth structure material. SMP Negeri 2 Namang has implemented an independent curriculum, but no similar research has been conducted. The study results are expected to be a reference for educator practitioners to improve and develop a learning system that supports critical thinking skills and concept mastery. Therefore, this research offers a significant contribution to our understanding of the development of students' critical thinking skills in the context of science learning at the junior high school level. By focusing on early studies, this research provides a strong basis for designing more effective learning interventions. In addition, by linking critical thinking skills with mastery of the concept of earth structure material, this research provides new insights into the factors that influence student learning success.

Therefore, improving critical thinking skills and concept mastery will support learning outcomes and independent curriculum programs that are characterized by the Pancasila student profile (Khairunnisa et al., 2024); (Chairatunnisa et al., 2023); (Er, 2023). Critical thinking skills and concept mastery are life skills that play a role in facing challenges in the 21st century (Prasetyowati & Suyatno, 2020); (Ramdani et al., 2019). So, this research is very relevant in supporting the development of education in the future. In addition, this study aims to map the level of critical thinking skills of grade VIII students at SMP Negeri 2 Namang on Earth Structure material. So, this study will also measure the extent to which students have mastered the basic concepts of the Earth's Structure. The results of this mapping are expected to be a starting point for designing learning strategies that are more effective and in accordance with the needs of students.

Method

This research was conducted on VIII grade students, as many as three classes totaling 79 students consisting of 37 female and 42 male students at SMP Negeri 2 Namang even semester of the 2023/2024 academic year. Sampling was done using purposive sampling techniques to illustrate the research objectives. The methodology used in the research is descriptive quantitative, using critical thinking ability tests and concept mastery tests, and qualitative, using interviews (Jannah, 2016). The descriptive method applied in this research is designed to provide a systematic description of information derived from the subject or object of research (Abadi H, 2020). The research flow can be seen in Figure 1.

Data collection techniques in this study include tests, interviews, and documentation. The instruments used in this study were critical thinking tests, concept mastery tests, interview sheets, and learning outcome documents. The critical thinking test questions in this study were in the form of multiple choice, as many as 12 questions that experts had validated before use. The questions given refer to the indicators of critical thinking skills, according to Robert Ennis, in the form of providing simple explanations, building basic skills, concluding, providing further explanations, and organizing strategies and techniques (Ennis, 2011). Furthermore, the data obtained were analyzed by correcting students' answers, and the scores were adjusted to the criteria used to assess critical thinking skills that had been assessed in the rubric. To obtain student acquisition scores using the formula in equation (1)

$$Score = \frac{score\ amount}{maximum\ score} \times 100 \tag{1}$$

Each question is grouped based on the elements and indicators of critical thinking skills, and then the presentation for each indicator is by converting the scores into critical thinking skills categories according to Table 1, adapted from Muntaha et al. (Muntaha et al., 2021)

Table 1. Classification of critical thinking skills

Category value	Predicate
0.00-19.00	Very low
20.00-39.00	Low
40.00-60.00	Simply
61.00-80.00	High
81.00-100.00	Very High

Indicators for categorizing critical thinking skills are shown in Table 2.

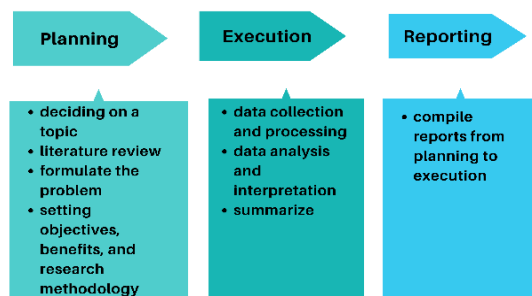


Figure 1. Research flow

Table 2. Indicators of critical thinking ability according to Ennis.

Steps	Critical Thinking Skills	Indicator
1	Elementary Clarification	1. Focusing the question 2. Analysing the questions/argument 3. Asking and answering clarifying questions
2	The Basis for the Decision	4. Consider whether the source is trustworthy 5. Make observation considerations
3	Inference	6. Construct and consider deductions 7. Compiple and consider inductions 8. Construct and determine consideration value
4	Advances Clarification	9. Define terms and consider definitions in three dimensions 10. Identifying assumptions
5	Supposition and Integration	11. Determine the cause of action 12. Interacting with others

Source: Ennis(2011) in (Crismasanti & Yunianta, 2017).

The concept mastery test on earth structure material was developed by referring to indicators according to Bloom (Anderson & Krathwohl, 2010); (Nafiati, 2021). The test was given in the form of multiple-choice five questions featuring indicators C4 (analyze), C5 (evaluate), and C6 (synthesis). To get the acquisition value, researchers used equation (1) and classified the acquisition value in the concept mastery criteria presented in Table 3 (Ramdani et al., 2020)

Table 3. Criteria for concept mastery

Category value	Predicate
0.00 - 40.00	Very low
41.00 - 55.00	Low
56.00 - 70.00	Simply
71.00 - 85.00	High
86.00 - 100.00	Very High

Interview data was taken directly after giving the test to the subject teacher, and the aim was to collect

systematic information related to the learning activities that had been implemented. The interview questions given to teachers refer to the grids shown in Table 4 (Yulianti et al., 2023).

Table 4. Interview grid

Aspect	Question items
Learning process Assessment	Student enthusiasm for learning
	Types of assessment conducted
	Level of difficulty of the instrument for students
	Frequency of experimental method
Learning outcomes	Application of various learning models
	Assessing student learning outcomes

The results of the interview instrument were analyzed qualitatively. In this study, interviews given to teachers are important data because researchers must be able to reveal and explore research subjects more precisely based on facts (Fadli, 2021).

After getting the results of the analysis, the relationship between critical thinking skills and concept mastery will be examined. This aims to help develop specific learning methods and models that are effective in improving both aspects (Fatimah et al., 2017). The relationship was analyzed using Spearman's correlation from SPSS version 26. The following are the criteria for testing Spearman's level system correlation, namely:

1. If the Significance value (Sig. 2-tailed) < 0.05, there is a significant relationship between critical thinking skills and students' concept mastery of earth structure material in class VIII at SMP Negeri 2 Namang, then H0 is rejected, and H1 is accepted.
2. If the Significance value (Sig. 2-tailed) > 0.05, there is no significant relationship between critical thinking skills and students' concept mastery of earth structure material in class VIII at SMP Negeri 2 Namang, then H0 is accepted, and H1 is rejected.

The strength of the relationship between critical thinking skills and concept mastery is shown through the meaning of the correlation value shown in Table 5 (Rosalina et al., 2023).

Table 5. Meaning of Spearman Correlation Value

Value	Meaning
0.00-0.19	Very week
0.20-0.39	Week
0.40-0.59	Medium
0.60-0.79	Strong
0.80-1.00	Very strong

Result and Discussion

Category of Students' Critical Thinking Ability

The research data were collected from the test results using multiple-choice questions, including as many as 12 questions. Then, the researcher analyzed the answers given by students and presented in Table 6.

Table 6. Critical thinking skills analysis results

Category	Value
Maximum score	83.33
Minimum score	8.33
Average value	43.78
Standard Deviation	11.82

After obtaining the analysis data from critical thinking skills, then a data recapitulation is prepared to see the presentation of the number of students based on the category. The data recapitulation of the critical thinking skills test results can be seen in Table 7.

Table 7. Recapitulation of critical thinking skills test data

Category	Value Range	Number of Students	Percentage (%)
Very low	0.00-19.00	3	3.80
Low	20.00-39.00	18	22.78
Simply	40.00-60.00	56	70.88
High	61.00-80.00	1	1.26
Very High	81.00-100.00	1	1.26
Total Students			79

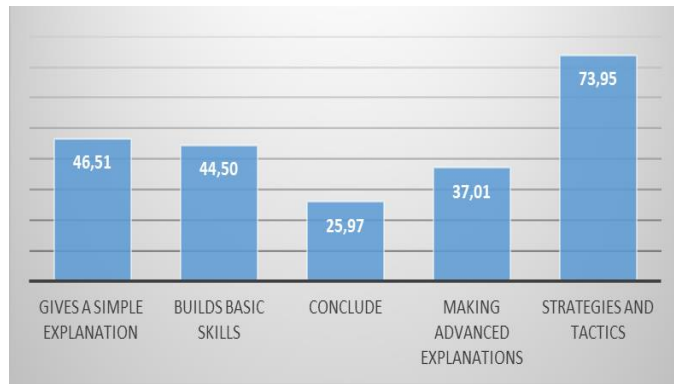
Based on Tables 6 and 7, the lowest score was 8.33 for as many as 3 students, and the highest score was 83.33, which only 1 student could achieve. From the data recapitulation, the majority of students get scores in the range of 40.00-60.00, with a total of 56 students (70.88%); this shows that most students are in the sufficient category. There are 3 students (3.80%) who get very low scores, and 1 student (1.26%) gets very high scores. This shows that as many as 3 students need additional material to improve critical thinking skills, while there is 1 student who needs more challenging material.

The average score achieved by students was 43.78. From Table 3, the value is included in the sufficient category, but the value is still far from the expected value in the education unit, which is 74. So, it can be concluded that the critical thinking skills of SMP Negeri 2 Namang students still need to be improved, especially on earth structure material.

Earth structure material is a broad material, so students need direct observation by displaying

interactive media to make abstract concepts real (Hakim & Wibowo, 2023). Even the results of the study explain that the material of the earth's structure is less interesting, so it requires student involvement in direct observation activities using media to improve critical thinking skills (Syawaludin et al., 2019).

Analysis was also carried out based on indicators based on critical thinking skills shown in Graph 1.



Graph 1. Results of data analysis based on aspects of critical thinking skills.

Based on Graph 1, it can be seen that the average student test scores for all indicators of critical thinking skills are below 75%. The average value of critical thinking skills in the lowest position is the conclusion aspect at 25.97%, followed by the aspect of making further explanations at 37.01%, which are both categorized as low. Meanwhile, the strategy and tactic aspect are the aspect of critical thinking skills that has the highest presentation of 73.95% with a high category.

In detail, it can be explained that as many as 25.97% or only 20-21 out of 79 students were able to answer questions number 6, 7, and 8 related to the aspect of concluding questions. The aspect of making further explanations in question numbers 9 and 10 also needs to be improved because only 37.01%, or only around 29 out of 79 students, were able to answer these questions. Meanwhile, 73.95% or 58-59 out of 79 students were able to answer questions number 11 and 12 related to the aspects of strategy and tactics.

It can be concluded that, students are still very weak in critical thinking skills, especially in the aspect of summarizing questions and further explanation. Therefore, teachers need to display learning that is able to connect material into simple conclusions that students often encounter in everyday life, such as adventure games (Rizki et al., 2024).

Concept Mastery Category

Data on students' concept mastery was collected using a test instrument in the form of multiple-choice 5

questions. Based on the results of the analysis that has been carried out, the concept mastery values are presented in table 8.

Table 8. Concept mastery analysis results

Category	Value
Maximum score	80.00
Minimum score	0.00
Average value	55.94
Standard Deviation	17.65

Furthermore, data recapitulation was carried out to see the number of students presented based on the concept mastery category displayed in Table 9.

Table 9. Recapitulation of concept mastery test data

Category	Value Range	Number of Students	Percentage (%)
very low	0.00 - 40.00	6	7.59
low	41.00-55.00	19	24.05
simply	56.00-70.00	38	48.10
high	71.00-85.00	16	20.25
very high	86.00-100.00	0	0
Total Students			79

Table 8 and 9 illustrate that the average student score is 55.94, which is within the low category. The minimum student score is the lowest score of 0, and the maximum score is 80. As many as 7.59% or 6 out of 79 students achieved mastery of concepts in the very low category with a score range below 40. And as many as 24.05% or 19 students were in the low category. Although as many as 48.10% were in the sufficient category, the number was only 38 students. This illustrates that more than 50% of students' mastery of concepts is still low.

The low concept mastery ability can be caused by learning media that has not been effectively given, so a learning model that supports student concept mastery is needed (Nurnadia et al., 2022). Therefore, teachers must be able to create an interactive learning environment so that students can learn easily and improve their understanding of abstract concepts (Rahmat et al., 2023). Misunderstanding of physics concepts will contribute to wrong answers and lead to new problems (Ogundeji et al., 2019).

Almost all earth structure concepts are imaginative and cannot be observed directly (Johan et al., 2018). Most of the natural phenomena in earth structure materials are difficult to experience directly, and earth science is the most likely to provide wrong concepts than other materials (Yang & Lim, 2021). Misunderstandings between scientific concept definitions and the definitions that students create in

their minds will hinder concept learning (Ozkan & Topsakal, 2020). Therefore, learning should get a strategy that focuses on a conceptual approach to the process of understanding concepts (Resbiantoro & Setiani, 2022). The critical thinking and concept mastery test activities are shown in Figure 2.



Figure 2. Students taking the exam

Relationship Between Critical Thinking Skills and Concept Mastery

After analyzing the data on critical thinking and concept mastery, researchers also measured the relationship using the correlation coefficient in SPSS version 26, which is shown in Table 10.

Tabel 10. Correlation Coefficient

		Description	Critical Thinking	Concept Mastery
Spearmans rho	Critical Thinking	Correlation Coefficient	1.000	.803**
		Sig. (2-tailed)	.	<,001
		N	79	79
	Concept Mastery	Correlation Coefficient	.803**	1.000
		Sig. (2-tailed)	<,001	.
		N	79	79

Based on Table 10, the value of Sig. (2-tailed) value is <0.001, so there is a significant relationship between critical thinking skills and students' concept mastery of earth structure material in class VIII at SMP Negeri 2 Namang, so it is concluded that Ho is rejected and Ha is accepted. From Table 10, it is also obtained that the correlation coefficient value is 0.803 and is positive. This illustrates a very strong and unidirectional relationship between critical thinking skills and students' concept mastery. In other words, the higher the students' critical thinking skills, the higher the level of concept mastery, and vice versa. These results are relevant to the research found by Widodo and Syazali, which found that there is a significant positive relationship between critical thinking skills and concept mastery (Widodo & Syazali, 2023). Research conducted by Naswar et al. at SMP Negeri 7 Kota Ternate also concluded that critical

thinking skills influence students' mastery of concepts (Naswar, 2023).

Interview With Science Teacher



Figure 3. Picture of an interview with a teacher

The researcher also interviewed the science teacher who became the sample of this study and stated that students' enthusiasm for this material was still relatively low. More than 50% of students showed less interest in learning this material. Moreover, this earth structure material is abstract material, so it does not attract students' attention. This is in line with the journal written by Benjamin that earth-related material requires additional media as a solution to learning. (Mijares III, 2023).

The assessment carried out by the teacher in the form of written and oral test questions is used to measure the extent of student understanding. In addition, teachers also provide questions that encourage students' level of reasoning. However, students need to connect several statements into an answer. Based on the learning results collected by the teacher, the average daily assessment is still low, below 75. This causes the Criteria for Achieving Learning Objectives (KKTP) that have been prepared by the teacher not to be achieved even though KKTP is prepared based on learning outcomes in accordance with the curriculum (Asbari & Santoso, 2023) (Wulandari et al., 2024).

From the interview with the teacher, it was also explained that the level of difficulty of the instrument questions was actually still affordable because the questions given were not outside the discussion of the material. However, students experience weaknesses when working on problems when new sentences in the question instrument are written in reverse from the material explanation. This indicates that students' ability to connect cause and effect and meta-cognitive is still very weak. Therefore, interactive strategies can be applied in developing meta-cognitive behaviour which is defined as awareness of what is known and not yet known (Mafarja et al., 2022).

Sometimes, teachers in the classroom also show learning videos to attract students' attention, but it still does not increase the effectiveness, so it makes students

bored with learning. Therefore, a variety of learning media is needed to support the achievement of learning objectives (Haagen-Schützenhöfer & Joham, 2018). Various learning media, such as digital games, augmented reality, and cooperative learning, can increase motivation and critical thinking skills (Rizki et al., 2024). In addition, learning can be interspersed with social media or online media to attract students' interest, especially critical thinking skills (Slisko, 2021).

Based on data collection through tests given to class VIII students at SMP Negeri 2 Namang, in general, the level of critical thinking skills and concept mastery is poor. This conclusion is drawn from the overall average value of critical thinking ability and concept mastery, the achievement of learning objectives and interviews with teachers. The results of this study also show that critical thinking skills are directly proportional to students' concept mastery.

Therefore, stakeholders and educational policymakers are encouraged to equip students with skills and abilities that foster competencies related to the development of critical thinking and concept mastery in students by using participatory strategies, project or problem-based learning, and simulation learning (Kumullah et al., 2018); (Merma-Molina et al., 2022). Critical thinking skills have emotional, social, and psychomotor benefits that help students verify various theories of complex concepts (Vlachos et al., 2024). Therefore, to prepare students who are able to think critically, all educational institutions, including teachers, must take more efficient and effective actions, considering that teachers play an important role in improving students' critical thinking skills ((Fikriyatii et al., 2022).

Conclusion

Based on research conducted on class VIII students of SMP Negeri 2 Namang on the material of the earth's structure, the results show that critical thinking skills and mastery of concepts fall into the poor category, especially in concluding and making further explanations. This is due to the low motivation of students towards the material of the earth's structure and the unfamiliarity of working on problems that require critical thinking skills and mastery of concepts. Another cause is the learning media, which does not support students' ability to reason about the material and questions. This indicates that serious handling is needed in an effort to stimulate the critical thinking skills and concept mastery of junior high school students. Initial studies on this matter are very important to know as a basis for educational policymakers to design further actions. Improving student literacy is also a concern,

given the importance of understanding the structure of the earth and its development. Therefore, educators need to improve their competence in mastering materials and media that support the achievement of learning objectives in earth structure material for the better.

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Author Contributions

Conceptualization, Y.T.H.N., S.M.S., and H.A.; methodology, Y.T.H.N., and S.M.S.; validation, S.M.S., and H.A.; formal analysis, Y.T.H.N.; investigation, Y.T.H.N., and S.M.S.; resources, Y.T.H.N., S.M.S., and H.A.; data curation, S.M.S.; writing-original draft preparation, Y.T.H.N., and S.M.S.; writing-review and editing, Y.T.H.N., S.M.S., and H.A.; visualization, H.A.; All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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