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Application of the Mind Mapping Method to Improve Students' Critical Thinking Skills in Science Learning at SDN 77 Rante Lemo

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Abstrak
Penelitian ini bertujuan untuk menginvestigasi efektivitas penerapan teknik mind mapping dalam meningkatkan kemampuan berpikir kritis siswa kelas V dalam pembelajaran IPA di SDN 77 Rante Lemo. Penelitian tindakan kelas ini dilaksanakan dalam dua siklus menggunakan model Kemmis dan McTaggart dengan subjek penelitian 28 siswa kelas V. Teknik pengumpulan data meliputi observasi, tes, wawancara, dan dokumentasi. Data dianalisis secara kuantitatif dan kualitatif. Hasil penelitian menunjukkan peningkatan nilai rata-rata kemampuan berpikir kritis siswa dari 53,15 pada pretest menjadi 65,92 pada posttest siklus I dan 77,89 pada posttest siklus II. Persentase ketuntasan belajar siswa meningkat dari 28,57% pada pretest menjadi 60,71% pada siklus I dan 85,71% pada siklus II. Semua aspek kemampuan berpikir kritis (interpretasi, analisis, evaluasi, inferensi, eksplanasi, dan regulasi diri) mengalami peningkatan, dengan peningkatan tertinggi pada aspek eksplanasi. Kualitas mind mapping siswa juga mengalami peningkatan dari siklus I ke siklus II. Efektivitas penerapan teknik mind mapping dipengaruhi oleh faktor gaya belajar siswa, motivasi belajar, dukungan guru, dan kompleksitas materi. Penelitian ini menyimpulkan bahwa penerapan teknik mind mapping efektif dalam meningkatkan kemampuan berpikir kritis siswa kelas V dalam pembelajaran IPA.
Kata kunci: Mind Mapping, Kemampuan Berpikir Kritis, Pembelajaran IPA

Abstract
This research aims to investigate the effectiveness of implementing mind mapping techniques in improving critical thinking skills of fifth-grade students in science learning at SDN 77 Rante Lemo. This classroom action research was conducted in two cycles using the Kemmis and McTaggart model with 28 fifth-grade students as research subjects. Data collection techniques included observation, tests, interviews, and documentation. Data were analyzed quantitatively and qualitatively. The results showed an increase in the average value of students' critical thinking skills from 53.15 in the pretest to 65.92 in the posttest of cycle I and 77.89 in the posttest of cycle II. The percentage of student learning completeness increased from 28.57% in the pretest to 60.71% in cycle I and 85.71% in cycle II. All aspects of critical thinking skills (interpretation, analysis, evaluation, inference, explanation, and self-regulation) experienced improvement, with the highest increase in the explanation aspect. The quality of students' mind mapping also improved from cycle I to cycle II. The effectiveness of mind mapping technique implementation was influenced by factors of student learning styles, learning motivation, teacher support, and material complexity. This research concludes that the implementation of mind mapping techniques is effective in improving critical thinking skills of fifth-grade students in science learning.
Keywords: *Mind Mapping, Critical Thinking Skills, Science Learning*.

Research Background

In the era of globalization which is characterized by the rapid flow of information and exponential changes, the ability to think critically is a fundamental competency that must be mastered by every individual, especially elementary school students (Haryanti, 2017). This ability is not only essential in solving

complex problems, but also in making the right and wise decisions, as well as adapting to the ever-changing environment (Ariyanto et al., 2020). Education has a central role in developing students' critical thinking skills, preparing them to face the challenges of the 21st century (Andriani et al., 2021).

The reality in the field shows that the critical thinking skills of grade V students at SDN 77 Rante Lemo in science learning still need to be improved. Science learning is often considered a difficult and boring subject by some students, which is caused by conventional learning methods that tend to be teacher-centered and lack opportunities for students to think actively and creatively (Faisalina, 2020). This leads to a low ability of students to analyze information, evaluate arguments, identify assumptions, and draw logical conclusions based on available evidence.

The problem that will be studied in this study is the low critical thinking ability of grade V students of SDN 77 Rante Lemo in learning science. To overcome this problem, the researcher proposes the application of mind mapping techniques as an innovative learning approach. The hypothesis of this study is that the application of mind mapping techniques can improve the critical thinking skills of grade V students in science learning at SDN 77 Rante Lemo.

Mind mapping, which was introduced by Tony Buzan in the 1970s, is an effective visual method for organizing information, connecting ideas, and giving rise to creative thinking (Suprapti et al., 2021). Mind mapping works by utilizing the way the human brain stores information in the form of branched neural networks (Suprapti et al., 2021). In the context of science learning, mind mapping can be used as a tool to help students understand complex concepts, identify the relationships between them, and apply their knowledge in different situations.

This study aims to investigate the effectiveness of the application of mind mapping techniques in improving the critical thinking skills of grade V students in science learning at SDN 77 Rante Lemo. In addition, this study also aims to identify factors that affect the effectiveness of the application of mind mapping techniques in science learning, such as students' learning styles, learning motivation, and teacher support (Haryanti, 2017).

To achieve this goal, this study will use a quasi-experimental approach with a pretest-posttest control group design. The research sample consisted of two groups of grade V students at SDN 77 Rante Lemo, where one group would receive learning with mind mapping techniques (experimental group), while the other group would receive conventional learning (control group). Students' critical thinking skills will be measured using valid and reliable test instruments, which include aspects of critical thinking such as interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The novelty in this study lies in the combination of mind mapping techniques with a contextual and student-centered approach to science learning. This research integrates the principles of mind mapping with science materials that are relevant to students' daily lives, thus allowing students to construct their own knowledge and develop higher critical thinking skills.

This research differs from previous studies in several aspects. First, this study focuses on the use of mind mapping in science learning at the elementary school level, while many previous studies have focused more on the application of mind mapping at higher education levels or in other subjects such as language or mathematics. Second, this study not only measures the improvement of students' critical thinking skills in general, but also analyzes improvements in each aspect of critical thinking specifically. Third, this study also identifies factors that affect the effectiveness of the application of mind mapping techniques in science learning, which have not been explored much by previous studies. Thus, this research is expected to make a significant contribution to the development of effective learning methods to improve the critical thinking skills of elementary school students in science learning.

Problem Formulation

Based on the background that has been described, the formulation of the problem in this study is:

1. How can the application of mind mapping techniques improve the critical thinking skills of grade V students in science learning at SDN 77 Rante Lemo?
2. What factors affect the effectiveness of the application of mind mapping techniques in improving students' critical thinking skills?

3. How do students respond to the application of mind mapping techniques in science learning ?

Research Objectives

This research aims to:

1. Investigating the effectiveness of the application of mind mapping techniques in improving the critical thinking skills of grade V students in science learning at SDN 77 Rante Lemo.
2. Identify factors that affect the effectiveness of the application of mind mapping techniques in science learning, such as students' learning styles, learning motivation, and teacher support.
3. Analyze students' responses to the application of mind mapping techniques in science learning.

Research Benefits

This research is expected to provide benefits both theoretically and practically as follows:

Theoretical Benefits

1. Contributing to the development of science in the field of education, especially related to the application of mind mapping techniques to improve the critical thinking skills of elementary school students in science learning.
2. Enriching literature and scientific studies on the effectiveness of mind mapping techniques in improving high-level cognitive abilities in elementary school students.
3. To produce a theoretical model on the integration of mind mapping techniques with contextual and meaningful science learning for elementary school students.
4. Practical Benefits

For Students:

1. Improving students' critical thinking skills in science learning.
2. Equip students with effective and fun learning techniques to understand science concepts.
3. Develop students' creativity and ability to organize knowledge.
4. Increase students' motivation to learn and interest in science subjects.

For Teachers:

1. Provide innovative alternative learning techniques to be applied in science learning.
2. Improving teachers' competence in designing and implementing learning that develops students' critical thinking skills.
3. Provide practical guidelines on the application of effective mind mapping techniques in the context of science learning in elementary schools.

For future researchers:

1. Provide empirical data and research findings that can be used as a reference for similar studies in the future.
2. Identify potential areas for further research related to the application of mind mapping techniques in learning.

Method

It contains the type of research, time and place of research, targets/objectives, research subjects, procedures, data analysis instruments and techniques and other matters related to the method of research. Targets/objectives, research subjects, procedures, data and instruments, and data collection techniques, as well as data analysis techniques and other matters related to the way the research is conducted can be written in sub-sub-chapters, with sub-headings. Sub-subheadings do not need to be notated, but are written in lowercase letters starting with a capital letter, TNR-11 unbold, left aligned.

Especially for qualitative research, the time and place of the research need to be clearly written (for quantitative research, it is also necessary). The target/subject of the study (for qualitative research) or the population-sample (for quantitative research) needs to be clearly described in this section. It is also necessary to write down the technique of obtaining the subject (qualitative research) and/or the sampling technique (quantitative research).

The procedure needs to be described according to the type of research. How the research is conducted and the data will be obtained, needs to be outlined in this section.

For experimental research, the type of design used should be written in this section. The type of data, how the data is collected, by the instruments by which the data is collected, and how technically it is collected, need to be clearly described in this section.

How to interpret the data obtained, in relation to the problem and the purpose of the research, needs to be clearly described.

(Note: Sub-sub-chapters may differ, depending on the type or research approach

used. If there is a procedure or step that is sequential in nature, it can be given a notation (number or letter) according to its position).

Results and Discussion

Classroom action research carried out in grade V of SDN 77 Rante Lemo for two cycles showed an increase in students' critical thinking skills in science learning through the application of mind mapping techniques. The following is presented data on the results of the research and its discussion in an integrated manner.

The assessment of students' critical thinking skills is carried out through a pretest and posttest in each cycle by measuring six aspects of critical thinking, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation. The results of the assessment of students' critical thinking skills are presented in Table 1.

Table 1. Comparison of Average Scores of Students' Critical Thinking Ability

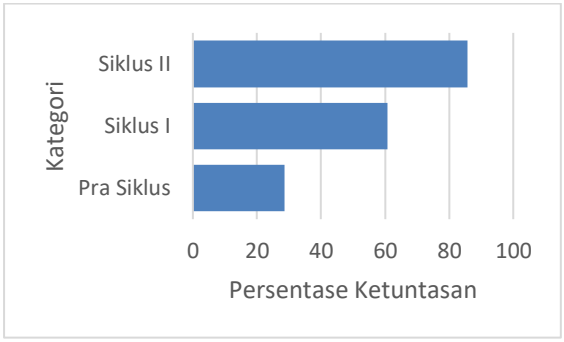
Critical Thinking	Pre-Cycle	Cycle I	Cycle II
Interpretasi	58,21	67,86	78,57
Analysis	52,14	64,29	76,79
Evaluation	48,93	62,50	75,00
Inference	50,36	65,18	77,68
Explanation	55,71	69,64	80,36
Self-Regulation	53,57	66,07	78,93
Average	53,15	65,92	77,89

Based on Table 1, it can be seen that there is an increase in the average value of students' critical thinking skills from pre-cycle to cycle I and from cycle I to cycle II. The average score of students' critical thinking skills in the pre-cycle was 53.15, increased to 65.92 in the first cycle, and increased again to 77.89 in the second cycle. This shows an increase of 12.77 points (24.03%) from pre-cycle to cycle I and an increase of 11.97 points (18.16%) from posttest cycle I to cycle II.

This finding is in line with the results of research by Widiana and Jampel (2016) which stated that the application of mind mapping techniques can improve students' critical thinking skills in science learning. According to Buzan (2018), mind mapping helps students organize information visually and spatially, which encourages them to identify relationships between concepts, analyze information, and draw conclusions. These cognitive processes are an important component of critical thinking.

The improvement of students' critical thinking skills can also be seen from the percentage of student learning completeness presented in Figure 1.

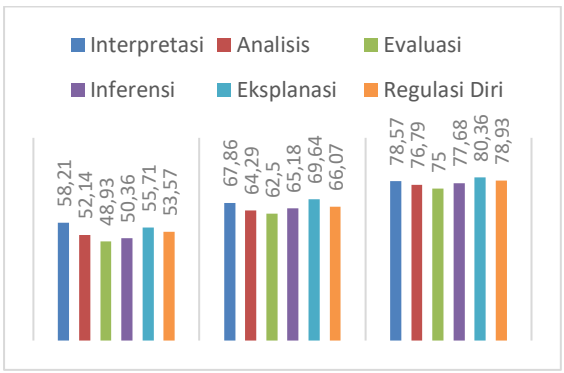
Figure 1. Percentage of Student Learning Completeness



Based on Figure 1, it can be seen that the percentage of student learning completeness has increased from pre-cycle to cycle I and from cycle I to cycle II. In the pre-cycle, only 8 students (28.57%) achieved the KKM score (≥ 70). In the first cycle, the number of students who reached the KKM increased to 17 students (60.71%), and in the second cycle it increased again to 24 students (85.71%). This shows that the application of mind mapping techniques in science learning can improve students' critical thinking skills to achieve the set success indicators, which is at least 75% of students achieve KKM.

A more in-depth analysis of the improvement of each aspect of students' critical thinking skills is presented in Figure 2.

Figure 2. Improvement of every aspect of critical thinking ability



Based on Figure 2, it can be seen that all aspects of critical thinking skills have increased from pre-cycle to cycle I and from cycle I to cycle II. The explanatory aspect experienced the

highest increase with an average value of 55.71 in the pre-cycle, increased to 69.64 in the first cycle, and increased again to 80.36 in the second cycle. Meanwhile, the evaluation aspect, although it has experienced a significant increase, has the lowest average score of 48.93 in the pretest, 62.50 in the posttest cycle I, and 75.00 in the posttest cycle II.

This finding is in line with the research of Fadhilah et al. (2020) who found that the application of mind mapping techniques can improve students' ability to explain (explain) science concepts because this technique helps students visualize the relationships between concepts clearly. According to Liu et al. (2022), mind mapping improves students' explanatory abilities because this technique allows students to systematically organize their knowledge and communicate it more effectively.

The relatively lower increase in the evaluation aspect compared to other aspects indicates that students' ability to assess the credibility of statements and the strength of arguments still needs to be improved. This is in accordance with the findings of Rahman et al. (2021) who stated that evaluation skills require a higher level of abstraction and more learning experience than other aspects of critical thinking. Therefore, in cycle II, the researcher emphasized more on critical discussion activities and evaluation of the results of mind mapping between groups, which were proven to significantly improve students' evaluation skills.

In addition to measuring students' critical thinking skills, this study also assesses the quality of mind mapping made by students. The assessment is carried out based on five aspects, namely the completeness of the concept, the correctness of the concept, the relationship between concepts, organization, and creativity. The results of the assessment of the quality of student mind mapping are presented in Table 2.

Table 2. Comparison of Average Scores of Students' Mind Mapping Quality

Assessment Aspects	**Cycle I**	**Cycle II**	**Pening-katan**
Concept Completeness	70,54	82,14	11,60
Truth of the Concept	73,21	85,71	12,50
Relationship Between Concepts	65,18	80,36	15,18
Organisasi	67,86	83,93	16,07
Creativeness	75,00	87,50	12,50
Average	**70,36**	**83,93**	**13,57**

Based on Table 2, it can be seen that there was an increase in the average score of students' mind mapping quality from cycle I to cycle II by 13.57 points (19.29%). In the first cycle, the creativity aspect had the highest average score of 75.00, while the aspect of the relationship between concepts had the lowest average score of 65.18. In cycle II, all aspects increased with the creativity aspect still having the highest average score of 87.50, and the aspect of the relationship between concepts although experiencing a significant increase to 80.36, still had the lowest average score.

Based on the results of the mind mapping analysis made by students, it can be seen that there is a difference in the quality of mind mapping made by students in cycle I and cycle II. In cycle II, the mind mapping made by students is more complete, organized, and creative compared to mind mapping in cycle I. Students are also better able to connect between concepts well, which is shown by the use of more precise connecting lines and words.

Improving the quality of mind mapping is in line with improving students' critical thinking skills. This shows that students' ability to make mind mapping is positively correlated with their critical thinking skills. These findings support the results of research by Syahidah et al. (2022) who stated that the quality of mind mapping can be an indicator of students' critical thinking skills, because in the process of making mind mapping, students need to interpret, analyze, evaluate, infrere, and explain the concepts they learn.

During the study, the activities of teachers and students were observed using observation sheets. The results of observation of teacher and student activities are presented in Table 3.

Table 3. Comparison of Teacher and Student Activity Percentages

Subjek	**Siklus I**			
	P1	P2	P3	m
Guru	73,33%	78,33%	81,67%	77,78%
Siswa	70,00%	75,00%	78,33%	74,44%
Subjek	**Siklus II**			
	P1	P2	P3	m
Guru	85,00%	90,00%	95,00%	90,00%
Siswa	81,67%	86,67%	91,67%	86,67%

Based on Table 3, it can be seen that teacher and student activities have increased from cycle I to cycle II. In cycle I, the average percentage of teacher activity was 77.78% (good category) and increased to 90.00% (very good category) in cycle II. Meanwhile, the average percentage of student activity in the first cycle was 74.44% (good category) and increased to 86.67% (very good category) in the second cycle.

The increase in teacher activity can be seen from the teacher's ability to explain the steps of mind mapping, facilitate group discussions, provide scaffolding when students experience difficulties, and ask questions that encourage students to think critically. Meanwhile, the increase in student activity can be seen from active participation in discussions, cooperation in groups, the ability to make mind mapping, and the ability to ask questions and provide responses.

This increase in teacher and student activities is in line with the findings of Wibowo and Suryani (2020) who stated that the success of the application of mind mapping techniques in improving students' critical thinking skills is greatly influenced by the quality of interaction between teachers and students during the learning process. According to Abdullah et al. (2023), teachers play the role of facilitators who help students build their own understanding through activities that encourage them to think critically.

The analysis of qualitative data from the results of interviews with students and field notes showed several factors that affect the effectiveness of the application of mind mapping techniques in improving students' critical thinking skills, namely:

Student Learning Style

Students with visual learning styles showed a more significant increase in critical thinking skills than students with auditory or kinesthetic learning styles. This is in accordance with the characteristics of mind mapping which utilizes visual elements such as colors, images, and spatial structures. These findings support the results of Novita et al.'s (2020) research which states that mind mapping techniques are very effective for students with visual learning styles because they help them visualize abstract concepts into more concrete.

Learning Motivation

Students with high learning motivation tend to be more enthusiastic in making mind mapping and more active in group discussions, resulting in a more significant increase in critical thinking skills. According to a study by Putra et al. (2021), learning motivation plays an important role in learning with mind mapping techniques because students need to invest enough time and energy to make quality mind mapping. To overcome this problem, in the second cycle the researcher gave positive reinforcement in the form of praise and appreciation to students who showed effort and progress, which was proven to increase students' motivation to learn.

Teacher Support

Teacher support in the form of scaffolding, constructive feedback, and guiding questions is very helpful for students in developing their critical thinking skills through mind mapping. This is in line with the findings of Zhao et al. (2019) who stated that the role of teachers as facilitators and mediators is very important in learning with mind mapping techniques, especially in the early stages when students are still learning about how to make effective mind mapping.

Material Complexity

The effectiveness of the application of mind mapping techniques is also influenced by the complexity of the learning material. Material that is too complex can make it difficult for students to organize information in the form of mind mapping, while material that is too simple can make mind mapping less challenging for the development of critical thinking skills. This finding is supported by research by Anwar et al. (2024) who suggest that the complexity of the material needs to be adjusted to the level of students' ability so that the application of mind mapping techniques can be optimal in improving students' critical thinking skills.

Reflections and Pedagogical Implications

Based on the results of the research, there are several reflections and pedagogical implications that can be taken to increase the effectiveness of the application of mind mapping techniques in science learning:

The Importance of Modeling and Guided Practice

At the beginning of learning, students need modeling and guided practice from

teachers on how to make effective mind mapping. This is in accordance with the scaffolding principle put forward by Vygotsky (in Karim & Mahmood, 2022), where teachers provide sufficient support at the beginning of learning and gradually reduce that support as students' abilities improve.

Integration with Other Learning Strategies

To maximize the development of critical thinking skills, mind mapping techniques need to be integrated with other learning strategies such as group discussions, problem-based projects, or inquiry learning. According to Suryani et al. (2022), the integration of various learning strategies can create a richer and more immersive learning experience for students, which in turn will encourage the development of their critical thinking skills.

Differentiation Based on Learning Style

Given the difference in the effectiveness of mind mapping techniques based on students' learning styles, teachers need to differentiate in learning, for example by providing visual representation alternatives for students with auditory or kinesthetic learning styles. This is in line with the principle of learning differentiation put forward by Tomlinson and Imbeau (2018), where teachers adjust learning based on students' needs, interests, and learning profiles.

Metacognitive Ability Development

In addition to developing critical thinking skills, mind mapping techniques can also be used to develop students' metacognitive abilities, namely the ability to monitor and evaluate their own thought processes. According to Wang and Chen (2023), metacognitive abilities are an important component of critical thinking because they allow students to recognize and correct flaws in their thinking.

Conclusion

Based on the results of the research and discussion, it can be concluded that the application of mind mapping techniques can improve the critical thinking skills of grade V students in science learning at SDN 77 Rante Lemo. This is shown by the increase in the average score of students' critical thinking skills from 53.15 in the pretest to 65.92 in the posttest cycle I and 77.89 in the posttest cycle II, as well as an increase in the percentage of student learning completeness from 28.57% in the pretest to 60.71% in the posttest cycle I and 85.71% in the posttest cycle II.

The effectiveness of the application of mind mapping techniques in improving students' critical thinking skills is influenced by several factors, namely students' learning styles, learning motivation, teacher support, and material complexity. To maximize the effectiveness of the application of mind mapping techniques, it is necessary to carry out modeling and guided practices, integration with other learning strategies, differentiation based on learning styles, and the development of students' metacognitive abilities.

The implication of this study is the importance of integrating mind mapping techniques in science learning in elementary schools to develop students' critical thinking skills. Teachers need to understand the principles of effective application of mind mapping techniques and consider the factors that affect their effectiveness in order to design optimal learning for the development of students' critical thinking skills.

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