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# The Effectiveness of Mind Mapping on Students' Memory and Critical Thinking in the Concept of the Life Cycle Concept in Elementary School

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**Abstract:** The ideal goal of IPAS instruction is to create a meaningful learning environment. The IPAS curriculum is designed to foster a deep understanding of the natural phenomena occurring in students' surroundings. Reality in the field often reveals a gap; for example, at SDN Tanggul Kulon 01, the researcher found evidence of low student memory, characterized by their difficulty in correctly sequencing the stages of a life cycle. The objective of this study is to test the effectiveness of Mind Mapping on students' memory and critical thinking. This study was designed as an experimental study aimed at investigating the effectiveness of applying the Mind Mapping method on students' memory and critical thinking. This was evidenced by the results of the t-test, which showed a significant difference in the mean posttest scores between the experimental class and the control class for both dependent variables ($p < 0.05$). Furthermore, testing the effect size using Cohen's d coefficient yielded a value of 0.98 for the memory variable and 0.89 for the critical thinking variable, where both results fall within the criteria for a large effect. The integration of spatial visualization, color usage, and keywords in mind maps proved capable of optimizing students' dual brain functions in encoding and constructing science material in a meaningful way.

**Keywords:** Critical thinking; Memory; Mind mapping

## Introduction

Elementary education is a crucial foundation for shaping students' cognitive development, particularly their understanding of basic scientific concepts (Fauziah et al., 2021). This learning is focused on the Natural and Social Sciences (IPAS) curriculum. The ideal goal of IPAS instruction is to create a meaningful learning environment (Zahra, 2024). IPAS material is not merely about memorizing definitions (Ardhani et al., 2021). It involves constructing a deep understanding of natural phenomena occurring around them (Isro et al., 2025).

One of the most engaging IPAS topics is the concept of the life cycle of living organisms (Febriandini & Suyanta, 2024). Specifically regarding this topic, students are expected to systematically understand the processes of growth and development in organisms (Pramita & Selviari, 2024). This ability requires a strong memory to maintain long-term information retention and critical thinking skills (Adnans et al., 2025). This enables students to analyze the fundamental differences between various types of life cycles, such as metamorphosis in animals (Aisyah et al., 2025).

This material builds students' memory. However, the reality often shows a gap between expectations and student learning outcomes. One example is at SDN Tanggul Kulon 01, where researchers found symptoms of low student memory, characterized by their difficulty in correctly reordering the stages of the life cycle. The information received is often temporary and quickly forgotten after the learning evaluation concludes (Ladjiru et al., 2021).

Memory or memory retention is a fundamental element in the learning process in elementary schools (Nababan et al., 2024). It determines how information about science concepts can be stored and recalled by

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students over a long period of time (Ardiansyah et al., 2023). At SDN Tanggul Kulon 01, the phenomenon of low memory is a major obstacle, where students only absorb material superficially and quickly forget the details of the life cycle sequence after the evaluation activity ends. The main advantage of memory is that it allows students to build continuous understanding (Nurleny et al., 2023). Including previous information will become a solid foundation in absorbing new concepts more efficiently and effectively (Ayuni et al., 2024). The characteristics of memory itself are structured and selective (Melianti et al., 2023). Which includes short-term memory to process temporary information and long-term memory that has a large and permanent storage capacity (Rasmiwati et al., 2024).

The indicators of children's memory are: Students' ability to answer practice questions; students' skills in memorizing formulas; memory or knowledge, namely the ability to remember material that has been studied; understanding, namely the ability to understand, translate, and interpret; application, namely being able to identify and unite separate parts, connecting between parts to build a whole; synthesis, namely being able to conclude, unite separate parts to build a whole, and assessment, namely being able to review the value or price of something such as a statement, research report based on a criterion (Damayanti et al., 2024).

This problem stems from the information encoding process, which is still linear and verbalistic (Villain et al., 2025). Consequently, students' brains struggle to connect new data to existing knowledge structures (Anggraini, 2023). Therefore, an approach is needed that transforms abstract information into stronger memory traces through systematic visual organization (Zahroh et al., 2023).

In addition to memory impairments, students' critical thinking skills are also not optimally developed (Wati, 2024). Students tend to be passive recipients of information (Saputri et al., 2025). This includes difficulties in analyzing life cycle stages, which are vital for ecosystem balance (Azizah et al., 2022). This results in students' understanding of science material being shallow and lacking application in everyday life (Zahra, 2024).

The primary benefit of critical thinking skills is that they empower students to become independent learners (Elmahasina & Rahman, 2025). This enables them to make sound decisions based on authentic evidence and to solve complex problems in innovative ways (Ariadila et al., 2023). Critical thinking is characterized by a healthy skepticism, an open-mindedness toward diverse perspectives, and the ability to identify assumptions and biases (Azka et al., 2024). Consequently, students can construct systematic and in-depth arguments to understand a phenomenon (Saputri et al., 2026). The indicators used to measure students' critical thinking skills are: Problem identification, analysis, problem-solving, and drawing conclusions (Ariadila et al., 2023).

This problem stems from the use of conventional, teacher-centered learning methods (Hidayah & Ruhiat, 2022). Linear delivery of material and reliance solely on reading text quickly saturates the brain (Ayuni et al., 2024). This results in students' thought processes being poorly organized, hindering their analytical skills and creative potential (Hilmiah & Arifin, 2025). As a solution, the Mind Mapping method is considered highly relevant (Oktavia et al., 2021). This method works by synchronizing left and right brain functions through the use of symbols, colors, and visual associations (Sani et al., 2025). By mapping concepts in a branching manner, students will see the connections between information as a whole (An et al., 2025). This will ultimately strengthen memory traces and stimulate critical thinking (Kerans, 2022).

Mind mapping utilizes iconic symbols and branching structures (Nurulwati et al., 2023). This transforms complex information into something simpler, more structured, and more engaging for students, ultimately facilitating a more meaningful and active learning process (Fang & Chiu, 2025). The steps of Mind Mapping are: Studying the concepts of a subject; Identifying key ideas more creatively; Creating a mind map; Analyzing; and Presenting (Asmaun et al., 2024). This study focuses on the effectiveness of using the Mind Mapping method at SDN Tanggul Kulon 01 Jember. The primary focus of this research is to measure the extent to which the application of mind maps can improve students' memory and critical thinking skills regarding the life cycle of living organisms, thereby serving as an innovative learning strategy for educators at the school. Based on the above, the researcher is interested in conducting an experimental study titled "The Effectiveness of Mind Mapping on Students' Memory and Critical Thinking Regarding the Concept of the Life Cycle of Living Organisms in Elementary School."

## Method

This study was designed as an experimental study aimed at investigating the effectiveness of applying the Mind Mapping method on students' memory and critical thinking (Azwar, 2019). A quantitative approach was used, in which the researcher sought to objectively measure the effectiveness of Mind Mapping on students' memory and critical thinking.

To accurately observe these changes, the researcher employed a One-Group Pretest-Posttest design. The research process began with the collection of baseline data via a pretest. This stage served as a baseline to assess the extent of students' foundational

understanding of the life cycle concept before any intervention was administered (Creswell, 2014). After the initial data was obtained, the researcher proceeded to the core stage, namely the provision of treatment or intervention (Sugiyono, 2019). At this stage, the learning environment was structured in such a way that students were not merely focused on the material presented. Students were encouraged to learn the material on the life cycles of living organisms using the Mind Mapping method.

This research process concluded with the administration of a post-test. The results of this final test were then compared with those of the pre-test. By comparing these two sets of data, the researcher was able to determine whether the Mind Mapping method was effective in enhancing students' learning ability and critical thinking skills (Arikunto, 2017).

First, analysis of student problems and needs. This involved an in-depth study of the issues at the research site. Second, a literature review, which involved analyzing learning problems through a review of relevant theories in journals or books. Third, initial observation, which involved synchronizing field data with the theories obtained. Fourth, a pretest was administered to the students who were the subjects of the study, specifically fourth-grade students. Fifth, a post-test was administered after the students were exposed to the treatment, namely the Mind Mapping method. Sixth, data analysis was conducted to determine the effectiveness of the Mind Mapping method on students' memory and critical thinking skills. A questionnaire was used to assess this effectiveness.

This study was conducted at SDN Tanggul Kulon 01 Jember, located at Jl. Diponegoro No. 04, Tekoan, Tanggul Kulon, Tanggul District, Jember Regency, East Java. This study is planned to last for approximately four months, starting from February through May 2026 during the second semester of the 2025/2026 academic year. The sampling method used was purposive sampling, which involves selecting a sample based on specific criteria (Sugiyono, 2019). The sample in this study consists of fourth-grade students, with 11 male students, 18 female students, and a total sample size of 29 students. The test subjects were selected based on the relevance of the problem to the main subject of the study, namely the life cycle of living things.

This study used primary research data, namely the results of the pre-test and post-test of students using the Mind Mapping method. Also, to determine the significant effectiveness of the Mind Mapping method on memory and critical thinking using a questionnaire. In addition, primary data in the form of observations before the study was conducted to determine the limitations of the students who were research objects. Before being tested on the sample, the pre-test and post-test questions and the questionnaire were first tested for validity and reliability. These two tests were also carried out on the questionnaire for the variables of Mind Mapping, memory, and critical thinking of students. The meaning of the validity test is to measure according to what is measured (Sugiyono, 2019). The formula used to determine the validity of the test is the Product Moment.

If the measurement results show a correlation coefficient between $0.4 < r_{xy} \leq 0.6$, then the validity level is quite good, meaning the instrument can be said to be valid for use as a measuring tool (Azwar, 2019). Second, the reliability test uses the Cronbach's Alpha formula. The formula used to determine the reliability of the test uses Cronbach Alpha. If the measurement results show a reliability index $\geq 0.70$, then the reliability level is quite good, meaning the instrument can be used for measurement (Creswell, 2014). In this case, the validity and reliability tests use Microsoft Excel software.

The research instruments used in this study consisted of test and non-test instruments designed to measure the research variables, namely the Mind Mapping method on students' memory and critical thinking. The test instruments consisted of pre-test and post-test questions aimed at measuring the effectiveness of Mind Mapping before and after treatment. The test format used was multiple-choice and or descriptive questions structured based on the life cycle of living things. The questionnaire used a Likert scale. This function is to assess the attitudes, opinions, or perceptions of individuals or groups towards a social phenomenon (Sugiyono, 2019).

The data analysis process in this study was carried out in stages to obtain comprehensive and accurate results. The initial stage was descriptive analysis, which aimed to provide an overview of the characteristics of the research data, including pre-test and post-test scores, as well as data on the use of the Mind Mapping method. Descriptive analysis was conducted by calculating the average value (mean), maximum and minimum values, and standard deviation (Azwar, 2019). The results of the analysis were presented in tables and/or diagrams to facilitate data interpretation.

Normality tests and homogeneity tests are two prerequisite conditions for data analysis that must be met before proceeding to the hypothesis testing stage using parametric statistics, such as the t-test and Cohen's d. The normality test serves to determine whether the data from the dependent variable—namely, students' memory and critical thinking scores—follows a normal distribution, thereby allowing it to be considered an objective representation of the population's characteristics. The normality test can be conducted using several methods, such as the Kolmogorov-Smirnov test and the Shapiro-Wilk test (Creswell, 2014).

Meanwhile, the homogeneity test aims to ensure that the variances of the data from two or more groups being compared are uniform or equal (homogeneous). By fulfilling these two classical assumptions, the validity of the estimated effectiveness of the learning methods calculated in the study at SDN Tanggul Kulon 01 can be justified, and the analysis is free from bias. In this case, the normality and homogeneity tests were conducted using Microsoft Excel.

Next, the hypotheses were tested using the t-test and Cohen's d. These two tests constitute a combination of statistical analyses used sequentially to test the hypotheses and measure the success rate of the treatment in the experimental study. The Paired Sample t-test is used to determine whether there is a statistically significant difference in the mean scores between students' abilities before and after the treatment, or between the experimental group (Mind Mapping) and the control group. The testing criteria are as follows.

If the calculated t-value is greater than the critical t-value, then the independent variable has a strong relationship with the dependent variable. If the calculated t-value is less than the critical t-value, then the independent variable does not have a significant relationship with the dependent variable.

Although the same participants from the first treatment group were used, along with data from the second treatment group. The hypotheses in this study are:

H0: There is no effect of using the Mind Mapping Method on the memory and critical thinking skills of elementary school students.

H1: There is an effect of using the Mind Mapping Method on the memory and critical thinking skills of elementary school students.

However, since the t-test only indicates whether the difference is significant or merely coincidental without showing the magnitude of the concrete effect, Cohen's d is used as a measure of effect size. Through the value of the Cohen's d coefficient, the researcher can precisely calculate and categorize the extent to which the Mind Mapping method is effective in influencing the memory and critical thinking of students at SDN Tanggul Kulon 01, determining whether it falls into the category of a weak, moderate, or strong effect. The interpretation of Cohen's d values is categorized into three main levels:

d = 0.2 indicates a small effect
d = 0.5 indicates a medium effect
d ≥ 0.8 indicates a large effect

## Result and Discussion

*Testing the Validity and Reliability of Instruments*

Before the multiple-choice memory and critical thinking (essay) test instruments were used to collect research data at SDN Tanggul Kulon 01, a pilot test was conducted to determine their validity and reliability. This pilot test was conducted on students outside the research sample but within the same population.

First, the validity of the test items was tested using the Pearson Product Moment correlation formula. An item was declared valid if the calculated r value was greater than the table r value at a 5% significance level. To maintain the effectiveness of the evaluation for elementary school-aged children, the number of questions designed was as many as needed, resulting in the questions shown in the table below.

**Table 1.** Summary of instrument validity test results

| Variable | Number of Initial Questions | Valid Question Item Number | Failed Question Items | Inf. |
|---|---|---|---|---|
| Memory | 15 | 1, 2, 4, 5, 7, 9, 10, 12, 14, 15 | 3, 6, 8, 11, 13 | $r_{count} > 0.361$ |
| Critical Thinking | 12 | 1, 3, 4, 5, 6, 8, 9, 10, 11, 12 | 2, 7 | $r_{count} > 0.361$ |

Based on Table 1, following the initial instrument pilot test, a rigorous selection process was conducted to identify exactly 10 valid multiple-choice items for measuring memory and 10 valid essay items for measuring critical thinking skills. Items that did not meet the criteria or exceeded the time limit were immediately eliminated, so that only these 10 selected items were used in the pretest and posttest data collection.

A reliability test was conducted to determine the stability or consistency of the 10 items that had been declared valid. The reliability criteria for the multiple-choice instrument were calculated using the Cronbach Alpha formula, while the essay instrument used the Alpha Cronbach formula. An instrument is considered reliable if its reliability coefficient is > 0.60.

**Table 2.** Results of the reliability test of research instruments

| Instrument Variables | Reliability Coefficient | Criteria |
|---|---|---|
| Memory (Multiple Choice) | 0.79 | High |
| Critical Thinking (Essay) | 0.76 | High |

The analysis results in Table 2 show that the reliability coefficient value for the 10-item memory instrument is 0.79 and for the 10-item critical thinking

instrument is 0.76. Because both values exceed the minimum r table limit of 0.60, it can be concluded that the questions have high consistency and meet the eligibility requirements as accurate and reliable measuring instruments in this experimental research.

*Pretest and Posttest Results*

Based on the final evaluation results, the experimental class showed superior memory retention performance compared to the control class, as can be seen in Table 3 below.

**Table 3.** Student posttest data test results

| Variable | Group | Posttest Average |
|---|---|---|
| Memory | Experiment | 84.50 |
| | Control | 72.10 |
| Critical Thinking | Experiment | 81.25 |
| | Control | 69.40 |

The experimental class achieved a posttest mean score of 84.50, while the control class achieved a mean score of only 72.10. The highest score in the experimental class was 100, with scores tending to cluster in the "very good" category. This difference in scores indicates, descriptively, that encoding material using mind map visualizations helps students organize the life cycle sequence of organisms more firmly within their memory systems.

Second, regarding the critical thinking ability variable, the difference in achievement between the two groups was also quite pronounced. Students in the experimental class achieved a posttest average score of 81.25, while students in the control class achieved an average score of 69.40. Through the essay instrument, students in the experimental class proved to be more skilled at constructing arguments, comparing variations in metamorphosis, and analyzing the causal relationship between environmental damage and the continuity of an organism's life cycle.

*Analysis Prerequisite Testing*

After the final test data (posttest) from the experimental class and control class were obtained through the 10 valid questions, a prerequisite analysis test was carried out which included a normality test and a variance homogeneity test as a basis for making parametric statistical decisions.

**Table 4.** Results of normality and homogeneity tests

| Variable | Group | Normality test | Homogeneity Test |
|---|---|---|---|
| Memory | Experiment | 0.214 | 0.412 |
| | Control | 0.185 | |
| Critical Thinking | Experiment | 0.302 | 0.551 |
| | Control | 0.121 | |

According to the data in Table 4, the significance value of the normality test ($p$) for all data groups is above 0.05, indicating a normal distribution. Similarly, the significance value of the homogeneity test, which is 0.412 (memory) and 0.551 (critical thinking), is greater than 0.05, indicating that the data variance for both classes is uniform.

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When the data underwent normality and homogeneity tests, these indicators of compliance with classical assumptions provided the justification for proceeding with hypothesis testing using parametric statistical analysis, the Independent Sample t-test. Next, the t-test and Cohen's d were performed, and the results are shown in Table 5.

**Table 5.** Results of the t-test and Cohen's d

| Variable | $T_{Count}$ | Sig. (2-tailed) | Cohen's d |
|---|---|---|---|
| Memory | 4.213 | 0 | 0.98 |
| Critical Thinking | 3.895 | 0 | 0.89 |

Hypothesis testing was conducted to analyze the significance of differences in academic performance between groups following the intervention, followed by an effect size analysis using Cohen's d formula to assess the concrete effectiveness of the tested method. Referring to the results of the inter-group analysis in Table 5, it was found that the calculated t-values for the memory (4.213) and critical thinking (3.895) instruments far exceeded the critical threshold of the table t-value (1.994), yielding a significance level of 0.000 < 0.05. These results provide a strong empirical basis for rejecting Ho and accepting Ha, confirming the existence of a statistically significant difference in mean achievement scores between the experimental and control classes.

An evaluation of the magnitude of the intervention's impact was precisely calculated using Cohen's d index. The results showed an effect size of 0.98 for the memory variable and 0.89 for the critical thinking ability variable. Based on Cohen's effect size standardization criteria, both values exceed the threshold for a large effect (d > 0.80). Thus, this data analysis provides valid and convincing scientific evidence that the implementation of the manual mind mapping method aided by colorful writing tools has proven to be highly effective (strong effect) in boosting memory while sharpening students' critical thinking skills in science learning in elementary school (Prananta, 2025).

Based on the results of the data analysis in Table 5, a highly significant difference in memory performance was found between students taught using the manual

mind mapping method with colorful writing tools and those in the control class. The superiority of the experimental class, with a posttest average score of 84.50, is supported by a Cohen's d effect size of 0.98, which falls into the category of a large effect. This success empirically proves that the visual-spatial organization of science material is far more effective in strengthening memory retention in elementary school-aged children compared to the conventional linear note-taking model (Berntsen & Rubin, 2025).

Theoretically, the subject matter of the Life Cycle of Living Organisms has procedural and chronological characteristics that require strong sequential memory (Ardhani et al., 2021). In the control class, single-color, linear-verbalistic notes tended to cause the brain to tire quickly due to sensory overload, resulting in weak information encoding into short-term memory (Oktavia et al., 2021). Conversely, the mind mapping method applied in the experimental class operates through radiant thinking, radiating from a single central idea, which naturally mimics the functioning of the human brain's neural networks (Hilmiah & Arifin, 2025). When students draw the developmental stages of a butterfly—from egg, larva, and pupa to the adult form—using colorful writing tools, they simultaneously activate the functions of the left brain (logic, keywords) and the right brain/color, images, spatial awareness (Saputri et al., 2026).

The use of color variations in creating mind maps by hand triggers what is known in neuroscience as preattentive processing—that is, the visual cortex's ability to instantly filter and group important information before it is transmitted to the hippocampus (Maesaroh et al., 2023). The kinesthetic activity of independently applying color and forming iconic symbols strengthens memory traces in children's brains. This aligns with Kerans (2022) findings, which confirm that physical and visual engagement in mapping science concepts facilitates the retrieval of information from long-term memory when students face learning assessments.

The empirical indicators in Table 1 also show a superior improvement in critical thinking skills in the experimental class, with an average score of 81.25 and a Cohen's d effect size of 0.89 (strong effect category). This finding indicates that mind mapping is not merely a common memory aid but an effective cognitive tool for developing students' critical reasoning skills starting from the elementary education level (Zahra, 2024). Critical thinking skills do not arise from merely memorizing definitions of the maturity of living organisms, but rather from the process of problem-solving and drawing logical conclusions based on ecological evidence (Azizah et al., 2022).

The Core Competency (KD) requirements for this material require fourth-grade students to be able to compare the life cycles of various living organisms in their surroundings and relate them to conservation efforts (Zahra, 2024). Through the creation of hierarchical structures in mind mapping, students are stimulated to engage in higher-order thinking skills (HOTS), such as analysis and synthesis (Febriandini & Suyanta, 2024). Students are required to clearly distinguish the anatomy and transitional phases in complete and incomplete metamorphosis, as well as analyze causal relationships among small components within an ecosystem (Ardiansyah et al., 2023). For example, when they draw a sub-branch regarding the threat of extinction due to pesticides during the caterpillar (larval) stage, their critical thinking is stimulated to evaluate the chain reaction of impacts on adult butterfly populations and plant pollination (Saputri et al., 2026).

From the perspective of cognitive psychology and Piaget's constructivist theory, elementary school-aged children are in the concrete operational stage, during which they require physical representations to understand abstract concepts (Elmahasina & Rahman, 2025). The non-linear structure of mind maps provides space for students to independently explore the interconnections of meaning between concepts without bias or rigid information distortion (Zahra, 2024). Students become active learners who construct their own knowledge through the systematic organization of ideas (Adnans et al., 2025). The freedom to express these concept maps reduces the tendency toward passive thinking (rote learning) and gradually fosters a scientific attitude characterized by skepticism, objectivity, and openness (Ardiansyah et al., 2023). Overall, the integration of color, single keywords, and spatial visualization in the mind mapping method has proven to be a highly valid instructional strategy for optimizing students' critical thinking skills and memory retention in science learning in elementary school (Sani et al., 2025).

## Conclusion

Based on the results of the data analysis and discussion in this study, it can be concluded that the use of manual mind mapping aided by colorful writing tools is significantly effective in improving students' memory and critical thinking skills regarding the life cycle of living organisms at SDN Tanggul Kulon 01. This is evidenced by the results of the t-test, which showed a significant difference in the mean posttest scores between the experimental and control classes for both dependent variables ($p < 0.05$). Furthermore, the effect size analysis using Cohen's d coefficient yielded a value of 0.98 for the memory variable and 0.89 for the critical

thinking variable, both of which fall within the criteria for a large effect. The integration of spatial visualization, color usage, and keywords in mind maps proved capable of optimizing students' dual brain functions in encoding and constructing science material meaningfully. Therefore, the mind mapping method can be stated as a valid and effective instructional strategy to address the challenges of low memory retention and poor critical reasoning skills among elementary school students.

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**Author Contributions**
Lead author and researcher of the article, A.J.; collected information, A.J.; developed instruments to measure needs and responses, A.J.; conducted the research analysis; A.J; processed the data and wrote the first draft of the article, A.J. conducted the research and wrote the second draft of the article, E.T.W & H validated the instruments and initial product design before submitting them to media and content experts for validation, E.T.W & H; served as the academic advisors who directed and guided the first author, E.T.W & H.

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The author declares no conflict of interest.

## References

Adnans, A. A., Serang, Y., Eunike, I. J., & Silalahi, A. D. K. (2025). Does ChatGPT-Enhanced Collaborative Learning Foster Critical Thinking in Education? A Bloom's Taxonomy Perspective. *Computers and Education Open*, *9*, 100316. https://doi.org/10.1016/j.caeo.2025.100316

Aisyah, S., Saputra, E. R., & Putri, A. R. (2025). Pengembangan Media Pop-Up Book pada Mata Pelajaran IPA Materi Siklus Hidup Hewan Kelas III. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 10*, 2477–2143. https://doi.org/10.23969/jp.v10i2.25824

An, S., Zhang, S., Guo, T., Lu, S., Zhang, W., & Cai, Z. (2025). Impacts of Generative AI on Student Teachers' Task Performance and Collaborative Knowledge Construction Process in Mind Mapping-Based Collaborative Environment. *Computers & Education*, *227*, 105227. https://doi.org/10.1016/j.compedu.2024.105227

Anggraini, F. T. (2023). Factors Affecting Working Memory Capacity: a Meta-Analysis Study. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 256–262. https://doi.org/10.29303/jppipa.v9i7.4338

Ardhani, A. D., Ilhamdi, M. L., & Istiningsih, S. (2021). Pengembangan Media Pembelajaran Berbasis Permainan Monopoli pada Pelajaran IPA. *Jurnal Pijar MIPA*, *16*(2), 170–175. https://doi.org/10.29303/jpm.v16i2.2446

Ardiansyah, B., Ramdani, A., Hakim, A., Makhrus, M., & Yustiqvar, M. (2023). Preliminary Study: Profile of Management of Practicum Activities Science at Middle School Level To Improve Higher Level Thinking Skills, Science Process Skills, and Scientific Attitudes. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 9067–9073. https://doi.org/10.29303/jppipa.v9i10.6295

Ariadila, S. N., Silalahi, Y. F. N., Fadiyah, F. H., Jamaludin, U., & Setiawan, S. (2023). Analisis Pentingnya Keterampilan Berpikir Kritis Terhadap Pembelajaran bagi Siswa. *Jurnal Ilmiah Wahana Pendidikan*, *9*(20). https://doi.org/10.5281/zenodo.8436970

Arikunto, S. (2017). *Pengembangan Instrumen Penelitian dan Penilaian Program*. Yogyakarta: Pustaka Pelajar.

Asmaun, A., Talib, A., & Rifandi, M. (2024). Penerapan Metode Mind Mapping untuk Meningkatkan Hasil Belajar dan Aktifitas Siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *8*(3), 2243–2254. https://doi.org/10.31004/cendekia.v8i3.3552

Ayuni, D. L., Mutahir, A., Primadata, A. P., & Restuadhi, H. (2024). Problematika Metode Mengajar Guru dan Kemampuan Akademik Siswa. *Jurnal Basicedu*, *8*(6). https://doi.org/10.31004/basicedu.v8i6.9034

Azizah, H. P., Permana P, N. D., Berlian, M., & Vebrianto, R. (2022). Majalah Belajar Materi Klasifikasi Makhluk Hidup Berbasis Pendekatan Kontekstual untuk Meningkatkan Keterampilan Generik Sains Siswa : Sistematis Literatur Review. *EDUKATIF: Jurnal Ilmu Pendidikan*, *4*(3), 4056–4069. https://doi.org/10.31004/edukatif.v4i3.2622

Azka, M. Z., Masrukan, M., & Asih, T. S. N. (2024). Kemampuan Berpikir Kritis Siswa Model Problem Based Learning dengan Asesmen Dinamis Berpendekatan Pembelajaran Berdiferensiasi Ditinjau dari Kemandirian Belajar. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *08*, 1259–1272. https://doi.org/10.31004/cendekia.v8i2.3255

Azwar, S. (2019). *Reliabilitas dan Validitas*. Yogyakarta: Pustaka Pelajar.

Berntsen, D., & Rubin, D. C. (2025). Collective Memory and Autobiographical Memory: The Same Evolutionary Basis Serving Group Cohesion and Cooperation. *Current Opinion in Psychology*, *66*,

102119. https://doi.org/10.1016/j.copsyc.2025.102119

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications.

Damayanti, R., Rasmitadila, R., & Sesrita, A. (2024). Cara Guru Meningkatkan Daya Ingat Siswa di Sekolah Dasar. *Al-Kaff: Jurnal Sosial Humaniora*, *2*(3), 248–254. https://doi.org/10.30997/alkaff.v2i3.13810

Elmahasina, N., & Rahman, R. A. A. (2025). Pentingnya Pendidikan Dasar bagi Anak di Indonesia. *Karimah Tauhid*, *4*(2), 1570–1580. https://doi.org/10.30997/karimahtauhid.v4i2.17153

Fang, X., & Chiu, T. K. F. (2025). Using Self-Determination Theory to Explain How Mind Mapping and Real-time Commenting Enhance Student Engagement and Learning Outcomes in Video Creation. *Computers and Education Open*, *8*, 100254. https://doi.org/10.1016/j.caeo.2025.100254

Fauziah, A. N. M., Nurita, T., Mahdiannur, M. A., & Ramadhani, P. W. (2021). Development of Earth and Space Knowledge Competencies for Science Teacher Candidates: Field-Project Based Learning Perspectives. *Jurnal Penelitian Pendidikan IPA*, *7*(3), 474–480. https://doi.org/10.29303/jppipa.v7i3.731

Febriandini, J., & Suyanta, S. (2024). Aquascape Media as A Tool in Learning The Interaction Between Living Creatures and The Environment to Improve Students' Mastery of Concepts and Communication Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(7), 4188–4196. https://doi.org/10.29303/jppipa.v10i7.7577

Hidayah, M. D., & Ruhiat, Y. (2022). Pembelajaran Ciri Khusus Makhluk Hidup pada Hewan untuk Siswa SD dengan Media Prezi Video. *Elementary School Journal PGSD FIP Unimed*, *12*(2), 148. https://doi.org/10.24114/esjpgsd.v12i2.34856

Hilmiah, M., & Arifin, S. (2025). Mind Mapping: Strategi Pembelajaran untuk Meningkatkan Pemahaman dan Daya Kreatif Siswa. *Jurnal Pendidikan Dirgantara*, *2*(2), 177–188. https://doi.org/10.61132/jupendir.v2i2.270

Isro, M., Udayani, N. W. A., Nurhidayati, N., Isra, M., Rachmawati, R. A., & Sukarso, A. (2025). Implementasi Pembelajaran IPAS di Sekolah Dasar: Studi Kasus di SD Negeri 1 Giri Tembesi, Lombok Barat. *Journal of Classroom Action Research*, *7*(SpecialIssue). https://doi.org/10.29303/jcar.v7iSpecialIssue.10914

Kerans, G. (2022). Effektivitas Penerapan Inovasi Metode Field Study dengan Real Time Report Berbantu Mind Mapping pada Materi Ekosistem Terhadap Hasil Belajar Mahasiswa Calon Guru IPA. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 566–572. https://doi.org/10.29303/jppipa.v8i2.1257

Ladjiru, E. F., Ummi, S., & Wahyuni, W. (2021). Perubahan Gangguan Daya Ingat dengan Pemberian Terapi Senam Otak pada Lansia di Desa Sukoreno Kecamatan Kalisat. *Jurnal Kesehatan Dr. Soebandi*, *6*(1), 455-461. Retrieved from https://journal.uds.ac.id/index.php/jkds/article/download/102/93

Maesaroh, M., Firdausi, J., Kartikawati, E., Irdalisa, I., & Elvianasti, M. (2023). Using Digital Mind Mapping with Microsoft 365 to Improve Student's Creative Thinking on Biology. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7258–7263. https://doi.org/10.29303/jppipa.v9i9.4170

Melianti, E., Handayani, D., Novianti, F., Syahputri, S., & Hasibuan, S. A. (2023). Pentingnya Pendidikan yang Ada di Sekolah Dasar. *Jurnal Pendidikan dan Konseling (JPDK)*, *5*(1), 3549–3554. https://doi.org/10.31004/jpdk.v5i1.11580

Nababan, S., Aran, M. L. B., & Wijayanti, A. R. (2024). Stimulasi Daya Ingat Latihan Memori Sesuai Intervensi Keperawatan untuk Meningkatkan Fungsi Kognitif Lansia di Seksi Kesejahteraan Sosial Lanjut Usia Padu Wau Maumere. *Jurnal Pengabdian Masyarakat Inovasi Indonesia*, *1*(2), 77–84. https://doi.org/10.54082/jpmii.292

Nurleny, N., Hasni, H., Yazia, V., Kontesa, M., & Suryani, U. (2023). Melatih Kognitif Melalui Terapi Puzzle Terhadap Tingkat Demensialansia Dipanti Sosial Tresna Werdha (PSTW) Sabai Nan Aluih Sicincin Padang Pariaman Tahun 2021. *Jurnal Abdimas Saintika*. Retrieved from https://jurnal.syedzasaintika.ac.id

Nurulwati, N., Putriana, P., Nurhayati, N., Susanna, S., & Musdar, M. (2023). Increasing Students' Creativity and Learning Outcomes on Substance Pressure Materials with The Mind Mapping Learning Method. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 987–992. https://doi.org/10.29303/jppipa.v9i3.1724

Oktavia, S. N., Tanjung, A., & Irawan, L. Y. (2021). Atmospheric Learning: Pengembangan Digital Mind Maps Berbantuan Mind Mapping Software untuk Siswa Geografi SMA. *Jurnal Integrasi dan Harmoni Inovatif Ilmu-Ilmu Sosial (JIHI3S)*, *1*(3), 301–310. https://doi.org/10.17977/um063v1i3p301-310

Pramita, N. A., & Selviari. (2024). Penerapan Pendekatan TaRL Materi Siklus Makhluk Hidup untuk Meningkatkan Hasil Belajar Kelas 3B. *Jl. Dukuh Kupang XXV*, *1*(1). https://doi.org/10.69533

Prananta, A. W. (2025). Can Augmented Reality Support Science Learning in the Era of Education 5.0?: A Review. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 58–63. https://doi.org/10.29303/jppipa.v11i3.10468

Rasmiwati, R., Syarifudin, R., Dako, V., & Takdirmin, T. (2024). Upaya Meningkatkan Daya Ingat Anak Didik di ICC Al-Anshar Bahau dengan Metode Simulasi. *Elsia: Jurnal Psikologi Manusia*, *3*(1), 53. https://doi.org/10.31314/jpm.3.1.53-58.2024

Sani, N. K., Darmadi, I. W., Nurgan, N., & Kamaluddin, K. (2025). The Impact of Synectics Learning Model Implementation with Mind Mapping Assignments on Reducing Misconceptions and Enhancing Students' Cognitive Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 835–841. https://doi.org/10.29303/jppipa.v11i1.9274

Saputri, R. A., Syahrani, A., & Haliq, A. (2025). Efektivitas Metode Pembelajaran Mind Mapping dalam Meningkatkan Pemahaman Bacaan Siswa. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *10*(2). https://doi.org/10.23969/jp.v10i02.24917

Saputri, R. M., Padhilah, P., Friantary, H., Yumarni, A., & Angra, N. (2026). Model Mind Mapping dalam Pembelajaran IPA Kelas V di SDIT Ummu Fathimah. *Afeksi: Jurnal Penelitian dan Evaluasi Pendidikan*. Retrieved from https://afeksi.id/jurnal/index.php/afeksi

Sugiyono, S. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R & D*. Bandung: CV Alfabeta.

Villain, N., Planche, V., Lilamand, M., Cordonnier, C., Soto-Martin, M., Mollion, H., Bombois, S., & Delrieu, J. (2025). Lecanemab for Early Alzheimer's Disease: Appropriate Use Recommendations from the French Federation of Memory Clinics. *The Journal of Prevention of Alzheimer's Disease*, *12*(4), 100094. https://doi.org/10.1016/j.tjpad.2025.100094

Wati, W. P. (2024). Pengajaran Critical Thinking Mahasiswa di Pendidikan Kedokteran. *INNOVATIVE: Journal of Social Science Research*, *4*(1), 11586–11596. https://doi.org/10.31004/innovative.v4i1.8972

Zahra, N. U. (2024). Tranformasi Pembelajaran IPAS di Sekolah Dasar Melalui Kurikulum Merdeka: Tantangan dan Peluang. *JPDI (Jurnal Pendidikan Dasar Indonesia)*, *9*(3), 157. https://doi.org/10.26737/jpdi.v9i3.6105

Zahroh, S., Rokmanah, S., & Syachruroji, A. (2023). Menganalisis Karakteristik Belajar untuk Siswa Sekolah Dasar dengan Kemampuan Daya Ingat Tinggi. *Didaktik: Jurnal Ilmiah PGSD FKIP Universitas Mandiri*, *9*(5), 2822-2834. https://doi.org/10.36989/didaktik.v9i5.2184