Identification of Critical Thinking Skills in Physics Based on Students Thinking Style in Class XI SMAN 5 Wajo

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Abstract *- This research is a quantitative study which aims to determine the description of critical thinking abilities in physics in terms of students' thinking styles. The thinking styles that will be used in this research are concrete sequential, abstract sequential, concrete random, and abstract random thinking styles. The sample in this research was all 37 students in class XI of SMAN 5 Wajo. Data collection techniques use thinking style tests and physics critical thinking ability tests. The thinking style instrument used in this research is an instrument developed by De Porter which consists of 15 numbers with four answer choices. Meanwhile, students' critical thinking abilities are in the form of test instruments. The research data were analyzed using descriptive statistical analysis, data presentation and drawing conclusions. Based on the results of data analysis, it was found that students who had a dominant concrete sequential thinking style had the critical thinking category, students who had a dominant abstract sequential thinking style had a level of critical thinking ability in the very critical category, while students who had a dominant concrete random thinking style had The level of critical thinking ability is in the non-critical category, and students who have a dominant abstract random thinking style have the level of critical thinking ability in the moderately critical category.*

Keywords*: Critical Thinking Skills; Thinking Style; Physics*

INTRODUCTION

One of the important skills that 21st century students must have been Critical thinking (Syarlisjiswan et al, 2021; Febriant et al, 2021; Musaad & Suparman, 2023). Critical thinking is defined as the ability to analyze, evaluate, and conclude information logically and systematically, which is essential for solving complex problems (Afrianti, 2019; Suryadi, 2025; Robbani, 2025). This ability not only helps students understand academic concepts but also prepares them to become individuals who are able to disseminate information, disseminate evidence, and make decisions based on logic and facts (Sumargono et al, 2022; Azmi et al, 2025). Critical thinking can get used to choosing the best alternative choices according to themselves, being able to act rationally and having the courage to be responsible for all decisions taken (Firdaus et al, 2019).

However, various studies show that students' critical thinking skills, especially in physics learning, are still relatively low (Sujanem et al, 2022; Solihah et al, 2023; Azmi et al, 2025). This is a serious challenge in physics learning, where learning often still focuses on memorization rather than

developing critical thinking skills (Marisda et al, 2022; Komariyatin & Dimas, 2022; Siyamuningsih et al, 2024).

One of the factors that is thought to influence critical thinking skills is the student's thinking style (Evendi et al, 2022). Thinking style is a unique way of learning both related to the way of receiving, or processing information towards information, or habits related to the learning environment (Dwirahayu, 2016; Lusiana, 2017; Sternberg, 2018). Therefore, a person's thinking style will vary according to their habits in processing and organizing the information they obtain. Different students' thinking styles are also influenced by the

habits they carry out in everyday life (Ismail et al, 2023; Mustafa, 2022).

Thinking styles consist of 4 groups namely concrete sequential, abstract sequential, concrete random and abstract random (Mansyur et al, 2024; Pramono et al, 2025). Someone who has concrete sequential thinking adheres to reality and processes information in an orderly, linear and sequential manner. While someone who has concrete random thinking has an experimental attitude accompanied by less structured behavior. It is different from someone who has abstract random thinking where the real world is a world of feelings and emotions. They are interested in nuances and some tend to mysticism. While someone who has abstract sequential thinking is someone who likes to think in concepts and analyze information. In this study, the group of thinking styles that will be studied are 4 thinking styles (Devy et al, 2022; Widiyastuti et al, 2022).

The study found a strong positive correlation (r = 0.714) between students' critical thinking styles and their critical thinking abilities, indicating that the way students think critically significantly influences their overall critical thinking skills. Regression analysis revealed that critical thinking style accounts for 51% of the variance in critical thinking ability. This suggests that understanding and assessing students' thinking styles can help educators select appropriate teaching materials and methods, ultimately enhancing students' critical thinking development in biology education (Juliyanti & Syahfitri, 2024).

Thus, it is necessary to conduct research related to the Identification of Critical Thinking Skills in Physics Learning Based on the Thinking Style of Grade XI Students at SMAN 5 Wajo. The purpose of this study is to provide an overview of critical thinking skills in physics reviewed from the thinking style of students at SMAN 5 Wajo.

RESEARCH METHODS

This research used a quantitative approach with a cross-sectional design. The cross-sectional design was chosen because this study aims to identify the relationship between critical thinking skills in physics and students' thinking styles at a certain point in time. This design is suitable for research that wants to collect data quickly and efficiently and allows researchers to analyze the relationship between variables without having to follow the development of research subjects over a long period of time (Creswell, 2018). The purpose of this study is to describe or illustrate the critical thinking skills of students in physics learning. The research was conducted in the 2023/2024 academic year at SMA Negeri 5 Wajo located in Ongkoe Village, Belawa District, Wajo Regency. The population in this study were all students of class XI MIPA SMAN 5 Wajo in the 2023/2024 academic year. The research sample consisted of 37 students, namely all class XI MIPA at SMAN 5 Wajo. This research uses a saturated sampling technique found in non-probability sampling. According to Sugiono (2014) saturated sampling is when all populations are used as samples. The use of saturated sampling techniques in this study is based on the consideration that the population is relatively small (37 students) and the study aims to obtain a comprehensive picture of the critical thinking skills of physics and the thinking styles of class XI MIPA students of SMAN 5 Wajo. By sampling ensuring the entire population as, this study that all variations in student characteristics are represented, so that the results of the study can be generalized to the entire population. In addition, this technique is also efficient in

time and resources, and in accordance with the objectives of the study which want to identify the relationship between thinking styles and critical thinking skills of physics.

The data collection technique in this study was by using a questionnaire and a test of students' critical thinking skills. The questionnaire contained a set of questions for respondents to answer. Before filling out the questionnaire, students were given instructions for filling out the questionnaire.

The research instrument includes a thinking style questionnaire, the questionnaire was developed by De Porter, this thinking style questionnaire consists of 15 points, each point contains 4 thinking styles, namely concrete sequential, abstract sequential, concrete random and abstract random. Then students are asked to choose 2 traits that best describe themselves.

Meanwhile, the critical thinking ability instrument used in this study uses 10 essay questions that have been validated by experts, which contain 4 indicators of Ennis' critical thinking (2011), namely the ability to provide simple explanations, the ability to provide further explanations, basic skills, and the ability to conclude. Critical thinking ability contains 4 categories, namely, not critical, quite critical, critical, and very critical.

Before the research instrument was used, content validity of research instrument testing by two experts. Data obtained from the assessment of two experts on the physics problem instrument were analyzed using the expert agreement index, namely Gregory with the condition that if $r \geq 0.75$ or $\geq 75\%$ then the tested instrument can be declared feasible to be used and tested. Based on the results of the internal consistency test, for the critical thinking ability instrument after being analyzed using the Gregory equation, $r = 1$ was obtained. This shows that the results of the critical thinking ability test of students at SMAN 5 Wajo are valid, reliable and feasible to be used in research.

RESULTS AND DISCUSSION

In this chapter, data and research results are presented regarding students' abilities in solving physics problems in terms of students' thinking styles. Data collection in this research was carried out through administering a thinking style questionnaire and a physics critical thinking ability test. The questionnaire used is a thinking style questionnaire to collect data about students' thinking style tendencies and a critical thinking ability test to collect data about students' critical thinking abilities in physics.

Results

The critical thinking ability scores of class XI students were analyzed using the following frequency distribution table:

Table 1. Categorization of Critical Thinking Ability of Class XI Students of SMAN 5 Wajo.

Interval Score	Category	Frequency	Percentage (%)
31-40	VC	5	13.5
21-30	C	14	37.8
11-20	QC	9	24.3
0-10	NC	9	24.3
	Total	37	100

Based on Table 1 above, it shows the critical thinking ability score of students at SMAN 5 Wajo, there are 37 students who took the critical thinking test, based on the results of the critical thinking test, there are 5 students who have a very critical category, there are 14 students who have a critical category, there are 9 students who have a fairly critical category, and 9 students who have a non-critical category. The results of the questionnaire test of the thinking style of class XI MIPA students at SMAN 5 Wajo are as shown in Table 2.

Based on Table 2, the number of students with a concrete sequential thinking style is 12 students (32.4%), 11 students (29.8%) with an abstract sequential thinking style, 7 students (18.9%) with a concrete random thinking style, and 7 students (18.9%) with an abstract random thinking style.

Table 2. Results of the Student Thinking Style Questionnaire Test.

Thinking Style	Frequency	Percentage (%)
Concrete Sequential	12	32.4
Abstract Sequential	11	29.8
Concrete Random	7	18.9
Abstract Random	7	18.9
Total	37	100

Based on the data presented in Table 2, there are significant differences in the distribution of thinking styles among students. The concrete sequential thinking style is the most dominant, with 12 students (32.4%) showing a preference for this style. This style tends to indicate that students are more comfortable with structured information, clear steps, and concrete tasks. They may excel in situations where detailed processes and logistical sequences are required.

On the other hand, the abstract sequential thinking style was chosen by 11 students (29.8%). Students with this style tend to be more analytical and logical, able to understand abstract concepts and connect ideas systematically. They may be better at solving problems that require theoretical thinking and deductive reasoning.

Abstract random and concrete random thinking styles were each chosen by 7 students (18.9%). Students with concrete random thinking styles tend to be more intuitive and experimental, often seeking unconventional solutions and being more flexible in their approach. Meanwhile, students with abstract random thinking styles may be more creative and holistic, preferring to work with big ideas and indirect relationships.

In the context of critical thinking skills, these differences in thinking styles can affect how students approach problems. Students with a sequential concrete style may be better at following established procedures, while students with a sequential abstract style may be stronger at logical analysis. Students with random concrete and random abstract styles may be more innovative and able to see multiple perspectives, which are also important aspects of critical thinking. Therefore, understanding these variations in thinking styles can help in designing more effective teaching approaches to develop students' critical thinking skills.

Meanwhile, the results of the analysis of students' critical thinking skills based on thinking style, obtained the following results:

1. Description of critical thinking abilities of students who have a concrete sequential thinking style

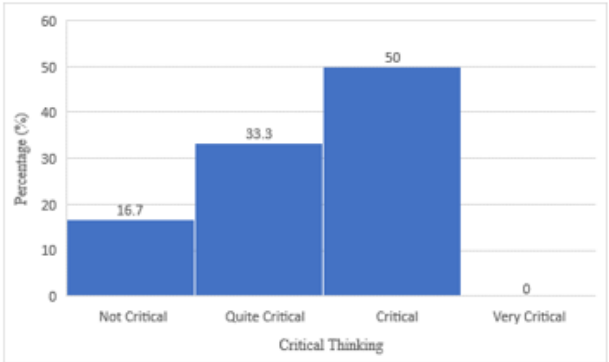

Figure 1. Test Results of Students with Concrete Sequential Thinking Style.

Based on Figure 1, it shows that there are 12 students who have a concrete sequential thinking style type, with critical, fairly critical and non-critical categories. In this type of thinking style, there are 6 students who have a critical category with a percentage of 50%, 4 fairly critical with a

percentage of 33.3% and 2 non-critical with a percentage of 16.7%.

2. Description of critical thinking skills of students who have an abstract sequential thinking style

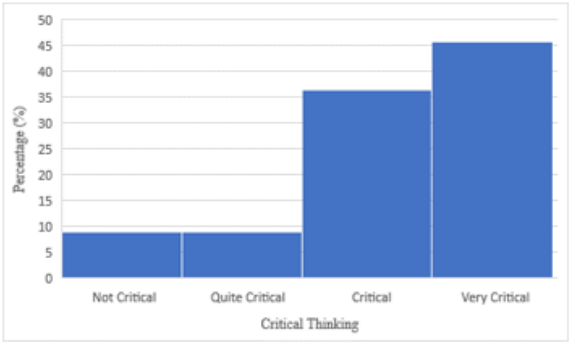

Figure 2. Test Results for Students with Abstract Sequential Thinking Style.

Based on Figure 2 above, it shows that there are 11 students who have an abstract sequential thinking style, with categories of very critical, critical, quite critical and not critical. In this type of thinking style, there are 5 students who have a very critical category with a percentage of 45.6%, 4 critical with a percentage of 336.4%, 1 quite critical with a percentage of 9% and 1 not critical with a percentage of 9%.

3. Description of critical thinking skills of students who have a concrete random thinking style

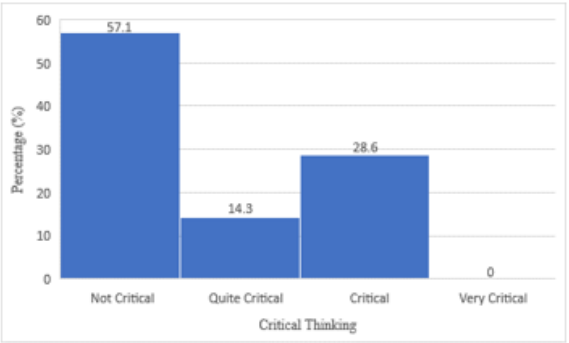

Figure 3. Test Results for Students with Concrete Random Thinking Style

Based on Figure 3 above, it shows that there are 7 students who have a concrete random thinking style type, with critical, quite critical and not critical categories. In this type of thinking style, there are 2 students who have a critical category with a percentage of 28.6%, 1 is quite critical with a percentage of 14.3% and 4 are not critical with a percentage of 57.1%.

4. Description of critical thinking skills of students who have an abstract random thinking style

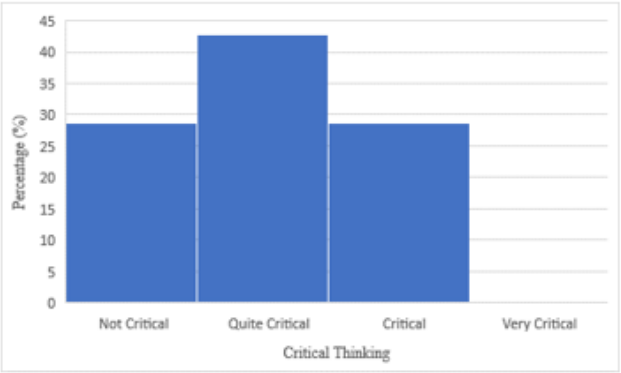

Figure 4. Test Results of Students with Abstract Random Thinking Style.

Based on Figure 4 above, it shows that there are 7 students who have a concrete random thinking style type, with critical, fairly critical and non-critical categories. In this type of thinking style, there are 2 students who have a critical category with a percentage of 26.8%, 3 fairly critical with a percentage of 42.8% and 2 non-critical with a percentage of 28.6%.

Discussion

1. Identification of Critical Thinking Skills in terms of Concrete Sequential Thinking Style (CS)

Based on the research data, there are 12 students who have a concrete sequential thinking style, where there are 6 students who have a critical thinking category, 4 students who have a fairly critical thinking category, and 2 students who have a non-critical thinking category. The results of the study showed that most students were able to write down what was known completely and sequentially and what was asked from the questions well. This is in accordance with

Zakir (2015) that students with the SK thinking style always collect known facts completely and in order based on the problem identification carried out.

Students with the characteristics of the SK type of thinking only answer questions with what is understood from the problems given, students do what is known and asked by following the information in the questions without analyzing it, for example putting together their own words. Students with the characteristics of the SK type of thinking in planning a solution (devising a plan) tend to have one way to solve the problem. SK respondents have fairly good critical thinking skills in physics so that this is one of the factors that influences SK respondents to be able to complete critical thinking questions well. The relationship between thinking style and problem-solving ability in SK respondents is, being able to work on problem-solving questions with good steps to the correct final result. So, it can be concluded that students who have a dominant concrete sequential style have a critical thinking category.

This is in accordance with DePorter and Hernacki (2015) that students with a SK thinking style always organize tasks into a step-by-step process and strive to achieve perfection at each stage, so that the method used is to write down the steps for completion in sequence and completely to obtain maximum results.

2. Identification of Critical Thinking Skills in terms of Abstrak Sequential Thinking Style (SA)

Based on the research data, there are 11 students who have an abstract sequential thinking style, where there are 5 students who have a very critical thinking category, 4 students who have a critical thinking category, 1 student who has a fairly critical thinking category, and 1 student who has a non-critical thinking category.

Students with an abstract sequential thinking style are mostly able to understand questions by mentioning and writing down what is known and asked in the question. At the stage of providing an explanation, the indicator provides a simple explanation and builds basic skills, students are able to mention and write down the concepts or formulas that will be used. In the indicator of providing conclusions, students are able to provide conclusions and are able to provide the most appropriate decisions that are in accordance with the concept of heat. In understanding the problem, write the answer in your own sentence completely, in order, the meaning is the same as the information in the question, choose to solve the problem in two ways, write the steps in order and the calculations are also written in detail, do not check the results of solving the problem.

This is in accordance with Zakir's opinion (2015) that students who know the SA thinking style tend to write down facts completely and in order by identifying the problems they are facing. Students with SA thinking style cannot utilize the results Identification carried out to solve the given problems such as indicators of analyzing arguments and providing explanations of the problems in the questions. So, in the basic specification ability, students with SA thinking style can only. Mention information based on the analysis of information obtained in the questions (Firdaus et al, 2019). This is in accordance with DePorter and Hernacki (2015) that students with SA thinking style prefer to think in analyzing information about regular events

Students with the SA style type think about solving problems by analyzing the problem so that they have good critical thinking skills, so it can be concluded that students who have a dominant concrete

sequential style have a very critical thinking category.

3. Identification of Critical Thinking Skills in terms of Concrete Random Thinking Style (CR)

Based on the research data, there are 7 students who have a concrete random thinking style, where there are 2 students who have a critical thinking category, 1 student who has a fairly critical thinking category, and 4 students who have a non-critical thinking category.

Students with a concrete random thinking style are mostly less able to answer questions correctly and precisely, KR students do not write down completely what is known from the questions such as in the indicator of building basic skills and the indicator of providing conclusions. In the indicator of building basic skills, KR students mention and write concepts or formulas that are not quite right.

Furthermore, in the indicator of providing a simple explanation, they have not been able to provide an explanation regarding the temperature in the room. In the indicator of concluding or deciding something, they are only able to provide decisions without concluding and providing reasons that are in accordance with the concept of heat. One of the influencing factors is that KR students are less able to solve physics problems because KR respondents have low physics abilities. In understanding the problem of rewriting the information needed in the problem-solving questions in the form of images, tables, choosing to solve problems in one way, writing incomplete steps to solve, checking answers without focusing on calculations or the order of answers correctly. This is in accordance with DePorter (2015) that students with an AK thinking style will do everything in their own way.

The relationship between thinking style and problem-solving ability in AK respondents is, not being able to work on problem solving questions with the correct steps and results, in addition to having low critical thinking skills. AK respondents in working on questions use a trial-and-error approach. This is in accordance with DePorter and Hernacki (2015) that one of the characteristics of students with a concrete random thinking style is using a true-false approach (trial and error). So, it can be concluded that students who have a dominant abstract random style have a category of non-critical thinking.

4. Identification of Critical Thinking Skills Reviewed from Abstract Random Thinking Style (AR)

Based on the research data, there are 7 students who have a concrete random thinking style, where there are 2 students who have a critical thinking category, 3 students who have a fairly critical thinking category, and 2 students who have a non-critical thinking category. Students with an abstract random thinking style are mostly quite able to answer questions correctly, but there are also some who are less able to answer questions correctly, such as in the indicator of providing a simple explanation, students have not been able to provide an explanation either based on the concept or with their own thoughts. In the indicator of providing a conclusion or making a decision, students can only provide a decision but have not been able to provide the right reasons regarding the concept of heat in the chosen decision.

Likewise, with the indicator of providing further explanation and building basic skills, several students are unable to mention and write what is known and the concept that will be used to solve the problem in the question. Students with the

AA thinking style type in understanding the problem, only write what is known incompletely and only write what is asked from the question, by following the information in the question without analyzing it. This is in accordance with DePorter and Hernacki (2015) that students with AA thinking style need a long time and do not like to be limited to think according to their condition. Meanwhile, in the indicator of drawing conclusions and assessments, students with AA thinking style have not been able to provide conclusions based on their assumptions and considerations and considerations of alternative solutions to problems presented in the questions properly.

Students with AA type thinking style in planning a solution (devising a plan) tend to have one way to solve the problem and write down the steps to solve the problem incompletely. This is in accordance with Zakir (2015) that students with AA thinking style cannot utilize their experience to solve the problems given, in this case students with AA thinking style are unable to use the results of the identification that has been done to provide assessments and reasons in solving problems in questions. So, it can be concluded that students who have a dominant abstract random style have a fairly critical thinking category.

CONCLUSION

The level of critical thinking ability of students in physics based on thinking style shows that students who have three dominant concrete sequential styles have a critical thinking category, students who have a dominant abstract sequential thinking style have a critical thinking ability level with a very critical category, while students who have a dominant concrete random thinking style have a critical thinking ability level with a non-critical category, and students who have a dominant abstract random thinking style have a critical thinking ability level with a fairly critical category.

Based on the results of the study, it is recommended that teachers, especially physics subject teachers, pay more attention to students' thinking styles in delivering their lessons, especially in training critical thinking skills. Teachers can apply appropriate learning designs and strategies by paying attention to each student's way of thinking so that students' problem-solving abilities become more optimal.

REFERENCES

Afrianti, Eva. (2019). Keterampilan Berpikir Kritis dalam Mata Pelajaran Fisika pada Peserta Didik Kelas X IPA di SMA Negeri 3 Polewali. Pendidikan Fisika. Makassar:Universitas Muhammadiyah Makassar. https://digilibadmin.unismuh.ac.id/upload/6046-Full_Text.pdf.

Azmi, I., Prasetya, D. S. B., & Sabrun, S. (2025). Profil Berpikir Kritis Siswa SMP pada Mata Pelajaran IPA. *Journal of Classroom Action Research*, 7(1), 163-175.

Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

De Porter, B & Hernacki, M. (2015). *Quantum Learning: Membiasakan Belajar Nyaman dan Menyenangkan*. Bandung: Kaifa.

Devy, N. K., Halim, A., Syukri, M., Yusrizal, Y., Nur, S., Khaldun, I., & Saminan, S. (2022). Analysis of Understanding Physics Concepts in terms of Students' Learning Styles and Thinking Styles. *Jurnal Penelitian Pendidikan IPA*, 8(4), 1937-1943.

Dwirahayu, G., & Firdausi, F. (2016). Pengaruh gaya berpikir terhadap kemampuan koneksi matematis mahasiswa. *JPPM (Jurnal Penelitian*

dan Pembelajaran Matematika), 9(2). https://jurnal.untirta.ac.id/index.php/JPPM/article/view/999.

Evendi, E., Kusaeri, A., Kusaeri, A., Pardi, M., Sucipto, L., Bayani, F., & Prayogi, S. (2022). Assessing Students' Critical Thinking Skills Viewed from Cognitive Style: Study on Implementation of Problem-Based e-Learning Model in Mathematics Courses. *Eurasia Journal of Mathematics, Science and Technology Education*, 18(7).

Ennis, R. H. (2011, July). The nature of critical thinking: An outline of critical thinking dispositions and abilities. *In Sixth International Conference on Thinking*, Cambridge, MA (pp. 1-8).

Febrianti, W., Zulyusri, Z., & Lufri, L. (2021). Meta analisis: pengembangan soal HOTS untuk meningkatkan kemampuan berpikir kritis peserta didik. *Bioilmi: Jurnal Pendidikan*, 7(1), 39-45.

Firdaus, A., Nisa, L. C., & Nadhifah, N. (2019). Kemampuan Berpikir Siswa pada Materi Barisan dan Deret Berdasarkan Gaya Berpikir. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 10(1), 68-77. https://journal.unnes.ac.id/nju/index.php/kreano/article/view/17822.

Ismail, I., Hasanuddin, H., & Chandra, A. (2023). The influence of thinking styles and learning styles on student learning achievement. *Al-Ishlah: Jurnal Pendidikan*, 15(1), 193-202.

Juliyanti, K., & Syahfitri, J. (2024). Exploring the Link Between Critical Thinking Styles and Students' Critical Thinking Ability in Biology Education. *Al-Ishlah*, 16(4). https://doi.org/10.35445/alishlah.v16i4.5800.

Komariyatin, P., & Dimas, A. (2022). Studi Literatur Efektifitas Model Pembelajaran Problem Based Learning dan Problem Solving Terhadap Kemampuan Berpikir Kritis Siswa Menengah Pertama. *Wacana Akademika: Majalah Ilmiah Kependidikan*, 6(1), 87-94.

Lusiana, R. (2017). Analisis Kesalahan Mahasiswa dalam Memecahkan Masalah pada Materi Himpunan Ditinjau dari Gaya Kognitif. *Jurnal Penelitian Pembelajaran Matematika*, 10(1), 24-29. https://jurnal.untirta.ac.id/index.php/JPPM/article/viewFile/1290/1033.

Mansyur, J., Laratu, W. N., & Tule, R. (2024). Mental Models Based on Students Thinking Style About Objects in Static Fluid. *Jurnal Penelitian Pendidikan IPA*, 10(11), 9770-9779.

Marisda, D. H., Ma'ruf, M. R., Riskawati, R., & Hamid, Y. H. (2022). Workshop Pembelajaran Komponen Instrumen Terpadu IPA Berbasis Lingkungan Bagi Guru-guru Sekolah Menengah Pertama. *JMM (Jurnal Masyarakat Mandiri)*, 6(2), 1435-1444.

Musaad, F., & Suparman, S. (2023). Pengembangan E-Modul Berbasis Problem Based Learning Untuk Memacu Kemampuan Berfikir Kritis Abad-21. AKSIOMA: *Jurnal Program Studi Pendidikan Matematika*, 12(3), 3162-3171.

Mustafa, P. S. (2022). Characteristics of learners and their implications in learning. AL-ISHLAH: *Jurnal Pendidikan*, 14(4), 7043-7056.

Pramono, Y. A. Z. A., Abdussakir, A., Irawan, W. H., & Sujarwo, I. (2025). Students Proportional Reasoning Level in Solving Ill Structured Problem on Proportion Material in Terms of Gregorc's Thinking Style. Journal of Medives: *Journal of Mathematics Education IKIP Veteran Semarang*, 9(1), 25-37.

Robbani, H. (2025). Pengembangan Keterampilan Berpikir Kritis Melalui Pembelajaran Berbasis Masalah. Abdussalam: *Jurnal Pendidikan Dan Kebudayaan*

Islam, 1(1), 79-85.

Siyamuningsih, L. A., Khoiri, N., Nuroso, H., & Hayat, M. S. (2024). Analisis Strategi Pembelajaran Berdiferensiasi Berbasis Esd (Education For Sustainable Development) dalam Pembelajaran Fisika Di SMAN 1 Semarang. *Jurnal Kajian Pendidikan*, 6(3).

Solihah, B., Hadi, W. P., Qomaria, N., Tamam, B., & Rakhmawan, A. (2023). Identifikasi kemampuan berpikir kritis siswa pada materi pencemaran lingkungan. *Natural Science Education Research (NSER)*, 6(1), 26-34.

Sujanem, R., Suwindra, I. N. P., & Suswandi, I. (2022). Efektivitas e-modul fisika berbasis masalah berbantuan simulasi phet dalam ujicoba terbatas untuk meningkatkan keterampilan berpikir kritis siswa SMA. *Jurnal Pendidikan Fisika Undiksha*, 12(2), 181-191.

Sumargono, S., Basri, M., Istiqomah, I., & Triaristina, A. (2022). Kemampuan berpikir kritis siswa pada mata pelajaran sejarah. Tarbiyah Wa Ta'lim: *Jurnal Penelitian Pendidikan dan Pembelajaran*, 141-149.

Sternberg, R. J. (2018). *Thinking Styles*. Cambridge University Press.

Suryadi, R. (2025). Meningkatkan Keterampilan Berpikir Kritis dan Pemecahan Masalah melalui Model Creative Problem Solving dalam Pembelajaran Geografi di Madrasah Aliyah. *el-Khuwailid*, 1(1), 13-19.

Syarlisjiswan, M. R., Sukarmin, & Wahyuningsih, D. (2021). The development of e-modules using Kodular software with problembased learning models in momentum and impulse material. *IOP Conference Series: Earth and Environmental Science*, 1796(1). https://doi.org/10.1088/1742-6596/1796/1/012078.

Widiyastuti, E., Ernawati, N., Setyaningsih, E., & Sugihandardji, C. (2022). Ability of mathematical representation junior high school students in completing open-ended problems are reviewed from the style of thinking. *International Journal of Multidisciplinary Research and Literature*, 1(1), 98-105.

Zakir, M. (2015). Description of Logical Reasoning In Solving Mathematics Problemss Based On Students' Thinking Style Of Students at SMPN 2 Pinrang. *Jurnal Daya Matematis*, 3(2), 152-165.