Revealing students' critical thinking ability according to facione's theory

by Ajeng Gelora Mastuti

Al-Jabar: Jurnal Pendidikan Matematika
Volume 13, Number 2, 2022, Pages 261 – 272
http://ejournal.radenintan.ac.id/index.php/al-jabar/index

Revealing students' critical thinking ability according to facione's theory

Ajeng Gelora Mastuti[1]*, Abdillah[1], Nurlaila Sehuwaky[1], Ratna Risahondua[1]
[1] IAIN Ambon, Indonesia
✉ ajeng.gelora.mastuti@iainambon.ac.id*

Article Information
Submitted July 11, 2022
Revised Aug 16, 2022
Accepted Sept 29, 2022

Keywords
Critical Thinking Ability;
Facione's Theory;
Comparison Material.

Abstract
The importance of critical thinking ability in solving mathematical problems can improve the quality of thinking and make thinkers better understand the content that has been studied. This research aims to reveal students' critical thinking ability using Facione's theory to solve comparative problems. The research method used in this research is descriptive qualitative. The subjects of this study consisted of 2 students taken from 20 participants based on data saturation. Data collection techniques used in this study were tests, interviews, validation sheets, and documentation. The data analysis technique of the research results was carried out through three stages: data reduction, data presentation, and drawing conclusions. Based on the discussion results, the researcher revealed students' critical thinking skills through six components of critical thinking based on Facione's theory, namely Interpretation, Analysis, Evaluation, Inference, Explanation, and Self-Regulation. Significant differences between the two subjects appear at the explanation stage. At this stage, subject 1 uses the procedure in the concept scheme, and the explanation of the argument of subject 1 is very logical. This can be seen in clarifying the evaluation and inference stages, where the subject performs calculations correctly and logically. Meanwhile, subject 2 uses detailed procedures in its planning, indicated by notes at the analysis stage.

INTRODUCTION

Understanding and assessment are closely related to mathematics (Ernest, 2021). Mathematics provides a constructive way of establishing mental order and motivating thinking and thoroughness. Furthermore, mathematics is essential in other disciplines, such as Science and Engineering (Li & Schoenfeld, 2019). The significance of mathematics can be seen in several fields, such as Engineering, Body Scanners, Software, Coding, and many more (Jay et al., 2018). Literacy in mathematics includes basic computational skills, quantitative reasoning, and spatial abilities (Kyttälä & Björn, 2014). Learning mathematics can make people think logically (Cresswell & Speelman, 2020). The ability to memorize and repeat previously given information is included in low-level reasoning (Lehtinen et al., 2017). While interpreting, analyzing, or manipulating data is contained in high-level reasoning (Saunders & Wong, 2020).

One of the higher-order reasoning is critical thinking. High-level reasoning characterized by careful analysis and consideration is the rule of critical thinking. Critical thinking allows students to process information logically, helping them to learn independently (Papathanasiou et al., 2014). Otherwise, students who graduate without critical thinking ability will have problems and compete in work and society (Gal et al., 2020). Given the role

How to cite Mastuti, A. G., Abdillah, A., Sehuwaky, N., & Risahondua, R. (2022). Revealing students' critical thinking ability according to facione's theory . *Al-Jabar: Jurnal Pendidikan Matematika*, *13*(2), 261-272.
e-ISSN 2540-7562.
Published by Mathematics Education Department, UIN Raden Intan Lampung.

of critical thinking, it is very important to include these skills in the current education system (Changwong et al., 2018). This skill facilitates students to practice their concentration, argue, and make a comprehensive analysis to conclude and solve problems (Asrita & Nurhilza, 2018). One of the subjects to improve critical thinking ability in mathematics developed through cognitive processes in solving problems and influencing students' attitudes toward these subjects (Runisah et al., 2017). Despite its role, most students worldwide have low critical thinking ability.

The importance of critical thinking ability in solving mathematical problems can improve the quality of thinking and make thinkers better understand the content that has been studied (Chukwuyenum, 2013). Not only that, students' way of thinking will be more systematic, more understanding, and able to make various solutions to solve a problem. Students who have critical thinking will be able to solve problems they have in their lives. Students will analyze problems and take advantage of the information he has to solve the problem (Nadeak & Naibaho, 2020).

Preliminary studies in several junior secondary schools in Maluku capture a different phenomenon. Students tend to be silent when the teacher asks about math problems. Because asking many questions and being active in learning can prove that students can think critically, which is very important for students to solve the problems they will face later. So this becomes a big question of whether the teacher is too monotonous in his assignments or whether students need more motivation to generate high-level reasoning.

Several experts have explained the definition of critical thinking ability. Critical thinking is thinking logically and reflectively, focusing on determining what to do (Heard et al., 2020). Turan et al. (2019) state that critical thinking is a mental process to clarify one's understanding in making accurate decisions. Critical thinking is logic and reflective thinking that involves analyzing, evaluating, and drawing conclusions to make the right decisions. Based on the above definition, the ability to analyze, evaluate arguments, and conclude is crucial to good critical thinking (Cresswell & Speelman, 2020; Mastuti et al., 2022).

Several experts give different opinions about the indicators of critical thinking ability. Facione (1990) suggests six indicators of critical thinking ability: Interpretation, Analysis, Evaluation, Inference, Explanation, and Self-Regulation. Halpern (2013) presents five indicators of critical thinking: verbal reasoning, argument analysis, thinking as hypothesis testing, probability and uncertainty, and decision and problem-making. Meanwhile, Ennis (1995) describes the components of critical thinking ability as FRISCO, which stands for focus, reason, inference, situation, clarity, and overview. In this study, researchers developed critical thinking problems based on the Facione indicator because it is considered more suitable for measuring students' critical thinking ability in mathematics.

Facione's critical thinking ability indicators used in this study consisted of 6 indicators (Facione, 2015). **First**, interpretation, namely understanding to express the meaning or meaning of various experiences, situations, data, events, judgments, habits, habits, beliefs, rules, procedures, or criteria. **Second**, the analysis identifies referential correlations aimed at questions, statements, concepts, descriptions, or other representations intended to express beliefs, judgments, experiences, reasons, information, or opinions. **Third**, evaluation means reviewing the credibility of questions or other representations in the form of reports or descriptions of perceptions, experiences, situations, judgments, beliefs, or opinions and interpreting the logical strength of the referential correlation or other representative objectives. **Fourth**, inference is identifying and obtaining the elements needed to conclude logically, make assumptions and hypotheses, consider relevant information and conclude consequences from data, situations, questions, and other representations. **Fifth**, the explanation is a skill to determine and share reasons directly and logically based on the data obtained. **Sixth**, self-regulation is a skill to monitor cognitive activity, the elements used in problem-solving, especially to apply skills in analyzing and evaluating.

Several studies on the critical thinking skills of junior high school students in solving math problems have been conducted (Aiyub et al., 2021; Basri et al., 2019; Cahyaningsih & Nahdi, 2021; Putri, 2020). The study concluded that the evaluation, analysis, and self-regulation sub-abilities were the lowest critical thinking skills mastered by students compared to other essential sub-abilities of thinking. So that students cannot account for their arguments which can affect conclusions. Critical thinking is part of compulsory thinking to synthesize various critical thinking and knowledge and then apply it to solve and use mathematical concepts. So in this article, researchers are interested in revealing students' critical thinking skills differently. Furthermore, in this article, the researcher wants to reveal students' critical thinking skills by asking questions in stages.

The research contained in this article aims to reveal students' critical thinking ability by using Facione's theory in solving comparison problems. Based on the description above, the researcher wants to reveal students' critical thinking skills based on six indicators using Facione's theory of critical thinking skills, including Interpretation, Analysis, Evaluation, Inference, Explanation, and Self- Regulation, through problems researchers have designed.

METHODS

This research was qualitative. The researchers wanted to reveal students' critical thinking using Facione's theory by using questions in stages. According to (Creswell, 2013), qualitative research aims to gain a better understanding through direct experience, honest reporting, and quotes from actual conversations. In addition, it aims to understand how participants derive meaning from their environment and how their meaning affects their behavior.

Participants in the study were 20 students taken from MTsN Ambon and SMP Muhammadiyah Ambon. The subject consisted of two students and was based on saturated data. Saturated data pays attention to problem-solving consistency based on critical thinking indicators and representatives of two critical thinking patterns. The pattern of critical thinking is a student's style in solving problems using certain methods.

The instruments in this study consisted of test questions related to comparison materials, validation sheets, and interview guidelines. The test questions, validation sheets, and interview guidelines were validated and tested on students. The test instrument used by the researcher is as follows.

1. To sew one sack of rice, you need 5 m of thread. So how many meters of thread are needed to sew 120 sacks?
2. The fodder supply of 50 cows is sufficient for 18 days. Suppose the cow increases by ten heads. How many days is the food only?

Data collection techniques used in this study were tests, interviews, validation sheets, and documentation. Interview guidelines were made by researchers based on critical thinking indicators according to Facione's theory. Table 1 describes the indicators of critical thinking according to Facione's theory used by researchers.

Table 1. Critical Thinking Ability Indicator based on Facione's Theory

Aspects of Critical Thinking Facione	Indicator
Interpretation	Understand and express the meaning or significance of various experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria.
Analysis	Identify the intended and inferential relationships between statements, questions, concepts, descriptions, or other forms of representation intended to express beliefs, judgments, experiences, reasons, information, or opinions.
Evaluation	Assess the credibility of any statement or other representation which is an account or description of a person's perceptions, experiences, situations, judgments, beliefs, or opinions; and assess the logical strength of actual or intended inferential relationships between statements, descriptions, questions, or other forms of representation.
Inference	Identify and secure the elements necessary to draw reasonable conclusions; form conjectures and hypotheses; consider relevant information and mitigate the consequences that flow from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation.
Explanation	State and justify those reasons in terms of the evidentiary, conceptual, methodological, and contextual considerations on which one's results are based, and present one's reasons as a convincing argument.
Self-Regulation	Self-consciously monitor one's cognitive activities, the elements used in those activities, and the results reduced, particularly by applying skills in analysis and evaluation to one's inferential judgments to question, confirm, validate, or correct either one's the reasoning or one's results.

In this interview, students were asked to state the results of their thoughts on solving problems given orally. This result is done to think aloud about the data. After working on the problem, the two subjects were interviewed to strengthen the research results. Data analysis is data that is compiled, revised, and choreographed (Creswell, 2013). The data analysis technique of the research results was carried out through three stages: data reduction, data presentation, and drawing conclusions. In data reduction, the researcher selects important points from the data according to the indicators that have been set. Then the researcher presented descriptive data that was arranged systematically. At the same time, the conclusions are obtained by describing the research findings obtained in the results.

RESULTS AND DISCUSSION

At the **Interpretation** stage, Subjects 1 (S1) and 2 (S2) understood what the researcher asked. This can be seen in Figure 1 and Figure 2.

Figure 1. Initial completion of S1 for question number 1

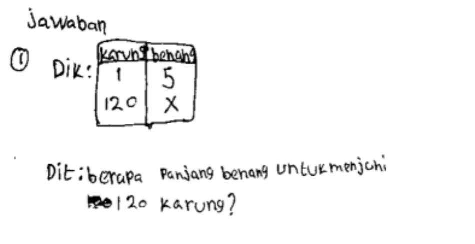
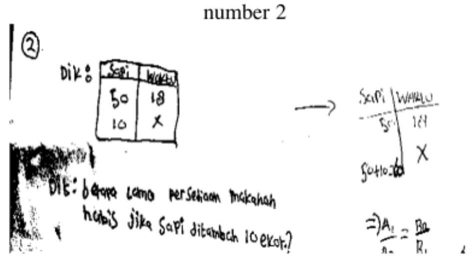


Figure 2. Initial completion of S2 for question number 2



Translation

It is known that:

Sack	Thread
1	5
120	x

Asked: how many meters of thread are needed to sew 120 sacks?

It is known that:

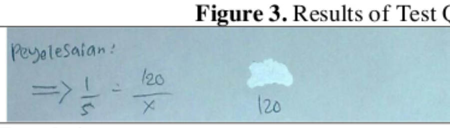
Cow	Time (day)
50	18
10	x

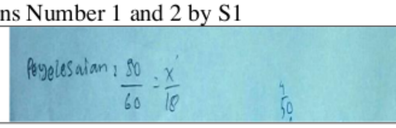
Asked: How long does it take for the cattle stock to run out if ten more heads are added?

The analysis of student abilities on the interpretation indicators shows that S1 can write down what is known and ask questions correctly on questions 1 and 2. Apart from being written in writing, it also reinforced the results of interviews that S1 can explain what is known and ask questions correctly in questions 1 and 2. Likewise, S2 can write down what is known and asked about correctly in question 1 and make mistakes in writing down the known numbers in question 2. However, it is strengthened by the results of the interviews that S2 can correctly explain what is known and asked about question number 1 and realized and corrected his mistakes in correctly writing the known numbers in question number 2 during the interview. Thus, it can be concluded that S1 and S2 can meet the interpretation indicators in solving tests number 1 and 2.

In analyzing, students can connect the statements, questions, and concepts given. This is indicated by correctly solving a model or mathematical formula to solve the problem. Students can present their arguments and know the reasons for the solutions they made. As can be seen in Figure 3 and Figure 4 as follows:

Figure 3. Results of Test Questions Number 1 and 2 by S1



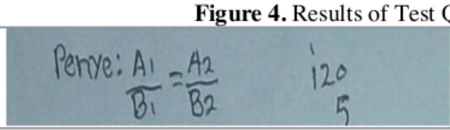


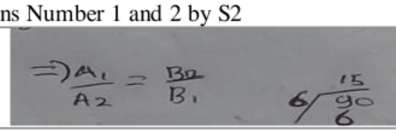
Translation

Solution:
$\frac{1}{5} = \frac{120}{x}$

Solution:
$\frac{50}{60} = \frac{x}{18}$

Figure 4. Results of Test Questions Number 1 and 2 by S2





Translation

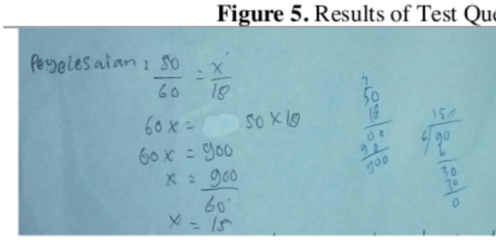
Solution:
$\frac{A_1}{B_1} = \frac{A_2}{B_2}$

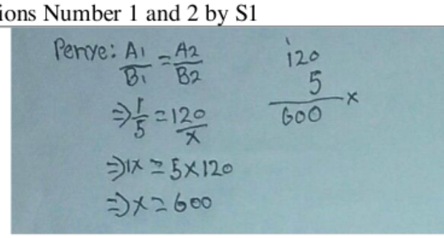
Solution:
$\frac{A_1}{A_2} = \frac{B_2}{B_1}$

Analysis of the ability of S1 and S2 students shows that they can make connections between statements, questions, and concepts, indicated by writing mathematical models or formulas correctly in solving problems. For example, based on observations, S1 writes the known numbers directly into the comparison formula to find the comparison of worth or reverse value. Based on interviews with S1 and S2, the two subjects correctly explained the plan's determination by using the comparison formula for worth or reverse value in questions number 1 and 2 correctly. The difference is that S2 can analyze problems with detailed planning and describe the analysis analytically. The student's notes indicate this at the analysis stage. In contrast, S1 analyzes problems with pre-existing concepts and works according to existing procedures.

The evaluation stage is indicated by students' ability to monitor cognitive skills in solving problems according to a mathematical model or formula determined by correctly performing calculations. For example, as can be seen in Figure 5 and Figure 6 as follows:

Figure 5. Results of Test Questions Number 1 and 2 by S1





Translation

Solution:

$\frac{50}{60} = \frac{x}{18}$

$60x = 50 \times 18$

$60x = 900$

$x = \frac{900}{60} = 15$

Solution:

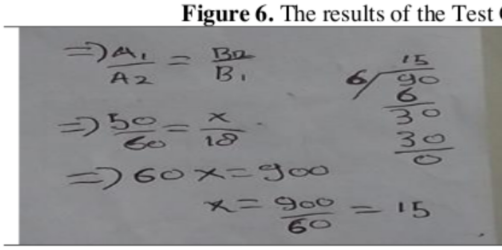
$\frac{A_1}{B_1} = \frac{A_2}{B_2}$

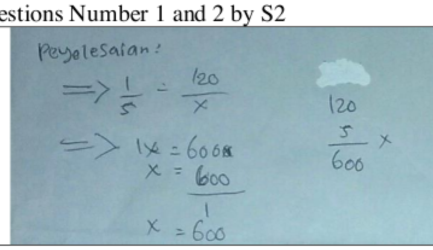
$\frac{1}{5} = \frac{120}{x}$

$x = 5 \times 120$

$\times = 600$

Figure 6. The results of the Test Questions Number 1 and 2 by S2





Translation

$\frac{A_1}{A_2} = \frac{B_2}{B_1}$

$\frac{50}{60} = \frac{x}{18}$

$60x = 900$

$x = \frac{900}{60} = 15$

Solution:

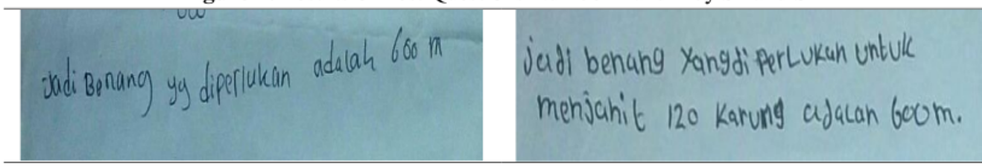
$\frac{1}{5} = \frac{120}{x}$

$x = \frac{600}{1} = 600$

The analysis of student abilities on the evaluation indicators shows that S1 and S2 can monitor their knowledge in solving problems according to the formula used to perform calculations correctly. As seen from the S1 and S2 test results, write down the steps for solving the problem by doing the calculations correctly. In addition, it is reinforced by the results of interviews where S1 and S2 can explain the steps for solving problems by doing calculations correctly. That way, it can be concluded that the two subjects can meet the evaluation indicators in completing test items 1 and 2.

The inference stage can be seen from the results of student work in concluding what is being asked about the right questions. For example, as can be seen in Figure 7 as follows:

Figure 7. Results of Test Questions Number 1 and 2 by S1 and S2



Translation

So the thread required is 600 m. So the thread needed to sew 120 sacks is 600 m.

The results of the analysis of students' abilities on the evaluation indicators can be seen from the test results of S1 and S2 students in concluding what was asked about the right questions. Apart from the test results, it is also reinforced by the results of interviews that S1 and S2 students can express conclusions correctly on items 1 and 2. S1 and S2 can claim their arguments and convey the correct conclusions.

At the **explanation** stage, S1 and S2 state and justify the reasons for proof and conceptual considerations and can state their arguments. S1 and S2 can explain every step from the beginning of working on the problem to the conclusion obtained in solving the problem. At this stage, S1 uses the procedures in the concept scheme and the explanation of S1 arguments is very logical. This is shown in the clarification of the evaluation and inference stage, where S1 performs calculations correctly and logically. At the same time, S2 uses a detailed procedure in its planning, which is indicated by the notes at the analysis stage.

In the **self-regulation stage,** S1 and S2 can monitor their cognitive knowledge as outlined in solving problems that have been done. The ability to self-regulate is also related to re-examination, where the subject has checked and is sure of the results that have been done previously. For example, S1 realizes a mistake in comparing the equations in problem 1, then reflects and admits it. At the same time, S2 realized the error in writing numbers in the results that had been done previously. However, S2 had time to clarify during the interview.

More specifically, **students critical thinking ability at the interpretation stage** can understand and express the meaning or significance of various experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria. As (Dosinaeng, 2019) said, the ability to interpret problems is the basis of critical thinking skills. When the research subject misinterprets the problem, he will make mistakes in analyzing and evaluating the problem (Brown et al., 2018). In line with Kogler (2018) interpretation ability is the ability to understand the intent of a problem.

At the Analysis stage, students can identify inferential relationships between statements, questions, concepts, descriptions, or other forms of representation intended to express beliefs, judgments, experiences, reasons, information, or opinions. Mastuti & Sehuwaky (2020) also reveal that in mathematics, understanding concepts is a crucial foundation for solving problems both in mathematics and everyday problems. So important is understanding concepts that the *Departemen Pendidikan Nasional* places the first goal in learning mathematics (Depdiknas, 2006). Understanding these concepts includes understanding mathematical concepts, explaining the relationship between concepts, and applying concepts or algorithms flexibly, accurately, efficiently, and precisely in problem-solving (Nurjanah et al., 2021). Furthermore, in line with the research results of Hartmann et al. (2021), students have good analytical aspects in solving problems, namely when students can make examples using variables and mathematical models of problems correctly. From this, it can be identified that students can relate the information known to the problem to create problem-solving strategies (Albay & Eisma, 2021). Meanwhile, Polya (2004) suggests that real problem-solving ability lies in the idea of compiling a solution plan.

At the inference stage, students can identify and secure the elements needed to draw reasonable conclusions; form conjectures and hypotheses. In addition, at this stage, students consider relevant information and reduce the consequences of the flow of concepts, descriptions, questions, or other forms of representation. Reinforced by Rakoczy et al. (2019), the inference is concluded appropriately according to the context of the problem. The study results show that students with high critical thinking ability can meet the criteria for all critical thinking indicators, one of which is an inference indicator.

At the Evaluation stage, students can assess the credibility of a statement or other representation, which is a person's experience, belief, or opinion. In addition, at this stage, students assess the logical strength between statements, descriptions, questions, or other forms of representation. This is in line with the research Upu et al. (2020) which says that students capable of higher-order thinking can plan a complete problem-solving strategy by writing how to work in the form of mathematical sentences correctly. Students can solve problems, namely to calculate correctly and make conclusions from solving these problems completely and precisely, because they can write down the facts in the problem and formulate questions completely (Doorman et al., 2007).

At the explanation stage, students can state and justify the reasons in terms of evidence, conceptual, methodological, and contextual considerations that form the basis of their results and present the reasons as convincing arguments. In line with the research results of Winarti et al. (2019) that students who achieve the explanation aspect well are when students can explain each work step, procedure, and method used in solving problems. The increase in argumentation skills is in line with the increase in students' knowledge (Mastuti et al., 2022).

Specifically, **in the self-regulation stage**, students are aware of monitoring their activities, the elements used, and the results developed from analyzing and evaluating self-ability in making decisions (Facione, 1990; Schunk & Greene, 2018). According to Kitsantas et al. (2004), self-regulation forms the motivation of individuals to cultivate and modify thoughts, feelings, desires, and actions in establishing, developing, assessing, revising, and implementing strategies for achieving life goals, including managing emotional responses to stimuli.

In the opinion of Ennis (1995), when someone can think critically, that person can automatically survive in solving problems. In this case, critical thinking can play an essential role in dealing with illogical and false arguments. Implementing critical thinking activities in the classroom is likely to sharpen sound arguments (Kuntze et al., 2017). Students can interpret each issue and topic with the best fair judgment according to the facts (Koichu et al., 2021). Critical thinking ability means a process that a person does carefully to obtain valid data to reach a reliable conclusion (Machete & Turpin, 2020). Another important aspect of critical thinking can equip learners with early preparation to succeed in their future work as they tend to communicate more effectively and analytically and overcome challenges in the workplace (ŽivkoviĿ, 2016). Therefore, critical thinking may have the potential to help individuals to maintain a realistic mindset approach in dealing with real-life problems and is required to be embedded in pedagogical engagement.

This research is limited to students' critical thinking processes in solving comparative problems using Facione's theory. Further research can be continued by developing critical thinking instruments for junior high school students and leveling critical thinking using these instruments. In addition, researchers need to look at the critical thinking perspective of the mathematics teacher's version.

CONCLUSIONS

Based on the results of research and discussion, students' critical thinking ability based on Facione's theory meet six indicators: Interpretation, Analysis, Evaluation, Inference, Explanation, and Self-Regulation. At the interpretation stage, students can understand and express the meaning or significance of various experiences by explaining their beliefs about what is known on the question and distinguishing which ones use-value comparisons and which use reverse comparisons. At the analysis stage, students can identify the intended and actual inferential relationships between statements, questions, and concepts in comparative questions. Students can identify and secure the elements needed to draw reasonable conclusions at the inference stage. At the evaluation stage, students can assess the statement's credibility, which describes students' beliefs about each problem-solving. At the explanation stage, students can state and justify the reasons for proving the answer. While at the self-regulation stage, students can monitor their activities related to solving the problem of comparison of values and turning values.

ACKNOWLEDGMENT

The author is very grateful to all the participants involved in this research, especially the students from MTsN Ambon and SMP Muhammadiyah Ambon.

AUTHOR CONTRIBUTIONS STATEMENT

RS is the research coordinator. He contributed to data collection in the field. AA is responsible for developing theory, designing instruments, and collecting and analyzing data.

REFERENCES

Aiyub, Suryadi, D., Fatimah, S., & Kusnandi. (2021). Investigation of Watson-Glaser critical thinking skills of junior high school students in solving mathematical problems. *Journal of Physics: Conference Series*, *1806*, 012090.

Albay, E. M., & Eisma, D. V. (2021). Performance task assessment supported by the design thinking process: Results from a true experimental research. *Social Sciences & Humanities Open*, *3*(1), 1–9.

Asrita, A., & Nurhilza, N. (2018). Students' critical thinking skills in group discussion: the case study of fifth grade students in sukma bangsa bireuen elementary school. *Sukma: Jurnal Pendidikan*, *2*, 67–92.

Basri, H., Purwanto, As'ari, A. R., & Sisworo. (2019). Investigating critical thinking skill of junior high school in solving mathematical problem. *International Journal of Instruction*, *12*(3), 745–758.

Brown, A. W., Kaiser, K. A., & Allison, D. B. (2018). Issues with data and analyses: Errors, underlying themes, and potential solutions. *Proceedings of the National Academy of Sciences*, *115*(11), 2563–2570.

Cahyaningsih, U., & Nahdi, D. S. (2021). The effect of realistic mathematics education on elementary students' critical thinking skills. *Journal of Physics: Conference Series*, *1764*(1), 012127.

Changwong, K., Sukkamart, A., & Sisan, B. (2018). Critical thinking skill development: Analysis of a new learning management model for Thai high schools. *Journal of International Studies*, *11*(2), 37–48.

Chukwuyenum, A. (2013). Impact of critical thinking on performance in mathematics among senior secondary school students in lagos State. *IOSR Journal of Research & Method in Education (IOSRJRME)*, *3*, 18–25.

Cresswell, C., & Speelman, C. P. (2020). Does mathematics training lead to better logical thinking and reasoning? A cross-sectional assessment from students to professors. *PLOS ONE*, *15*(7), e0236153.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3. ed). Sage.

Depdiknas. (2006). *Kurikulum tingkat satuan pendidikan: Kerangka dasar*. Pusat Kurikulum.

Doorman, M., Drijvers, P., Dekker, T., van den Heuvel-Panhuizen, M., de Lange, J., & Wijers, M. (2007). Problem solving as a challenge for mathematics education in The Netherlands. *ZDM*, *39*(5), 405–418.

Dosinaeng, W. (2019). Analysis of students' higher order thinking skills in solving basic combinatorics problems. *Math Didactic: Jurnal Pendidikan Matematika*, *5*, 133–147.

Ennis, R. H. (1995). *Critical Thinking* (1st edition). Pearson.

Ernest, P. (2021). Mathematics, ethics and purism: An application of MacIntyre's virtue theory. *Synthese*, *199*(1), 3137–3167.

Facione, P. (1990). Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. *Research Findings and Recommendations*, *315*.

Facione, P. (2015). Critical thinking: What it is and why it counts. *Insight Assessment*.

Gal, I., Grotlüschen, A., Tout, D., & Kaiser, G. (2020). Numeracy, adult education, and vulnerable adults: A critical view of a neglected field. *ZDM*, *52*(3), 377–394.

Halpern, D. F. (2013). *Thought and knowledge*. Psychology Press.

Hartmann, L.-M., Krawitz, J., & Schukajlow, S. (2021). Create your problem! Do students pose and solve modelling problems when given descriptions of real-world situations?. *ZDM – Mathematics Education*, *53*(4), 919–935.

Heard, J., Scoular, C., Duckworth, D., Ramalingam, D., & Teo, I. (2020). *Critical thinking: Definition and structure*. The Australian Council for Educational Research Ltd.

Jay, T., Rose, J., & Simmons, B. (2018). Why is parental involvement in children's mathematics learning hard? parental perspectives on their role supporting children's learning. *SAGE Open*, *8*(2), 2158244018775466.

Kitsantas, A., Robert, A., & Doster, J. (2004). Developing self-regulated learners: Goal setting, self-evaluation, and organizational signals during acquisition of procedural skills. *Journal of Experimental Education - J EXP EDUC*, *72*, 269–287.

Kogler, H. H. (2018). *Empathy And Agency: The Problem Of Understanding In The Human Sciences*. Routledge.

Koichu, B., Aguilar, M. S., & Misfeldt, M. (2021). Implementation-related research in mathematics education: The search for identity. *ZDM – Mathematics Education*, *53*(5), 975–989.

Kuntze, S., Aizikovitsh-Udi, E., & Clarke, D. (2017). Hybrid task design: Connecting learning opportunities related to critical thinking and statistical thinking. *ZDM*, *49*(6), 923–935.

Kyttälä, M., & Björn, P. M. (2014). The role of literacy skills in adolescents' mathematics word problem performance: Controlling for visuo-spatial ability and mathematics anxiety. *Learning and Individual Differences*, *29*, 59–66.

Lehtinen, E., Hannula-Sormunen, M., McMullen, J., & Gruber, H. (2017). Cultivating mathematical skills: From drill-and-practice to deliberate practice. *ZDM*, *49*.

Li, Y., & Schoenfeld, A. H. (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *International Journal of STEM Education*, *6*(1), 1–13.

Machete, P., & Turpin, M. (2020). The Use of Critical Thinking to Identify Fake News: A Systematic Literature Review. In M. Hattingh, M. Matthee, H. Smuts, I. Pappas, Y. K. Dwivedi, & M. Mäntymäki (Eds.), Responsible design, implementation and use of information and communication technology, 235–246. Springer International

Makina, A. (2010). The role of visualisation in developing critical thinking in mathematics. *Perspectives in Education*, *28*, 24–33.

Mastuti, A. G., Abdillah, A., & Rijal, M. (2022). Teachers promoting mathematical reasoning in tasks. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *6*(2), 371–385.

Mastuti, A. G., & Sehuwaky, N. (2020). Pembelajaran STAD berbasis IT dengan integrasi keislaman terhadap pemahaman konsep siswa materi bangun ruang sisi lengkung. In *Prosiding SI MaNIs (Seminar Nasional Integrasi Matematika dan Nilai-Nilai Islami)*, *3*(1), 413-417.

Nadeak, B., & Naibaho, L. (2020). The effectiveness of problem-based learning on students' critical thinking. *Jurnal Dinamika Pendidikan,13*(1), 1–7.

Nurjanah, N., Dahlan, J. A. (2021). The effect of hands-on and computer-based learning activities on conceptual understanding and mathematical reasoning. *International Journal of Instruction*, *14*(1), 143–160.

Papathanasiou, I. V., Kleisiaris, C. F., Fradelos, E. C., Kakou, K., & Kourkouta, L. (2014). Critical thinking: The development of an essential skill for nursing students. *Acta Informatica Medica*, *22*(4), 283–286.

Polya, G. (2004). *How to solve it: A new aspect of mathematical method*. Princeton University Press.

Putri, A. (2020). The mathematical critical thinking of MTs students in solving math problems. *Journal of Research on Mathematics Instruction*, *1*(2), 38–45.

Rakoczy, K., Pinger, P., Hochweber, J., Klieme, E., Schütze, B., & Besser, M. (2019). Formative assessment in mathematics: Mediated by feedback's perceived usefulness and students' self-efficacy. *Learning and Instruction*, *60*, 154–165.

Runisah, R., Herman, T., & Dahlan, J. (2017). *The enhancement of students' critical thinking skills in mathematics through the 5E learning cycle with metacognitive technique*.

Saunders, L., & Wong, M. A. (2020). *Learning theories: Understanding how people learn*. Pressbooks.

Schunk, D. H., & Greene, J. A. (Eds.). (2018). *Handbook of self-regulation of learning and performance* (second edition). Routledge, Taylor & Francis Group.

Turan, U., Fidan, Y., & Yıldıran, C. (2019). Critical thinking as a qualified decision making tool. *Journal of History Culture and Art Research*, *8*(1), 1-8.

Upu, H., Maman, M., Asdar, A., & Fatma, D. (2020). Mathematical problem solving profiles of students viewed from adversity quotient (AQ) in the class X SMAN 14 Bulukumba. *Daya Matematis: Jurnal Inovasi Pendidikan Matematika*, *7*, 251.

Winarti, A., Yuanita, L., & Nur, M. (2019). The effectiveness of multiple intelligences based teaching strategy in enhancing the multiple intelligences and science process skills of junior high school students. *Journal of Technology and Science Education*, *9*(2), 122–135.

ŽivkoviĿ, S. (2016). A model of critical thinking as an important attribute for success in the 21st Century. *Procedia - Social and Behavioral Sciences*, *232*, 102–108.

Revealing students' critical thinking ability according to facione's theory

ORIGINALITY REPORT

23%	19%	19%	18%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

3%

★ Syaiful Anwar, Wahyu Setyaningrum. "CAN BLENDED LEARNING HELP IMPROVE STUDENTS' CRITICAL THINKING SKILLS?", AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 2021

Publication

Exclude quotes	Off	Exclude matches	< 1%
Exclude bibliography	Off		