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Critical Mathematical Thinking Ability Viewed from The Mathematical Disposition of Junior High School Students

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ABSTRACT

This study was conducted to examine the problem that students' mathematical critical thinking skills remain varied and are assumed to be influenced by their mathematical disposition. Therefore, this research aims to describe students' mathematical critical thinking skills from the perspective of their mathematical disposition. This research employed a qualitative approach with a descriptive design. The subjects were six eighth-grade students from SMP IT Al-Marjan Bengkulu, categorized into high, medium, and low levels of mathematical disposition. Data were collected through a mathematical disposition questionnaire, a mathematical critical thinking skills test, and semi-structured interviews. Data were analyzed through data reduction, data display, and conclusion drawing. The findings indicate that students with high mathematical disposition demonstrate strong performance across all critical thinking indicators, including interpretation, analysis, evaluation, inference, and explanation. Students with medium disposition show adequate ability but lack consistency in drawing conclusions and providing logical justification. Meanwhile, students with low mathematical disposition tend to rely on procedural strategies rather than developing deeper conceptual understanding. These results confirm that mathematical disposition contributes to the quality of students' critical thinking in mathematics.

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1. INTRODUCTION

Critical thinking is recognized as an essential competency in 21st-century education. In mathematics learning, critical thinking enables students to analyze problems, evaluate arguments, construct logical reasoning, and make justified conclusions [1], [2]. According to Facione [2], critical thinking consists of interpretation, analysis, evaluation,

inference, and explanation. These indicators are interconnected and form the foundation for reflective and rational problem-solving.

In mathematics classrooms, however, students often focus on procedural steps rather than conceptual understanding. Jablonka [3] explains that mathematical critical thinking is not limited to obtaining correct answers but involves examining reasoning processes and underlying structures. Similarly, Halpern [19] argues that critical thinking requires deliberate practice and structured learning environments.

Previous studies indicate that students' critical mathematical thinking skills are still relatively low, especially when dealing with non-routine problems [4], [15]. This condition is frequently influenced by instructional approaches that emphasize memorization instead of reasoning and conceptual connections [18], [24]. However, previous studies tend to examine mathematical critical thinking and mathematical disposition separately. Limited studies provide qualitative descriptions of how different levels of mathematical disposition shape students' critical thinking characteristics in solving non-routine number pattern problems at the junior high school level.

Apart from cognitive ability, affective factors such as mathematical disposition also influence students' performance. Mathematical disposition refers to students' confidence, persistence, curiosity, and openness toward mathematics [6], [21]. Students with positive mathematical dispositions tend to demonstrate stronger reasoning skills and better problem-solving performance [7], [12].

Although numerous studies have examined either mathematical critical thinking or mathematical disposition separately, limited research provides qualitative descriptions of how different levels of mathematical disposition shape students' critical thinking characteristics, particularly at the junior high school level. Therefore, this study aims to describe students' mathematical critical thinking abilities, as reflected in their mathematical disposition, in solving non-routine number pattern problems.

2. METHOD

This research uses a qualitative, descriptive approach. This approach was chosen because the research aims to describe students' mathematical critical thinking abilities in terms of mathematical disposition without providing special treatment to the research subjects. Descriptive qualitative research seeks to understand phenomena in depth through narrative and contextual data, with the researcher acting as the main instrument in data collection and analysis [9]. Data were analyzed using the interactive model of Miles, Huberman, and Saldaña [5], which consists of data reduction, data display, and conclusion drawing.

The research subjects were class VIII students of SMP IT Al-Marjan Bengkulu who had studied the number pattern material. The research subjects were six students selected based on the results of the mathematical disposition questionnaire. Based on the questionnaire results, students were grouped into three categories of mathematical disposition: high, medium, and low [15]. From each category, two students were selected as research subjects for in-depth analysis. Subject selection was carried out using

purposive sampling techniques, with consideration of the selected subjects' ability to provide relevant and in-depth data in accordance with the research focus [9].

The research instruments used consisted of a mathematical disposition questionnaire, a mathematical critical thinking skills test, and interview guidelines.

a. The mathematical disposition questionnaire was used to measure the level of mathematical disposition of junior high school students. The questionnaire consisted of 25 statements on a four-level Likert scale: strongly disagree, disagree, agree, and strongly agree. The questionnaire scores were used to group students into high, medium, and low mathematical disposition categories based on their total scores. The students' mathematical disposition category was determined as presented in Table 1, based on the criteria outlined by Almerino [6].

Table 1. Mathematical disposition categories based on total score percentage

Disposition category	Percentage range of scores	Interpretation
High	≥ 81%	Students have a very positive mathematical disposition, as demonstrated by self-confidence, persistence, and a reflective attitude toward learning mathematics.
Medium	61% - 80%	Students have a fairly positive mathematical disposition, but are not yet consistently positive in their attitude towards learning mathematics.
Low	≤ 60%	Students have a low mathematical disposition, characterized by a lack of interest and a tendency to give up easily in learning mathematics.

Source: adapted from Almerino [6]

b. The mathematical critical thinking skills test was used to measure students' critical thinking skills on non-routine number patterns. The test consisted of questions that required students to reason, analyze patterns, and draw conclusions that were not immediately apparent from the given number sequence. The test instrument was designed based on critical thinking ability indicators, as defined by Facione [2], namely interpretation, analysis, evaluation, inference, and explanation. Before use, the test instrument was reviewed by two mathematics education lecturers and one junior high school mathematics teacher to ensure the suitability of the content, indicators, and difficulty level of the questions. Given that this study was qualitative and focused on in-depth understanding, the test instrument was not statistically tested but rather used as a tool to explore students' thinking abilities. The mathematical critical thinking skills test was scored using an analytical rubric with a 0–4 score range for each indicator. A score of 4 was given if the student's answer was complete, logical, and used the correct concept; a score of 3 was given if the answer was quite correct with few conceptual errors; a score of 2 was given if the answer showed partial understanding of the concept; a score of 1 was given if the answer was less accurate and did not show clear reasoning. A score of 0 is given if the student does not answer or if the answer is

irrelevant. The average mathematical critical thinking skills score is then converted into three categories: high, medium, and low, as presented in Table 2.

Table 2. Categories of students' mathematical critical thinking abilities

Category	Average range of total scores
High	80 – 100
Medium	60 – 79
Low	< 60

(putra & suherman [8])

c. An interview guide was developed to gather more in-depth information related to the test and questionnaire results. Interview questions focused on students' thought processes in solving problems, the reasons for their choice of problem-solving strategies, and their attitudes toward mathematics learning. The interviews were semi-structured, allowing researchers to tailor the questions to the situation and student responses.

The validity of the data in this study was maintained through technical and source triangulation. Technical triangulation was conducted by comparing test, questionnaire, and interview results to ensure data consistency. Meanwhile, source triangulation was conducted by comparing information from research subjects with different mathematical disposition categories. This step aims to ensure that the data obtained truly reflects students' thinking conditions in a factual and accountable manner.

The collected data were analyzed descriptively qualitatively following the stages of data analysis outlined by Miles, Huberman, and Saldaña [5], namely data condensation, data display, and conclusion drawing/verification. The data condensation stage involves selecting, focusing, and simplifying relevant data from test results, questionnaires, and interviews. The data display stage presents data in the form of score tables, interview excerpts, and descriptions of student work for easy understanding and thematic analysis. Next, the conclusion-drawing/verification stage involves interpreting the data and drawing conclusions that illustrate the relationship between students' mathematical dispositions and critical mathematical thinking skills.

3. RESULTS AND DISCUSSION

3.1. Results

Based on the results of the mathematical critical thinking test, students were grouped into high, medium, and low categories. The test consisted of five indicators, namely interpretation, analysis, evaluation, inference, and explanation. A summary of students’ scores for each indicator is presented in Table 3.

The results show that students with high mathematical dispositions obtained the highest average scores. Student S1 achieved an average score of 87.8, and S2 obtained 80.8, both of which fall into the high critical thinking category. These students were able to accurately interpret problems, apply appropriate strategies, evaluate their solutions, and provide logical explanations.

Students with moderate mathematical dispositions demonstrated adequate performance but were not yet consistent across all indicators. Student S3 obtained an average score of 71.4, and S4 scored 66.2, both of which are categorized as medium. These students generally understood the problems and applied the correct procedures; however, they experienced difficulties during the evaluation stage and in formulating comprehensive conclusions.

Meanwhile, students with low mathematical dispositions showed limited performance in most indicators. Student S5 obtained an average score of 57.8, and S6 scored 48.6, both of which fall into the low category. These students tended to focus on procedural steps without providing clear reasoning and had difficulty explaining the relationships between concepts.

Overall, the average score for students' mathematical critical thinking skills was 68.7, which falls in the medium range. This finding indicates that students are not yet fully capable of consistently applying analytical and evaluative reasoning when solving non-routine number pattern problems.

Table 3. Students' Mathematical Critical Thinking Skills Test Scores

Subject	Interpretation	Analysis	Evaluation	Inference	Explanation	Average total score	Category
S1	88	90	85	87	89	87.8	High
S2	83	80	78	81	82	80.8	High
S3	74	70	68	72	73	71.4	Medium
S4	69	66	64	67	65	66.2	Medium
S5	60	58	55	59	57	57.8	Low
S6	52	48	46	50	47	48.6	Low
Overall average	71	69	66	69	69	68.7	Medium

The results of the mathematical disposition questionnaire indicate differences in students' attitudes toward mathematics. The grouping of research subjects based on disposition scores is shown in Table 4. Students S1 and S2 were categorized as having high mathematical dispositions, with percentages of 89.6% and 84.0%, respectively. These students demonstrated confidence, persistence, and curiosity when solving mathematical problems. Students S3 and S4 were categorized as having moderate mathematical dispositions, with percentages of 72.0% and 69.6%. They showed a positive attitude toward mathematics but were less consistent in maintaining confidence when faced with complex problems.

Table 4. Grouping of subjects based on mathematical disposition

Subject	Total Questionnaire Score	Percentage %	Disposition Category
S1	113	89.6%	High
S2	105	84%	High
S3	90	72%	Medium
S4	87	69.6%	Medium
S5	70	56%	Low
S6	63	50.4%	Low

Students with high mathematical dispositions (S1 and S2) demonstrated strong performance across all critical thinking indicators. During the interpretation stage, they accurately identified relevant information. In the analysis and inference stages, they applied logical reasoning and appropriately connected number patterns. They also evaluated their solutions and provided clear and coherent explanations.

Students with moderate mathematical dispositions (S3 and S4) were able to understand the problems and apply correct procedures; however, they were less able to provide logical justification for their answers. Their responses were often procedurally correct but lacked deeper conceptual reasoning. In contrast, students with low mathematical dispositions (S5 and S6) had difficulty across most indicators. They tended to imitate previously learned procedures and experienced confusion when faced with non-routine problems. Their explanations were incomplete, and they were not confident in evaluating their own solutions. These findings indicate that mathematical disposition influences the depth of students' reasoning in solving non-routine number pattern problems.

3.2. Discussion

The findings of this study demonstrate a consistent relationship between students' mathematical disposition and their mathematical critical thinking skills. Students categorized as having a high mathematical disposition showed stronger performance across all critical thinking indicators, including interpretation, analysis, evaluation, inference, and explanation. Meanwhile, students with low mathematical disposition tended to rely on procedural strategies and were less able to provide logical justification for their answers.

These findings are in line with previous research showing that students with positive mathematical dispositions tend to demonstrate stronger reasoning and analytical abilities in problem solving [6], [21]. Similarly, Prajono et al. [7] found that students with higher self-efficacy perform better at evaluating and justifying mathematical solutions. The present study strengthens these findings by showing qualitative evidence from students' written work and interview data, illustrating how disposition influences the depth of reasoning displayed in problem-solving processes.

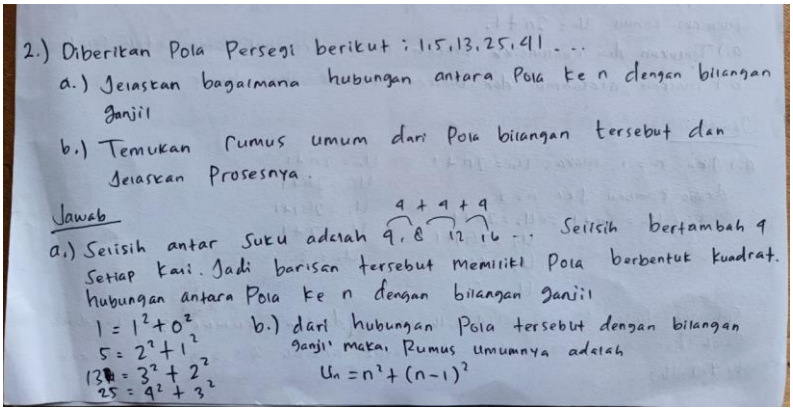

Figure 1. Example of the work results of students with high mathematical disposition on the mathematical critical thinking skills test questions

As shown in Figure 1, students with high mathematical disposition were able to interpret number patterns and systematically transform them into symbolic representations. Their answers reflected structured reasoning, conceptual understanding, and careful evaluation of each step. This result supports Facione's [2] argument that critical thinking involves not only cognitive skills but also a reflective disposition that drives individuals to question, analyze, and justify their reasoning.

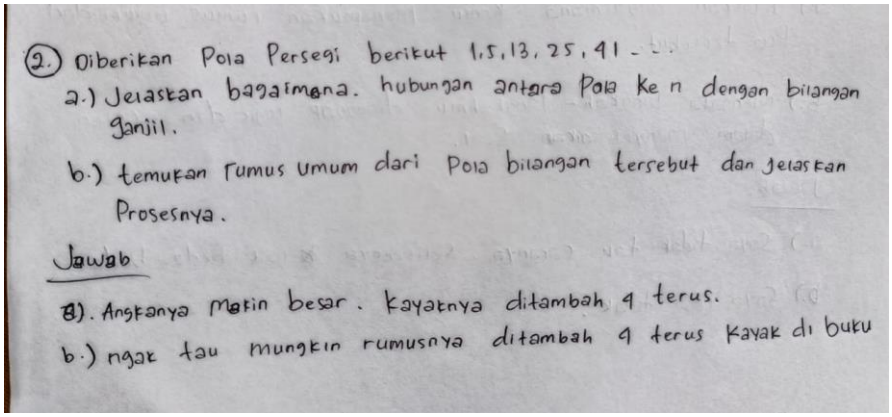

Figure 2. Example of the work results of students with low mathematical disposition on the mathematical critical thinking skills test questions

In contrast, the results in Figure 2 indicate that students with low mathematical disposition tended to focus on identifying surface-level patterns rather than explaining the underlying relationships between terms. This tendency is consistent with previous studies reporting that students with weaker mathematical dispositions often struggle to engage in evaluative and inferential thinking when faced with non-routine problems [7], [12]. Interview results in this study further revealed that students with low disposition expressed doubt and lack of confidence in explaining their reasoning, which supports the view that affective factors such as confidence and persistence play an important role in activating critical thinking processes [6], [21].

Moreover, the comparison between students' work in Figures 1 and 2 highlights that mathematical disposition functions as a mediating factor between cognitive ability and

actual performance. While some students correctly identified patterns, only those with a strong mathematical disposition consistently justified their reasoning and evaluated their answers critically. This supports the view proposed by Miles, Huberman, and Saldaña [5] that qualitative evidence from students' work provides deeper insight into how affective factors shape learning behavior.

Students with moderate mathematical dispositions showed adequate reasoning abilities but lacked consistency in providing complete explanations. This result aligns with Monteleone et al. [4], who found that students often demonstrate partial analytical skills but struggle to articulate reasoning comprehensively. In contrast, students with low mathematical dispositions tended to focus on procedural completion rather than explaining the underlying reasoning. This finding supports previous research indicating that low confidence and weak disposition are associated with limited reflective thinking [7], [12].

Furthermore, the results reinforce the argument that mathematical disposition functions as a supporting factor in the development of higher-order thinking skills [6], [21]. Positive attitudes toward mathematics encourage students to persist in solving complex problems and to evaluate their solutions critically.

Thus, the development of mathematical critical thinking skills requires instructional designs that integrate cognitive and affective dimensions simultaneously. Learning environments that promote reasoning, discussion, and reflection may strengthen both disposition and critical thinking processes [18], [25].

4. CONCLUSION

This study confirms that mathematical disposition is strongly associated with students' critical thinking skills in mathematics. Students who demonstrate positive dispositions toward mathematics—such as confidence, perseverance, curiosity, and openness—tend to perform more strongly across critical thinking indicators, including interpretation, analysis, evaluation, inference, and explanation. Conversely, students with low mathematical dispositions have difficulty articulating their reasoning, connecting concepts, and reflecting on solution processes. These findings support previous theoretical perspectives on the role of disposition in mathematical learning [6], [21]. Strengthening critical thinking skills requires more than procedural mastery. Mathematics instruction should integrate strategies that cultivate positive learning attitudes alongside conceptual understanding and the development of reasoning. Thus, fostering mathematical disposition is an essential component in improving students' overall critical thinking.

This study contributes by providing a qualitative analysis of how different levels of mathematical disposition shape students' reasoning characteristics in solving non-routine number pattern problems. The results enrich existing literature by offering detailed evidence from written responses and interview data at the junior high school level. This study is limited to a small number of subjects and focuses only on non-routine number pattern problems; therefore, the findings cannot be generalized to all mathematical topics. Future research is recommended to design and test instructional interventions that simultaneously enhance mathematical disposition and critical thinking skills. Expanding

the study to larger samples and different educational contexts may also provide broader generalization of the findings.

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