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Mathematical Critical Thinking Skills of Islamic Junior High School Students: A Facione Framework Analysis

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Abstract:
This study aims to describe the critical thinking skills of Islamic Junior High School in MTs 'Aisyiyah Medan students in mathematics learning based on Facione's indicators, namely interpretation, analysis, evaluation, inference, explanation, and self regulation. A descriptive qualitative approach was adopted to obtain an in depth understanding of phenomena occurring naturally within the school environment. Data were collected through a written critical thinking test, in depth semi structured interviews with six purposively selected students representing the high, medium, and low ability groups, and classroom observations across three sessions. Data analysis followed the interactive model of Miles and Huberman, comprising data collection, data reduction (coding and categorization), data display, and conclusion drawing. The trustworthiness of the data was ensured through triangulation of sources and techniques. The results showed that students' overall critical thinking skills fell into the medium category, with an average score of 55,29%. The interpretation indicator obtained the highest score (67,33%), while inference obtained the lowest score (38,67%). Qualitative analysis of the interviews revealed three dominant factors: limited exposure to HOTS based questions, restricted opportunities for classroom discussions, and a strong reliance on rote memorization of procedures. This finding underscores the urgency of implementing student centered and contextual learning models in MTs mathematics instruction.

Abstrak:
Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir kritis dalam pembelajaran siswa MTs 'Aisyiyah Medan berdasarkan indikator Facione, yaitu interpretasi, analisis, evaluasi, inferensi, penjelasan, dan regulasi diri. Pendekatan yang digunakan adalah kualitatif deskriptif, dipilih untuk memperoleh pemahaman mendalam terhadap fenomena yang terjadi secara alami dalam lingkungan sekolah. Pengumpulan data dilakukan melalui tes uraian kemampuan berpikir kritis, wawancara semi terstruktur mendalam terhadap enam siswa yang dipilih secara purposif yang mewakili kelompok kemampuan tinggi, sedang, dan rendah, serta observasi kelas selama tiga pertemuan. Analisis data mengikuti model interaktif Miles and Huberman, yang terdiri dari pengumpulan data, reduksi data (pengkodean dan

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kategorisasi), penyajian data, dan penarikan kesimpulan. Keabsahan data dipastikan melalui triangulasi sumber dan teknik. Hasil penelitian menunjukkan bahwa kemampuan berpikir kritis siswa secara keseluruhan termasuk dalam kategori sedang, dengan skor rata-rata 55,29%. Indikator interpretasi memperoleh skor tertinggi (67,33%), sedangkan inferensi memperoleh skor terendah (38,67%). Analisis kualitatif dari wawancara mengungkapkan tiga faktor dominan: minimnya pembiasaan soal HOTS, terbatasnya kesempatan untuk diskusi kelas, dan ketergantungan pada hafalan prosedur. Temuan ini menegaskan urgensi penerapan model pembelajaran yang berpusat pada siswa dan kontekstual dalam pembelajaran matematika di MTs.

Keywords:
Critical Thinking, Mathematics Learning, Islamic Junior High School Students

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INTRODUCTION

Mathematics education has a strategic role in preparing a generation capable of thinking logically, critically, and creatively. In the context of 21st-century learning, critical thinking skills are essential competencies needed to face current challenges (Muavi, Mustaji, Sumarno, Widodo, & Bidandari, 2024). Facione (2015) defines critical thinking as purposeful, self regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based.

This definition emphasizes that critical thinking is not merely a simple cognitive ability but a reflective process that involves the entire dimension of reasoning. Individuals who possess critical thinking skills are able to make sound decisions and solve problems by analyzing, evaluating, and drawing conclusions based on relevant information. This ability is part of the 4C competencies (critical thinking, creativity, communication, and collaboration) that are central to modern education (Elmawati & Juandi, 2022), and is consistent with the Regulation of the Minister of Education, Culture, Research, and Technology Number 13 of 2022 (2022), which states that critical thinking skills are needed so that students can acquire, manage, and utilize information to survive in increasingly dynamic, uncertain, and competitive circumstances.

Facione identified six core indicators of critical thinking skills, namely, (1) interpretation, the ability to understand and classify the meaning of a problem; (2) analysis, the ability to identify relationships between concepts; (3) evaluation, the ability to assess the credibility of arguments and the logical accuracy of solutions; (4) inference, the ability to draw valid conclusions; (5) explanation, the ability to explain the reasons and steps of a solution; and (6) self regulation, the ability to reflect on and re examine the results of a solution (Facione, 2015). These six indicators form a holistic and measurable set of critical thinking skills.

Mathematics is a subject that inherently requires high-level thinking skills. According to the NCTM (2000), mathematics serves as a tool for training reasoning and for building students' ability to solve problems systematically through analysis, generalization, and proof. Critical thinking in mathematics learning encompasses students' ability to understand problems in depth, identify appropriate solution strategies, evaluate the procedures used, and draw logical and justifiable conclusions (Padmakrisya & Meiliasari, 2023).

Critical thinking skills are, therefore, among the most important goals of school mathematics learning. This ability helps students connect mathematical concepts and apply logical reasoning to solve complex problems (Nafiah, Kusumah, & Afgani, 2024). Critical thinking encourages students not only to accept information at face value but to analyze, evaluate, and consider multiple points of view.

In reality, however, the critical thinking skills of Indonesian students remain a serious concern. Results from the Trends in International Mathematics and Science Study (TIMSS) 2015 ranked 44th out of 49 participating countries with a mathematics score of 397, far below the international average of 500 (Hadi & Novaliyosi, 2019). A similar trends in evident in the Programme for International Student Assessment (PISA), where the average mathematics score of Indonesian students declined from 386 in 2015 to 379 in 2018, and further to 366 in 2022 (OECD, 2023). These results indicate that mathematics learning in Indonesia has not yet been optimal in developing students' critical thinking skills.

At the Madrasah Tsanawiyah (MTs) level, similar problems have been documented. Erlita and Hakim (2022) found that most MTs students' critical thinking skills fell into the medium category, with 19% of students in the low category, and only 6% in the high category. Likewise, Sakinah and Nasution (2023) reported that the mathematical critical thinking skills of MTs. students

were not yet optimal, particularly in the inference indicator, which reached only 43,9%. These conditions are reinforced by the limited use of Higher Order Thinking Skills (HOTS) based questions in daily mathematics instruction.

Various factors contribute to the low critical thinking ability of MTs students, both internal and external. Internally, low learning motivation and students' habit of memorizing procedures without deep conceptual understanding play a role. Externally, the dominance of conventional, teacher-centered learning methods remains the main obstacle to the development of students' critical thinking skills (Ammy & Syahputri, 2024). Anggraini, Siagian, and Agustinsa (2022) found that junior high school students' mathematical critical thinking ability in solving AKM (Minimum Competency Assessment) based problems was very low, particularly in the inference indicator, which reached only 15,95%. More recently, Harahap, Bentri, Musdi, Yerizon, and Armiati (2024) confirmed that students' critical thinking performance varies considerably according to their initial mathematical ability, with inference and evaluation consistently among the weakest indicators across ability levels.

Various efforts to improve critical thinking skills have been undertaken through innovative learning models, contextual approaches, and technology based learning media. Susanti, Abidin, and Mirda (2024) demonstrated that a scaffolding approach can raise students' mathematical critical thinking ability from the very low category (18,75) to the medium category (62,5). Ammy and Syahputri (2024) found that an Integrative Learning model increased students' average score from 67,28 (cycle I) to 75,55 (cycle II). Rahmawati, Supratman, and Lestari (2024) also reported significant improvements through meaningful, problem-based learning supported by digital book media.

Although the studies above have examined the critical thinking skills of MTs. students, several research gaps remain. First, most existing studies focus on only one or two critical thinking indicators; none comprehensively and proportionally analyzed all six Facione indicators within a single study (Erlita & Hakim, 2022; Sakinah & Nasution, 2023). Second, existing studies generally adopt a quantitative approach focused on scores and percentages and have therefore not deeply explored the thinking patterns and contextual factors underlying weaknesses in particular indicators from the students' own perspective (Abdar, Pamungkas, & Raharja, 2025; Anggraini, Siagian, & Agustinsa, 2022; Harahap, Bentri, Musdi, Yerizon, & Armiati, 2024). Third, in depth qualitative research that integrates test analysis, interviews, and

observations to understand the mathematical critical thinking skills of MTs. Students remain very limited. These gaps are the basis of the present study.

The objectives of this study are: (1) to describe the critical thinking skills in mathematics learning of Islamic Junior High School (MTs) 'Aisyiyah Medan students based on the six Facione critical thinking indicators (interpretation, analysis, evaluation, inference, explanation, and self-regulation); (2) to identify the critical thinking indicators that are most difficult for students to master; and (3) to analyze the contextual factors that affect students' critical thinking skills from the students' own perspectives through in depth interviews. The results of this study are expected to provide an empirical picture useful for the development of more effective mathematics learning at the Islamic Junior High School level.

METHODS

This study employs a descriptive qualitative approach. This approach was chosen because the research objectives require an in-depth understanding (thick description) of how Islamic Junior High School (MTs) students' critical thinking skills manifest in the context of authentic mathematics learning, including the meanings, patterns, and contextual factors that cannot be captured through numbers alone (Creswell, 2013). The study is not merely concerned with measuring scores, but also with understanding students' thinking processes, learning experiences, and the classroom conditions that underlie the achievement of each critical thinking indicator. Test score percentages, therefore, serve only as a preliminary map, while the in depth interviews and observations constitute the core of the analysis that produces rich and meaningful descriptions (Elfrianto & Lesmana, 2022).

The percentages reported in this study are used solely as descriptive quantification to facilitate the identification of students' ability profiles, rather than as inferential statistics. This is consistent with a descriptive qualitative design, in which numerical data function as supporting evidence for qualitative interpretation. Although numerical scores and percentages are reported, they are not used for statistical inference or hypothesis testing. Instead, they serve as descriptive quantification to support qualitative interpretation and to facilitate the selection of interview informants. The main focus of this study remains the exploration of students' experinces, thinking processes, and contextual factors influencing critical thinking skills.

The subjects of the study were 30 students of grade VIII at MTs. 'Aisyiyah Medan, all of whom completed the critical thinking ability test as preliminary data. Grade VIII was selected because these students had already passed the adaptation period at the MTs. level and had not yet faced the pressure of national examination experienced by grade IX students, allowing the learning process to take place under more representative and natural conditions.

For the in depth interviews, six students were selected as key informants through purposive sampling. The number of six informants was determined based on representation across ability categories: two students from the high ability group (test score ≥ 70%), two students from the medium ability group (test score 55% – 69%), and two students from the low ability group (test score < 55%). Grouping was based on the results of the critical thinking ability test, not on report card grades. Selecting two informants per group was intended to capture a more diverse range of perspectives within each category and to allow cross checking between informants in the same group. Six informants were considered sufficient to achieve data saturation within the scope of a small-scale descriptive qualitative research (Sugiyono, 2013). The profiles of the six informants are presented is presented table 1.

Table 1. Profile of Interview Informant

Code	Ability Groups	Test Score (%)	Selection Criteria
S1	High	78	Highest scoring student in the high ability group.
S2	High	72	Alternative representation of the high ability groups.
S3	Medium	63	Median score within the medium ability group.
S4	Medium	57	Representation of the lower boundary of the medium ability group.
S5	Low	48	Low ability student with communicative interview responses.
S6	Low	38	Lowest scoring student, selected for in depth difficulty analysis.

The research instruments comprised three types. First, the critical thinking ability test consisted of 12 questions developed based on six Facione critical thinking indicators, namely interpretation, analysis, evaluation,

inference, explanation, and self-regulation. The test instrument was first validated by two experts in the field of mathematics education to assess the suitability of the question items with indicators, difficulty levels, and readability. After being validated and revised, the instrument was tested on 20 students outside the sample to calculate reliability. The reliability of the test was calculated using the Alpha Cronbach coefficient, because the instrument was a polytomy (a tiered score of 0 – 4 per item), and a reliability coefficient of 0.84 was obtained, which was included in the high category. The selection of Alpha Cronbach was considered appropriate because it measured the internal consistency between the items of the description questions using the tiered score rubric.

Table 2. Operationalization of Critical Thinking Indicators and Test Items

Indicator	Description	No Item	Test Task	Scoring Rubric
Interpretation	Ability to understand and classify the meaning of a problem	1,2	Students identify known and unknown information in a contextual problem	0 = No answer 1 = Incorrect identification 2 = Partially correct 3 = Mostly correct 4 = Complete and correct
Analysis	ability to identify relationships between concepts	3,4	Students determine relationships between variables and formulate solution strategies.	
Evaluation	ability to assess the credibility of arguments and the logical accuracy of solutions	5,6	Students evaluate whether a given solution is logically correct	
Inference	ability to draw valid conclusions	7,8	Students infer conclusions based on mathematical evidence	
Explanation	ability to explain the reasons and steps of a solution	9,10	Students explain their reasoning process and justify answers	
Self Regulation	The ability to reflect on and re-examine the results of a solution	11,12	Students review and revise their solutions critically	

The 12 essay items were developed proportionally based on the six critical thinking indicators proposed by Fasione, with two items representing each indicator.

Second, semi-structured interview guidelines were developed based on Facion's critical thinking indicators and students' test results. Each informant was interviewed for approximately 15 minutes. The interview questions were designed to explore students' thinking process (retrospective think aloud), their perceptions of the difficulties encountered, their mathematics learning habits, and their experiences during classroom learning. Interviews were audio recorded with the informants and transcribed verbatim for analysis.

Third, a classroom observation sheet was used to record learning activities, including teachers students interaction patterns, the frequency of higher order questions posed by the teachers, opportunities provided for discussion, and the types of tasks assigned. Observations were conducted by the main researcher across three learning sessions using a structured checklist supplemented with field notes to document phenomena that arose spontaneously.

The qualitative data analysis, Miles and Huberman's interactive model, consisting of data collection, data reduction, data display, and conclusion (in Prasetia, 2022), comprises four stages summarized in figure 1. First, data were collected concurrently through written tests, semi structured interviews, and classroom observations, so each source complemented the others to provide a comprehensive picture. Second, in the data-reduction stage, all interview transcripts were read repeatedly to identify relevant units of meaning, which were then coded and grouped into themes. Third, data were displayed in the form of a percentage table for each indicator, the distribution of students across ability categories, a descriptive narrative accompanied by direct quotations from the interview transcript, and relevant observation notes. Fourth, conclusions were drawn based on patterns and themes identified and were verified by returning to the original data.

During the coding stage, interview transcripts were read repeatedly and segmented into meaningful units. Open coding was first conducted to identify keywords and phrases related to students' experiences in mathematics learning. Similar codes were then grouped through axial coding into broader categories, such as learning habits, classroom interaction, and exposure to HOTS questions. Finally, selective coding was applied to develop overarching themes explaining students' critical thinking profiles.

Data confluence was considered achieved when no new categories or themes emerged from the last two interviews and when information obtained from interviews was consistently confirmed through classroom observations and students' written responses. The triangulation of data sources and methods further enhanced the credibility and trustworthiness of the findings. The data analysis flow in this study can be described as follows.

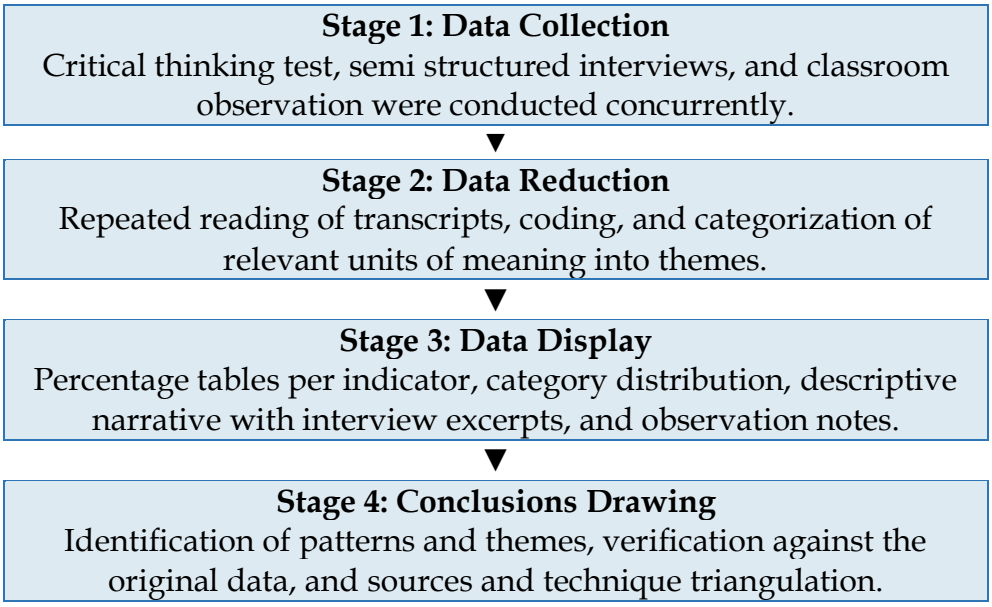

Figure 1. Stage of Data Analysis

RESULTS AND DISCUSSION

1. Critical Thinking Skills Based on Facione Indicators

Based on the critical thinking ability test administered to 30 students of grade VIII MTs. 'Aisyiyah Medan, an overview of students' critical thinking ability for each Facione indicator is presented in table 3.

Table 3. Results of Students' Critical Thinking Ability by Facione Indicator

No	Critical Thinking Indicators	Percentage (%)	Categori
1.	Interpretation	67,33	Medium
2.	Analysis	63,67	Medium
3.	Evaluation	46,67	Low
4.	Inference	38,67	Very Low
5.	Explanation	54	Low
6.	Self-Regulation	61,33	Medium
Overall Average		**55,29**	**Medium**

From table 3 above, the critical thinking ability of MTs 'Aisyiyah Medan students as a whole is in the medium category with an average percentage of 55,29%. The categorization of critical thinking ability levels in this study adopts the criteria adapted from (Sugiyono, 2013), in which scores are grouped into five categories: very high (85% – 100%), high (70% – 84%), medium (55% – 69%), low (40% – 54%), and very low (0% – 39%). The interpretation indicator obtained the highest percentage of 67,33%, while the inference indicator obtained the lowest percentage of 38,67%, with a very low category. These findings show that students are relatively able to understand and classify the meaning of mathematical problems, but experience significant difficulties in drawing logically valid conclusions.

Table 4. Distribution of Students' Critical Thinking Ability Categories

No	Categories	Number of Students	Percentage (%)
1.	Very High (85% – 100%)	1	3,33
2.	High (70% – 84%)	4	13,33
3.	Medium (55% – 69%)	14	46,67
4.	Low (40% – 54%)	8	26,67
5.	Very Low (0% – 39%)	3	10
Quantity		**30**	**100**

Table 4 shows that almost half of the students (46,67%) were in the medium category, while 36,67% remained in the low and very low categories. Only 16,66% of students were in the high and very high categories. This distribution is consistent with the findings of Abdar, Pamungkas, and Raharja (2025), who likewise found that the critical thinking ability of MTs students was predominantly in the medium category. Most students were able to understand the problem and to conduct initial analysis, but were not yet optimal in evaluation and inference.

2. In Depth Analysis Per Indicator

The low achievement of the inference indicator (38,67%) reflects complex cognitive difficulties. Inference requires students to integrate information from multiple sources, make logical deductions, and consider alternative solutions-cognitive processes that are rarely practiced in conventional, lecture-based learning and routine practice questions (Rosliani & Munandar, 2022). Analysis of students' answer sheets showed that most students ended their solutions

without drawing adequate conclusions, or drew conclusions that were grounded in coherent logical arguments.

The evaluation indicators (46,67%) also showed low achievement. In the evaluation items, students were asked to assess the accuracy of given solution procedures and to identify errors in mathematical arguments. Analysis of students' answers showed that most students accepted the given procedures at face value without any critical examination, reflecting a learning habit that emphasized the execution of procedures rather than critical reasoning.

3. In Depth Interview Findings: Factors Affecting Critical Thinking Skills

Analysis of the transcripts from the six informants' interviews yielded three main themes that consistently emerged as contributing factors to students' low critical thinking skills in mathematics learning.

Theme 1: Limited Experience with Higher-Level Thinking Questions (HOTS)

Information from all three ability groups consistently stated that the questions in the critical thinking test felt different from the problems they usually encountered in daily learning. Informant S1 from the high-ability group said: "*The questions are very different from the usual ones, Mr. teacher. Usually, we just need to use a formula and immediately find the answer. This is a question asking us to explain why, and ask us which value is correct. I am confused about where to start.*" In line with that, the S4 informant from the group stated: "*I am not used to problems like this. If it is an ordinary question, it immediately seems that what to do, but I read this repeatedly and I am still confused about how to do it*". Even S2 informants who belong to the high-ability group admitted: "*I usually can do maths, but this problem is difficult, because it is not just calculations, but you have to think deeper and must be able to explain*".

The consistent recognition of this ability group informant indicates that the low ability to think critically is not solely due to the limitations of students' cognitive abilities, but also due to the lack of habituation and practice of questions that require a high level of reasoning in the daily learning process.

Theme 2: Limitations of Discussion Space in Learning

Almost all of the informants reported that mathematics learning in grade VIII rarely involved meaningful group discussions or collaborative activities. The S3 informant from the group stated: "*In class, it is usually the teacher who explains, and we continue to work on sensory problems. It is very rare to discuss with friends. At least if you can't, ask your classmates.*" The absence of a structured discussion forum has an impact on the lack of opportunities for students to

build, articulate, and evaluate their own mathematical arguments with essential skills for the development of critical thinking, evaluation, and inference.

Theme 3: Procedural Learning Orientation

Informants from the low-ability group specifically expressed a high dependence on memorization of formulas and standard completion steps. The S6 informant stated: "*I learned mathematics by memorizing the formula first. If I forgot the formula, I didn't know how to solve or do the problem. There was no formula for this problem that I could memorize.*" Meanwhile, the S5 informant added, "*Usually, if you have memorized the method, you can do it immediately. But if the problem is different from the example, I am confused.*"

This procedural learning orientation reflects that the mathematics learning that students have received so far emphasizes mastery of algorithms more than deep conceptual understanding, so that when faced with problems that demand flexibility of thinking, students do not have adequate strategies.

4. Observational Findings

The results of classroom observation across the three sessions reinforced the interview findings above. The learning process in grade VIII MTs 'Aisyiyah Medan was strongly dominated by a teacher centered pattern. Field notes showed that, of the approximately 80 minutes of instructional time observed in each session, an average of 78% (around 62 minutes) was used by teachers for material exposition and worked examples, while only 22% (around 18 minutes) was allocated to independent or group students' activities. Most of which consisted of procedural practice. Higher order questions were almost absent from classroom interactions.

The overall findings of this study show that the critical thinking skills of MTs "Aisyiyah Medan students in this study context have not been developed optimally. The ability profile produced by interpretation as the strongest indicator and inference as the weakest indicator is consistent with the findings of previous studies (Abdar, Pamungkas, & Raharja, 2025; Erlita & Hakim, 2022; Sakinah & Nasution, 2023).

An important contribution of this research is a deep understanding of why these patterns occur. Through a qualitative analysis of interviews, it was revealed that low critical thinking skills are not solely individual cognitive problems, but rather a product of learning conditions that do not provide enough stimulation and opportunities for the development of these abilities. These findings are in line with the argument of Nurkasanah, Suryanti, and Sari

(2025) that every student has the potential for critical thinking, but that the level of achievement is greatly influenced by the learning experience received.

The implications of these findings show the need to shift the learning paradigm from teacher centered to student-centered problem based learning. Learning models such as SSCR (Search, Solve, Create, Share) (Munawaroh & Auliya, 2022), RME approach (Nurkasanah, Suryanti, & Sari, 2025), and problem based meaningful learning (Rahmawati, Supratman, & Lestari, 2024) have proven to improve critical thinking skills and relevance to be implemented in MTs 'Aisyiyah Medan, especially to strengthen the weakest indicators of inference and evaluation.

From the perspective of Fasione's critical thinking theory, the low performance on inference and evaluation indicates that students have not yet developed higher order reasoning processes optimally. Inference requires learners to synthesize information, generate alternative possibilities, and formulate logical conclusions, whereas evaluation demands the ability to assess the credibility and validity of arguments critically (Facione, 2015). The predominance of teacher centered instruction observed in this study limits opportunities for students to practice these higher order cognitive processes.

Furthermore, constructivist learning theory emphasizes that knowledge is actively constructed through social interaction, discussion, and reflection. The lack of collaborative learning activities found in this study may explain students' difficulties in evaluation and inference. Therefore, mathematics learning should be redesigned to encourage problem solving, argumentation, and reflective thinking through student centered approaches.

Theoretically, this study contributes empirical evidence supporting the relevance of Facione's framework in mathematics education at the MTs. level. Practically, the findings suggest that mathematics teachers should provide more HOTS based tasks, facilitate classroom discussions, and implement innovative learning models that promote critical reasoning.

CONCLUSION

The ability to think critically in mathematics learning for grade VIII students of MTs 'Aisyiyah Medan as a whole is in the medium category. Based on six Facione indicators, the interpretation indicator shows the highest mastery, reflecting the student's ability to understand mathematical problems, while the inference indicator is in the very low category as the weakest achievement. The evaluation indicators are also relatively low, which indicates

that students' ability to assess the accuracy of mathematical procedures and arguments still needs to be significantly improved.

Qualitative analysis through in depth interviews with six informants revealed three dominant factors that explain the critical thinking ability profile: (1) the lack of habituation of HOTS based questions in the daily mathematics learning process, as consistently recognized by all informants across ability groups; (2) limited space for discussion and mathematical argumentation in learning dominated by the teacher centered pattern; and (3) the procedural learning orientation of students due to learning that emphasizes algorithm memorization rather than conceptual understanding.

The implication of the study is the need for MTs. 'Aisyiyah Medan mathematics teachers apply innovative and contextual learning models that have proven to be effective in improving students' critical thinking skills, especially in inference and evaluation indicators. Further research is suggested to test the effectiveness of various innovative learning models in improving each of Facione's critical thinking indicators, more specifically, as well as to expand the scope of the sample to increase the transferability of findings.

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DECLARATION

Author Contribution	:	PMA: Conceptualization, Investigation, Methodology, Instrument Development, Data Analysis, Writing-Original Draft, Supervision, and Writing-Review and Editing. ID: Conceptualization, Methodology, Validation, Supervision, Instrument Development. KMAF: Conceptualization, Methodology, Validation, Supervision, Instrument Development.

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