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The Role of Emotional Intelligence in Mathematical Critical Thinking: A Systematic Literature Review

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Abstract: Critical thinking ability is a fundamental ability in the process of developing other thinking abilities in improving students' intellectual abilities, especially in learning mathematics. One factor that influences critical thinking skills is emotional intelligence, especially awareness of controlling one's emotions. This research aims to apply a literature review in analyzing mathematical critical thinking skills in terms of emotional intelligence. The research method used in this research is a Systematic Literature Review (SLR) by reviewing relevant literature regarding critical thinking abilities in terms of emotional intelligence. Data collection was carried out through article searches using Publish or Perish on Google Scholar, Scopus, and Semantic Scholar with a publication range from 2015 to 2024. Article selection was carried out based on inclusion and exclusion criteria to obtain 10 journals that were relevant and suitable for further analysis. Based on the results of the analysis, it show that: (1) The type of research that is most widely used is quantitative, whereas other types of research are the qualitative and mixed method; (2) Most levels of education are at the junior high school level while other levels include elementary school, high school, and university students (3) Emotional intelligence has a positive relationship with students' mathematical critical thinking abilities (4) Factors that influence students' critical thinking abilities in terms of students' emotional intelligence are negative emotions such as stress, and frustration and negative thoughts that dominate and limit students' abilities. Based on research findings, good emotional handling strategies are needed in the learning process so that students can develop critical thinking skills optimally. Future research could explore more deeply the mechanisms of how emotional intelligence influences mathematical critical thinking abilities, as well as examine the effectiveness of interventions designed to improve emotional intelligence and mathematical critical thinking abilities simultaneously.

Keywords: mathematical critical thinking ability, emotional intelligence, systematic literature review.

▪ INTRODUCTION

Mathematics is one of the essential branches of science that students learn from elementary school to college level whose concepts are very common in everyday life (Begovic, et al., 2017). The concepts in mathematics will provide real problems or social problems that have an impact on themselves or community life to provide space for students in the internalization process to understand and solve mathematical problems related to everyday life (Sihite, et al., 2024). Therefore, it requires an ability to assimilate and process the information obtained so that students can maximize four student abilities including critical thinking skills that are important to have in learning mathematics.

Critical thinking is one of the thinking skills that prove, interpret, synthesize, and evaluate information to get to the truth (Facione, 2015). Meanwhile, critical thinking ability according to Ennis (1985) is a reflexive and rational way of thinking which is a benchmark in making decisions on what can be trusted or done. This illustrates that critical thinking ability is an ability that assembles cognitive thinking processes and

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evaluates them in an organized manner so that it can think reflectively and reasonably in making decisions.

Someone who thinks critically can make inferences from the information obtained and can use that information in solving problems and can look for relevant sources of information that support problem-solving (Ida, et al., 2021). This shows that critical thinking skills are needed in the process of learning mathematics to overcome mathematical concept problems.

However, students' mathematical critical thinking skills are still relatively low. A review of PISA (Program for International Assessment of Students) in 2022 shows that Indonesia is in position 66 out of 81 countries or the 15th lowest in the world whose assessment focuses on mathematical reasoning. In this case, the government has introduced the Merdeka Curriculum, which contains more activities designed to sharpen students' reasoning power and competence to encourage students to think critically and solve their problems. Facione (2015) suggests that there are six indicators or standards, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation. However, many researchers only use four indicators including interpretation, analysis, evaluation, and inference.

The ability to think critically is influenced by many factors, one of which is one's emotional condition so emotional intelligence is needed in controlling emotions in individuals. So emotional intelligence is needed in controlling emotions in individuals. In controlling emotions, good emotional intelligence is needed (Sulastri, et al., 2023). Emotional intelligence is the ability to realize feelings or emotions of oneself and others, to motivate oneself, and to control emotions both within oneself and in relationships with others (Goleman, 2009). Emotional intelligence also affects how students' thinking process, especially in critical thinking. This is supported by research by Shafee et al (2016) which shows that emotional intelligence contributes to students' critical thinking skills and math scores. To improve students' mathematical critical thinking skills, this research specifically presents relevant references for the last 8 years. This comprehensive systematic literature review aims to provide answers regarding the following research topics.

1. What types of research are used in the 2015-2023 articles related to mathematical critical thinking abilities in terms of emotional intelligence?
2. What level of education tends to be used regarding mathematical critical thinking abilities in terms of emotional intelligence in the 2015-2024 period?
3. How is emotional intelligence related to students' critical mathematical thinking based on existing empirical evidence?
4. What are the factors that influence critical thinking abilities seen in students' emotional intelligence?

High emotional intelligence can not only control themselves well but also ensure that students can think logically and use their minds in the best way to find solutions to the problems they face. On the other hand, low emotional intelligence will immediately give up when they encounter problems they are unable to solve. This is also based on one's experience (Li, et al., 2021).

Based on the background of the discussion above, the objectives of this study are: (1) Describe the type of research used in the year article related to mathematical critical

thinking ability in terms of emotional intelligence in the 2015-2023 range (2) Describe what level of education tends to be used related to mathematical critical thinking ability in terms of intelligence (3) Analyzing the relationship between emotional intelligence and students' critical mathematical thinking; (4) Analyzing the factors that influence students' critical thinking in terms of students' emotional intelligence.

▪ METHOD

Research Design

The research method used is Systematic Literature Review (SLR) research. SLR is the process of collecting, identifying, and analyzing a particular topic that is relevant to the topic that has been determined to get answers to the questions under study (Mengist, et al., 2019). Researchers will review several journals related to students' mathematical critical thinking skills in terms of students' emotional intelligence. According to Triandini et al. (2019), there are six stages in the SLR there are Research Question, search process, inclusion and exclusion criteria, Quality Assessment, Data Collection, and deviation from protocol

Search Strategy

The articles collected in this research relate to the importance of emotional intelligence in students' mathematical critical thinking abilities. Eleven articles were selected using Publish of Peris with Scopus, Google Scholar, and Semantic Scholar by searching date on February 10, 2025). The selected articles use the keywords "emotional intelligence AND critical thinking AND math". The selected articles are adjusted to the inclusion criteria and are relevant. Then proceed with grouping articles for further analysis. Findings at the final stage will be presented. In this step, an approach using PRISMA is used to synthesize research findings clearly and methodically. The steps involved are as follows.

The first stage of the Research Question (RQ) is made based on the research topic. The research questions include (RQ1) What types of research are used in the 2015-2023 article related to mathematical critical thinking skills in terms of emotional intelligence?; (RQ2) What level of education tends to be used related to mathematical critical thinking skills in terms of emotional intelligence in the 2015-2024 range?; (RQ3 How is emotional intelligence related to students' critical mathematical thinking based on existing empirical evidence? (RQ4) What are the factors that influence critical thinking abilities seen in students' emotional intelligence?

The second stage is the search process which is used to find journal references that are relevant to the research question (RQ). Researchers collect references in the form of research that has been published from national journal articles, or registered electronic databases such as Google Scholar or direct URLs of international journals published from 2015-2024 with the keyword "mathematical critical thinking skills in terms of emotional intelligence". Journals that have been collected will be extracted that meet the keyword criteria and will be included in the analysis stage.

Inclusion and Exclusion Criteria

The third stage is the inclusion and exclusion criteria used to determine whether or not the data collected is suitable for use in this study. The inclusion and exclusion criteria can be seen below.

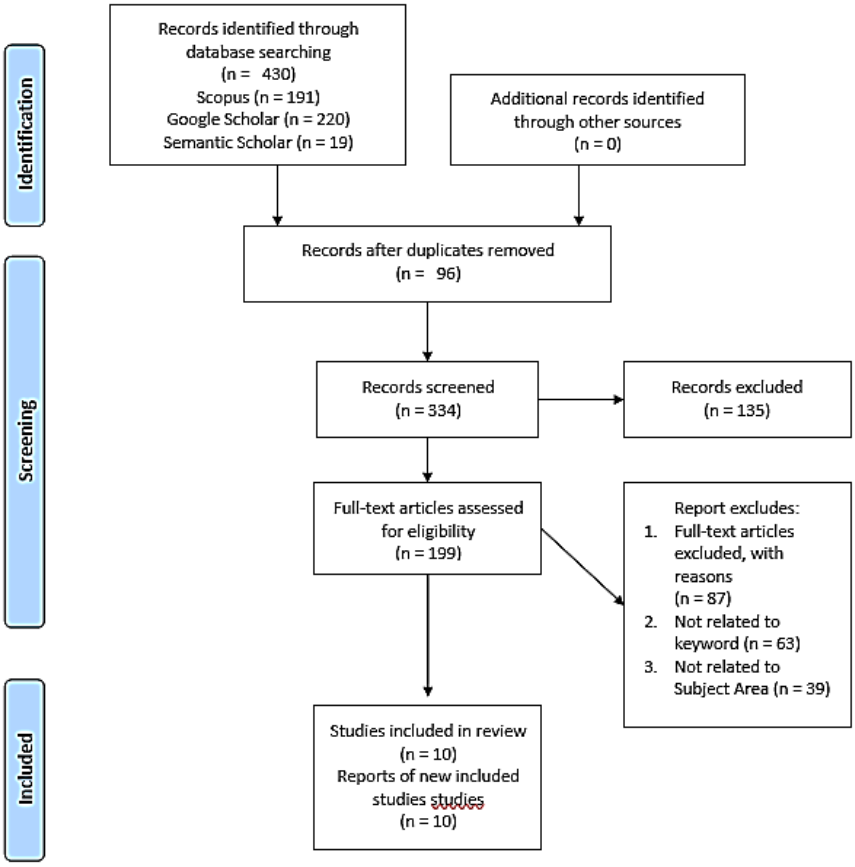

Figure 1. PRISMA flowchart

The inclusion criteria in this research are national or international articles that are relevant to the research topic, the source of the article comes from Scopus, Google Scholar, and Semantic Scholar which comes from a trusted source with higher journal accreditation, the publication year ranges from 2015-2024, the sample consists of students because this research goes through a wider educational process to see the critical thinking of students and students who are in the learning process, and the language used is Indonesian or English so that the research is more widespread at home and abroad.

Meanwhile, the exclusion criteria are national or international articles that are not relevant to the research topic, the source of the article was not obtained through Google Scholar or a registered electronic database, the time period for which the article was published was before 2015, the sample did not consist of pupils or university students and the language used was other than Indonesian or English.

Data Analysis

The fourth stage is Quality Assessment (QA) which is used to assess journal quality criteria. The guideline used in analyzing journal quality among the selected studies is the Critical Appraisal Skills Program Tools (CASP). The CASP instrument consists of 11 questions, including questions related to the internal validity of the study, namely whether the objectives and methods used are appropriate and biased in the research, the validity of the results and questions, and the relationship of relevance to practice in a wider context

and its implications. (CASP, 2017). The CASP assessment uses a numerical system but is based on qualitative evaluation with three main criteria, namely validity, research results, and relevance. The questions on each CASP checklist can be answered with "yes", "no", or "unclear" to assess the quality of the research. If the majority of answers are "Yes", then the journal is of good quality and appropriate, but if there are many answers "No" or "Unclear" then the quality of the research needs to be reviewed further before use.

The fifth stage is data collection. In this research, researchers collected 10 scientific articles that were relevant to keywords. In analyzing articles, journals are grouped first based on themes and keywords using thematic analysis. First, journals were collected from various sources, namely Google Scholar and Semantic Scholar via Publish of Perish, then coding was carried out to mark relevant sections with aspects of critical thinking and emotional intelligence. After that, the code is grouped based on RQ. Then, it will be revised to ensure suitability and relevance and then presented in the final synthesis.

▪ RESULT AND DISSCUSSION

Journal search results through the Google Scholar database and journal searches in the range 2015-2023 12 relevant articles with keywords related to mathematical critical thinking skills in terms of emotional intelligence were obtained. Next, review the articles that are following the problem. The research data is presented in Table 1 below.

Table 1. Research results related to mathematical critical thinking skills in terms of emotional

Author and Year	Methodology	Journal	Research result
Fong-Luan Kang (2015)	Cross-sectional design survey method (quantitative). Data was collected through questionnaires and analyzed using statistical and inferential methods The sample consisted of 338 students.	International Journal of Education and Literacy Studies	Based on 338 postgraduate students, emotional intelligence and critical thinking tendencies were positively correlated (r=0.609). The significant differences are age and gender.
Maryam Shafie, Hendeh Majdi, Maryam Khoshkou, and Fatemeh Rajabi (2016)	This research is descriptive correlational (quantitative experimental and control groups) Data was collected using an emotional intelligence questionnaire. The sample consisted of 120 high school students.	International Journal of Innovation and Research in Educational Sciences	The results show that there is a positive and significant relationship between emotional intelligence and students' critical thinking abilities; The correlation coefficient of 0.643 is in the strong category.

Maryam Akbari Lakeh Atefeh Nadei, Azizollah Arbabisarjou (2018)	This study used a cross-sectional descriptive-analytic design at Zahedan University of Medical Sciences. The research sample consisted of 50 nursing students Data was collected using the California Critical Thinking Skills Test (CCTST) to measure critical thinking as well as an emotional intelligence questionnaire	Argentine Medical Press	The research results show that critical thinking skills and emotional intelligence have a significant relationship with academic achievement, with emotional intelligence having a stronger influence with a correlation coefficient of 0.802. In addition, demographic factors such as marital status and gender did not have a significant influence on this relationship.
Sahanowas Sk, Santoshi Halder (2020)	This research uses a descriptive cross-sectional study design. The research population consisted of 500 first-year students of different study programs from various universities in India Data were collected through EI questionnaires and critical thinking disposition assessment Facione indicators	Journal Heliyon	This study found that emotional intelligence (EI) had a significant influence on freshmen's critical thinking disposition (CT), with EI explaining 40% of the variance in CT ($\beta = 0.64$, $p < 0.001$). In addition, the results show that the relationship between EI and CT is not influenced by gender. These findings confirm that increasing emotional intelligence can help students think critically, overcome academic stress, and adapt better to the college environment.
Nur Aini Azizah, I Ketut R Sudiarditha, Aditya Pratama (2022)	This research is quantitative research with an explanatory survey method. The sample was 84 students of class XI IPS at SMAN 41 Jakarta. Instruments for test questions and questionnaires with a Likert scale via Google Form	International Journal of Multidisciplinary Research and Literature	The results of this study The results of this research show that emotional intelligence has a positive and significant effect on students' critical thinking abilities with a regression coefficient of 0.895. The results of this research have the implication that students' emotional intelligence and self-efficacy can improve their critical thinking abilities.

Sukriadi, Kartono & Wiyanto. (2015)	Concurrent Mix Method Model research design where qualitative research is the primary method. Embedded Strategy, The instrument uses a diagnostic test of critical thinking abilities Research subjects for class VIII SMP	Unnes Journal of Mathematics Education Research	The results of the research show that there is a pattern of relationship between emotional intelligence and mathematical critical thinking abilities, namely that there are deficiencies in certain aspects at each level of emotional intelligence. Where aspects consist of interpretation, deduction, assumption, evaluation argument and inference.
Winda Lestari, Soffil Widadah, Nurina Ayuningtyas. (2021)	The research design uses a qualitative descriptive design. The research subjects were three students in class VIII of junior high school. The instruments used were emotional intelligence questionnaires, Pisa test questions, and interviews.	Musamus Journal of Mathematics Education	The results of the research show that students with high emotional intelligence are less able to think critically, students with moderate emotional intelligence are able to think critically, and students with low emotional intelligence are unable to think critically in solving PISA questions, so innovative strategies are needed to improve student's critical thinking skills in dealing with questions that require in-depth analysis.
Lala Nurhayati, Luthfi Hamdani Maula, Iis Nurasiah. (2021)	The research uses an associative design with correlational methods and survey techniques. The sample consisted of 64 fourth-grade elementary school students. The instruments used were emotional intelligence questionnaires and critical thinking ability description tests.	Pulpit Science Journal	The results of the research show that there is a positive relationship between emotional intelligence and students' critical thinking abilities with a correlation coefficient of 0.411 in the medium category. Students must be able to control emotions in the learning process to improve student's critical thinking abilities.

Septilia Harefa, Convinced of Telaumbanua and Agnes Renostini Harefa's intentions. (2023)	The research uses qualitative descriptive. ·A sample of 61 junior high school students as informants. Data was collected through emotional intelligence questionnaires, observations, interviews, and documentation analyzed by the Miles and Huberman technique.	Educatum: Journal of Educational Sciences	Based on the research results, the characteristics of emotional intelligence will contribute to student learning. This shows that students with high emotional intelligence are able to learn well, finding solutions to every learning obstacle. Students with moderate emotional intelligence are able to learn well, but when they experience obstacles in learning they are unable to think creatively in solving problems. Students with low emotional intelligence are not able to learn well and are less motivated so this has an impact on students' knowledge results.
Hastuty Musa, Rusli, Ranak Lince, Abdul Gaffar & Jusnawati (2021)	The research uses an ex post facto design with a causality approach. The research sample was 57 class VIII students at Sungguminasa State Middle School. Critical thinking ability test instruments, emotional intelligence and learning independence questionnaires, as well as documentation of mathematics learning results. Descriptive statistical data analysis using multiple linear regression te	Deangku: Journal of Humanities and Social Science Innovation	The research results show that the critical thinking abilities, emotional intelligence, and learning independence of class VIII students are in the good category, while the mathematics learning outcomes are in the medium category. Critical thinking skills, emotional intelligence, and learning independence come together to influence on the mathematics learning outcomes of class students and emotional intelligence has a positive influence on the mathematics learning outcomes of class VIII students of SMP Negeri 1 Sungguminasa with a coefficient of 0.619

RQ 1: What types of research are used in the 2015-2023 articles related to mathematical critical thinking abilities in terms of emotional intelligence?

In Research Question 1, which is about what types of research are used in 2015-2021 articles related to mathematical thinking skills in terms of students' emotional intelligence. Based on the results of the identification and analysis of journals that have

been collected on journals related to mathematical thinking skills in terms of emotional intelligence, can be seen in Figure 2.

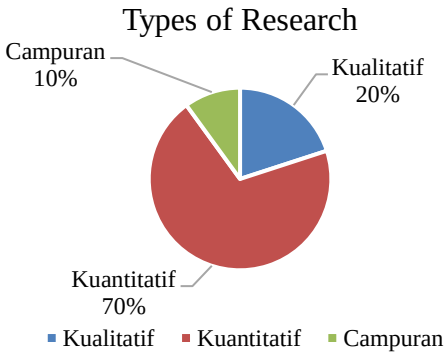

Figure 2. Types of research related to mathematical critical thinking skills in terms of emotional intelligence

Based on the picture above, it can be seen that the types of research used are qualitative, quantitative, and mixed. These results can be seen that quantitative research is the most common type of research, namely 70% in the 2015-2024 period. Meanwhile, qualitative is around 20%, and the mixed method has a range of 10%. In quantitative terms, 3 articles use a cross-sectional descriptive analysis design, and 4 articles use correlational methods. In the qualitative method, the design used is descriptive qualitative, while in the mix method, the concurrent mix method model is used.

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RQ 2: What level of education tends to be used regarding mathematical critical thinking abilities in terms of emotional intelligence in the 2015-2024 period?

In Research Question 2, which is about what level of education tends to be used related to mathematical critical thinking skills in terms of emotional intelligence in the 2015-2024 range. Based on the results of relevant reviews, it can be seen in Figure 3

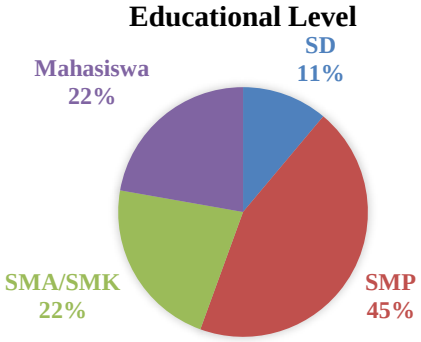

Figure 3. Education level related to mathematical critical thinking skills in terms of emotional intelligence

Based on the figure above, it is found that the level of education that tends to be used in this study in the 2015-2024 range is at the junior high school level with 46%, this is slightly different from high school which is 36%. Meanwhile, the elementary school level is 18%.

RQ 3: How is emotional intelligence related to students' critical mathematical thinking based on existing empirical evidence?

Research Question 3 is about how emotional intelligence relates to students' mathematical critical thinking abilities. Based on Kang's (2015) findings, emotional intelligence is positively correlated (r=.609) with the tendency to think critically. This is supported by Shafiee's research (2016) where there is a significant positive relationship between all components of emotional intelligence and students' mathematics scores. Other factors analyzed are age and gender. Research shows there is no significant difference between the emotional intelligence of graduate students by age category. Apart from that, it shows that the tendency to think critically does not differ significantly according to gender. Shanowas & Halder (2020) stated that the role of gender as a research moderator was not significantly related to EI and CT. Meanwhile, the findings of Nurhayati, et al. (2021) stated that there is a positive relationship between emotional intelligence and critical mathematical thinking ability with a correlation coefficient of 0.411 which is categorized as a medium degree of relationship. This means that the higher the emotional intelligence, the higher it will be. The results of Musa's (2021) research also state that the influence of emotional intelligence on mathematics results has a contribution of 13.5%.

Slightly different, the results of research by Lestari et al (2021) revealed that students with emotional intelligence and critical thinking were not significant. This is because students with good emotional intelligence are less critical in solving mathematical problems. This is because students are less careful in solving problems and have not made inferences. However, students with moderate emotional intelligence can solve mathematical problems well.

The differences above show that the relationship between emotional intelligence and critical mathematical thinking is dominated by the strong relationship between emotional intelligence and gender. This difference is due to other factors where students do not focus on solving problems. However, overall it can be said that students have a positive relationship with emotional intelligence. This is reinforced in Harefa's (2023) research where students with low emotional intelligence have difficulty learning and are unable to motivate themselves and their learning relationships with other students are poor, which has an impact on students' knowledge. Students who have moderate emotional intelligence can learn and think better. Meanwhile, high emotional intelligence can learn and find better solutions and can motivate themselves to be enthusiastic about learning in developing students' mathematical critical thinking abilities.

RQ4: What are the factors that influence critical thinking abilities seen from students' emotional intelligence?

In the next question, it was found that one of the factors that has an important role in emotional intelligence is being able to think critically, including sensitivity to handling emotions, is the key to strengthening critical thinking tendencies (Kang, 2015).

Sometimes negative thoughts, stress and frustration dominate and limit students' abilities. Therefore, developing EI is very important in critical thinking skills and helps solve problems effectively (Sahanowas, 2020). Goleman revealed that emotional turmoil which is part of emotional intelligence greatly influences a person's thinking process. When students are not enthusiastic about daily learning activities, learning goals will not be achieved and students will not be able to maximize their critical thinking abilities (Azizah et al., 2022).

The importance of critical thinking skills and emotional intelligence places demands on teachers to choose the right method even though students' emotional intelligence varies. Sukriadi et al (2015) applied the IMRE (Indonesian Realistic Mathematics Education) method which was considered effective based on the difference in the average of the experimental class and the control class. Based on research by Musa et al (2021), apart from emotional intelligence, independent learning has a positive influence on students' mathematical critical thinking abilities

This research is in line with research by Rupande (2015) which collected relevant literature and revealed that emotional intelligence is very important in student learning and has big implications in education. This is because EI has an influence on academic achievement through students' ability to cope with pressure, the dynamics of group collaboration, and social demands in academic life, thereby enabling students to fully integrate academically and socially in the educational environment. Based on the results of Shafiee's research (2016), emotional intelligence makes students active learners, innovative in solving problems with teacher guidance, have high social intelligence, and understand philosophy which gives rise to good spiritual intelligence.

▪ CONCLUSION

Based on the results of the identification and analysis of the 10 journals above, it can be concluded that the type of research that tends to be used in journals related to critical thinking skills in terms of emotional intelligence in the 20015-2024 range is quantitative research with a junior high school education level. Based on 10 relevant journals show that (1) The type of research that is most widely used is quantitative, whereas other types of research are the qualitative and mixed method; (2) Most levels of education are at the junior high school level while other levels include elementary school, high school, and university students (3) Emotional intelligence has a positive relationship with students' mathematical critical thinking abilities (4) Factors that influence students' critical thinking abilities in terms of students' emotional intelligence are negative emotions such as stress, and frustration and negative thoughts that dominate and limit students' abilities. Based on research findings, good emotional handling strategies are needed in the learning process so that students can develop critical thinking skills optimally. Future research could explore more deeply the mechanisms of how emotional intelligence influences mathematical critical thinking abilities, as well as examine the effectiveness of interventions designed to improve emotional intelligence and mathematical critical thinking abilities simultaneously.

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