JPPIPA 11(11) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Critical Thinking Skills of Junior High School Students in Environmental Content: A Gender-Based Profile

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Received: August 03, 2025
Revised: October 07, 2025
Accepted: November 25, 2025
Published: November 30, 2025

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DOI: 10.29303/jppipa.v11i11.12390

Abstract: This study aims to analyze the critical thinking skills of junior high school students in environmental pollution materials based on gender differences. The research used a descriptive-comparative design with 60 Grade VII students at MTs Raudhatul Azhar, East Lombok, selected purposively. Data was collected using an essay test consisting of four indicators of critical thinking: elementary clarification, advanced clarification, information gathering, and inference. Descriptive results showed that female students had higher average scores (M = 77.8; SD = 5.4) than male students (M = 68.9; SD = 6.1). Independent t-test results confirmed significant differences in all indicators ($p < 0.05$), indicating that female students demonstrated higher levels of critical thinking skills. The results highlight the importance of developing learning strategies that are sensitive to gender characteristics to support the equitable development of students' critical thinking skills.

Keywords: Critical thinking skills; Environmental pollution; Gender; Profile

Introduction

One of the important skills in the 21st century is critical thinking skills, which must be developed early on, especially during junior high school. Students who have this ability not only succeed in learning, but are also able to make logical decisions, solve problems, and develop scientific attitudes (OECD, 2018; Pentury et al., 2023). Critical thinking skills are included in the Pancasila Student Profile in the Merdeka Curriculum. This encourages students to be able to think critically, analytically, and reflectively about various problems they face (Kemendikbudristek, 2022). Critical thinking is an important process in science education for developing and refining scientific ideas (Santos, 2017). Critical thinking skills are essential for assessing information and making decisions in science education (Sujatmika et al., 2024). By thinking critically, students can make better decisions by using the information they have, assessing evidence, and analyzing arguments with these skills (Carvalho et al., 2015). Critical thinking is also the basis of science learning for deep conceptual understanding and scientific literacy (Pratiwi, & Doyan, 2024). Students' critical thinking skills in Indonesia are still in the moderate to low category (Maryani et al., 2021; Irhasyuarna et al, 2023). Therefore, training critical thinking skills is very important to equip students as early as possible so that students are ready to face complex challenges in the contemporary era. However, various studies show that the level of critical thinking skills of students at the junior high school level is still relatively low. It is very important to pay attention to the low critical thinking skills of junior high school students (Pradana et al., 2020). They are still lacking in critical thinking at an early stage (Ramadhani & Nurita, 2022). Students do not develop reflective thinking (Rijal et al., 2021; Husamah et al., 2018). Most students show critical skills below the moderate category in environment-based learning (Fadilah, 2023).

Early observation results show that teachers rarely use questions that require high-level thinking skills (HOTS). The emphasis is still focused on memorizing facts and mastering basic concepts, and students are not involved in reasoning activities, evaluating, or solving

How to Cite:
Fatmawati, B., & Khotimah, H. (2025). Critical Thinking Skills of Junior High School Students in Environmental Content: A Gender-Based Profile. *Jurnal Penelitian Pendidikan IPA*, *11*(11), 1271–1280. https://doi.org/10.29303/jppipa.v11i11.12390

environmental problems critically and creatively. Tyas et al. (2019) reported that teachers face many challenges when creating HOTS questions. Pammu et al. (2021) stated that most teachers only use summative assessments to assess students' cognitive abilities. Musa (2021) found that teachers face difficulties in creating and implementing HOTS questions, which are still dominated by low cognitive skills. Dima et al. (2021) found that although teachers understand HOTS, its implementation is ineffective because teachers lack the necessary skills, have limited facilities, and receive insufficient HOTS training. Retnawati et al. (2021) found that teachers do not have the ability to create HOTS-based strategies and questions. Sarkawi et al. (2023) reported that teachers often ignore high cognitive levels because they are not prepared and do not have the practical skills to create HOTS questions. Alic et al. (2022) found that most teacher interactions do not encourage critical thinking. This is exacerbated by the dominance of conventional learning approaches to environmental material that tend to be teacher-centered and only emphasize mastery of concepts rather than deep thinking processes. Students often only receive information passively, without space to talk about ideas, solve real problems, or explore concepts independently. Students' HOTS levels are very low in environmental learning, according to Ichsan et al. (2019), indicating the dominance of memorization and basic concepts. Nurwidodo et al. (2023) said that environmental learning often does not improve the ability to think critically; instead, it concentrates more on memorization and simple concepts.

Students often have difficulty relating concepts to real-world contexts. In fact, this topic is very relevant to students' lives and has great potential to be a medium for developing critical thinking skills. As a result, learning feels non-contextual and insignificant. Because the material is not absorbed through experience or direct problem solving, this has an impact on students' critical thinking skills (Ali et al., 2020; Kartini et al., 2019). Jais et al. (2021) students learning environmental material have not been developed based on HOTS. Environmental material is one of the strategic learning contexts for improving critical thinking skills (Aripin et al., 2024; Uddin et al., 2020).

Most of the research on critical thinking skills has been conducted in various learning contexts, but most of the research is still general and has not specifically looked at the differences in abilities between males and females in terms of problem solving and analytical reasoning (Hsu et al., 2022; Setiawan et al., 2024). Gender can affect students' critical thinking skills (Dewi & Erman, 2022; Marnı et al., 2020). Supriyati et al. (2021) found significant differences in the way high school students think critically based on gender when learning biology online. Problem-solving skills do not differ between males and females (Hadiprayitno et al., 2022). Therefore, efforts to develop critical thinking skills are necessary using various teaching strategies, such as problem-based learning and/or digital assistance (Nasution et al., 2023; Neswary & Prahani, 2022).

This study focuses on the analysis of the critical thinking profile of junior high school students, combining three main elements at once: critical thinking skills, environmental material context, and gender differences among junior high school students. It is hoped that this study will provide new contributions to the literature and the development of contextual learning strategies that are responsive to the diversity of learners.

Method

Research design: This survey study uses a quantitative descriptive and comparative approach. The main objectives of this study are to analyze the critical thinking skills of junior high school students in studying environmental materials and to analyze differences based on gender. Subjects: Purposive sampling was used to determine the sample, with a total number of 76 students in class VII of Madrasah Tsanawiyah Raudhatul Azhar Lombok Timur, divided into 28 male students and 48 female students. Research procedure: This research was conducted in several stages, namely determining the problem and research objectives, which consisted of determining the material, determining the respondents, and analyzing critical thinking indicators; compiling question formats related to environmental material in the form of descriptive tests; conducting tests to determine students' critical thinking skills; conducting data analysis, namely determining data analysis that is in accordance with the research design; and concluding, namely recording the findings from the results of data analysis. The following is the flow of the research procedure presented in Figure 1.

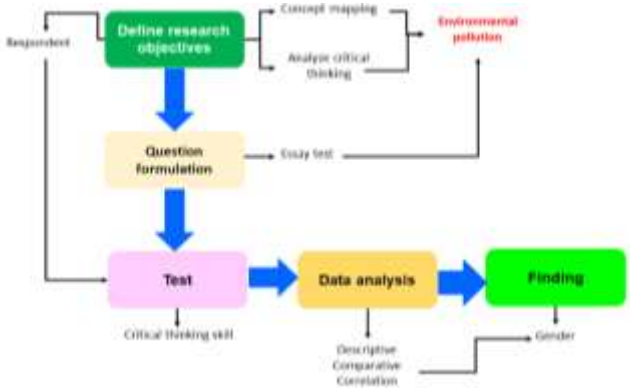

Figure 1. Flow of procedures for critical thinking analysis survey research

Research instrument: The critical thinking skills test instrument was created based on indicators from Ennis (2011) and adapted to environmental materials. The indicators are basic understanding, in-depth understanding, basic information gathering, and inference. Each question is scored on a scale of 1-3, the form of the critical thinking test instrument is presented in table 1.

Table 1. Form of Critical Thinking Test for Junior High School Students

Critical thinking indicators	Question
Elementary Clarification	 Write down the questions that come to mind when you see environmental conditions like those in the picture.
Advanced clarification	What will you do to overcome environmental pollution based on the questions you asked?
Gathering information	 Try to state the impacts caused by the types of pollution based on the picture.
Inference	 Observe the picture and make some conclusions.

Data Analysis

Descriptive statistics: Initial data were analyzed descriptively to obtain the average value for each component of critical thinking skills based on gender. The normal formula used (Kuncoro, 2009).

$$X = \frac{\sum X_i}{n} \quad (1)$$

Description:
- X = average
- X_i = score of each student
- n = number of students

Comparative (Independent t-test): To determine the significance of the difference in scores between genders, the independent sample t-test is used. The t-test formula is as follows (Gravetter & Wallnau, 2013):

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2})}} \quad (2)$$

Description:
- X_1, X_2 = average of groups 1 and 2
- s_1^2, s_2^2 = variance of each group
- n_1, n_2 = number of students per group

All analyses used Python version 3.11.

Results and Discussion

Descriptive Statistics: To get an initial picture of the level of students' critical thinking skills based on gender, descriptive statistical analysis was conducted. The purpose of this presentation is to find the initial tendency of differences in critical thinking skills based on gender. The data presented includes the average score for each component of critical thinking including basic understanding, in-depth understanding, information gathering, and inference. The comparison of the average scores between male and female students is shown in the figure 1.

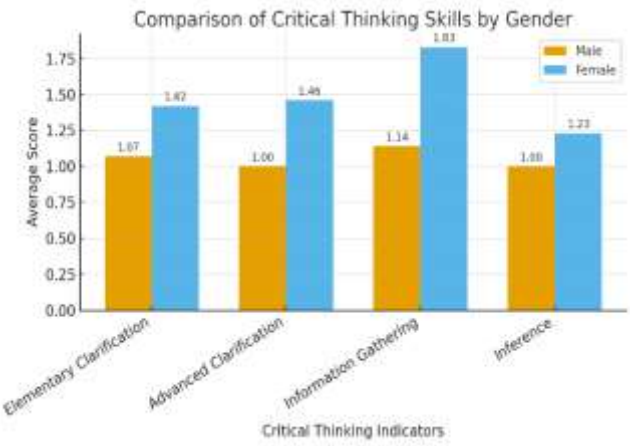

Figure 2. Comparison of average critical thinking between female and male student

The figure 1 shows the average score of critical thinking skills of male and female students based on four main components, namely: Elementary Clarification (Male: 1.07; Female: 1.42); Female students received higher scores than male students, indicating that female students tend to be better able to find and explain basic statements or problems, Advanced Clarification (Male: 1.00; Female: 1.46); Advanced clarification shows a significant difference. This indicates that female students are better at linking arguments to broader principles or contexts, Gathering Information (Male: 1.14; Female: 1.83); This is the aspect that shows the biggest difference: females are better able to gather and critically assess information before making conclusions, Inference (Male: 1.00; Female: 1.23); Although the difference is not as large as the previous component, female students are still better at making logical conclusions based on the information available (Marni et al., 2020; Arini et al., 2023). Female students received higher average scores in various critical thinking indicators compared to male students. Darmaji et al. (2022), female students have better critical thinking skills and science processes. Harun et al. (2021), female students have higher critical thinking scores than male students; the average female score is 77 and the average male score is 64.

Comparative (Independent t-test): The next step is inferential testing to determine whether male and female students have significant differences in critical thinking skills. An independent t-test was used because the data came from two unpaired groups and were assumed to have a normal distribution. The test results are displayed in Table 2, which includes the statistical t-value, p-value, and conclusion based on a significance level of 5% ($\alpha = 0.05$).

Table 2. The results of the T-test on critical thinking skills of men and women

Components	t-Statistic	P-Value	Conclusion
Elementary Clarification	-3.952	0.00018	Significant ($p < 0.05$)
Advanced Clarification	-6.306	0.000000092	Significant ($p < 0.05$)
Gathering Basic Information	-6.324	0.000000017	Significant ($p < 0.05$)
Inference	-3.738	0.00050	Significant ($p < 0.05$)

There is a significant difference between male and female students with a p value < 0.05. Since the test order is male versus female, the negative sign on the T-Statistic indicates that female students are on average taller.

Elementary Clarification; In the basic explanation section, there is a significant difference between male and female students. The T-statistic value of -3.952 and p-value 0.00018 < 0.05 indicates that female students get a better average score than male students in explaining basic statements or arguments. Advanced Clarification; The t-statistic -6.306 and p-value 0.000000092 < 0.05 indicate a significant difference. Assessment of the credibility of information and relationships between concepts, where females have an advantage. This difference is the largest of all components tested. Gathering Basic Information: The t-statistic is -6.324, and the p-value is 0.000000017 less than 0.05. Female students are better at gathering and evaluating basic information about the problem. Inference; With a p-value of 0.00050 < 0.05, inference shows a significant difference with a T-statistic of -3.738. This suggests that female students are better at drawing rational conclusions based on the information they have.

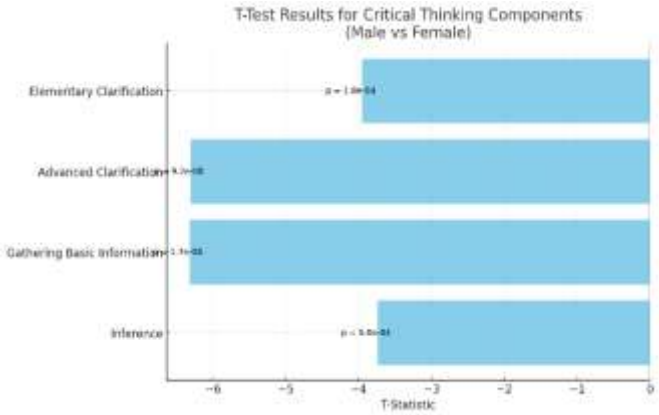

Figure 3. Result of indicator critical thinking between female and male student

The t-test results showed statistically significant differences between male and female students in every aspect of critical thinking ability. Due to the negative direction of all T values, it can be concluded that female students obtained higher average critical thinking ability scores than male students in this study. The results of this study support the results of the previous descriptive analysis and indicate that the results of descriptive and inferential statistics are consistent. Sukarma et al. (2019) found that female prospective teachers are superior in several aspects of critical thinking dispositions, such as intellectual curiosity, maturity of thinking, and open-mindedness. Hartanto et al. (2019) reported that female students show a more systematic way of solving mathematical problems. Rahmah et al. (2021) found that the sequential-abstract thinking style possessed by most female students helps them perform better in problem solving than male students. Fatmawati et al. (2024) and Ameliasari et al. (2023) reported that female students have higher literacy and problem-solving skills compared to males. However, males and females are equal in terms of empowering metacognitive skills,

critical thinking, and science process skills (Sari, 2023; Kurniawan et al., 2023).

These research findings provide a strong basis for the idea that a person's lifestyle and the way they deal with problems are influenced by their gender. The results are crucial when building adaptive and inclusive learning strategies. Siregar et al. (2019), Barta et al. (2023), Zhao et al. (2024), and Hadi et al. (2024) reported that female students use more systematic critical thinking strategies in solving important problems, such as planning, monitoring, and evaluating in academic writing. Güler et al. (2023) found that female students show an advantage in problem-posing, indicating a more structured and reflective approach. Cruz-Sandoval et al. (2023) reported that females have a higher perception of systemic (integrative) thinking. Albarracín-Vivo et al. (2024) found that females show a more diffuse and integrative thinking style, while males tend to think linearly and in a less connected manner. Oktavia et al. (2024) reported that female students are more likely to use a more systematic and evaluative approach, which is important to consider when building inclusive learning strategies. Gender fundamentally influences learning outcomes and differences in critical thinking dispositions (Syahfitri & Firman, 2022). However, both male and female students excel in critical thinking skills and science process skills (Kurniawan et al., 2023).

Male students are more likely to use trial-and-error and spontaneous action thinking styles, while female students are more likely to use systematic and evaluation-based thinking styles. Kocijan et al. (2017) reported that males are more impulsive and try repeatedly, while females are more organized. Shubina et al. (2019) found that males have lower inference and deduction scores than females in analytical tasks. Borgonovi et al. (2020) reported that males generally perform better in cognitive dimensions of problem solving, including a faster and more direct approach. Thaler (2021) stated that males are more confident and act quickly without thinking deeply about what they are doing, while females are more organized and careful. Djidu et al. (2021) found that male students tend to try various solutions without engaging in a deep-thinking process. Annizar et al. (2023) reported that male students make more mistakes in the transformation and problem-solving stages. Giofrè et al. (2022) found that the intellectual profiles of boys and girls with specific learning problems differ. Medina-Vidal et al. (2023) reported that males are more linearly predictive. Albarracín-Vivo et al. (2024) reported that, while males tend to make arguments linearly, females show a broader and deeper "breadth of thought."

Female critical thinking skills can be improved through the improvement of information gathering and filtering skills. It is recommended that learning strategies such as evidence maps, literacy-based barriers, and systematic argumentation be consistently implemented in the curriculum. Cheryan et al. (2017) suggested that different learning styles and ways of thinking between men and women should be a primary consideration when designing a curriculum, especially in STEM education, so that all students have equal opportunities to learn. Pretorius et al. (2021) conceptualized gender thinking styles in terms of innovation and problem solving. If information literacy is included in the higher education curriculum, it can help support the development of information gathering and filtering skills, which are essential for critical thinking (Ardyawin & Habiburrahman, 2024). Critical literacy improves students' critical thinking skills because it helps them understand and evaluate information better (Najah et al., 2023). Project-based learning has a significant impact on critical thinking and self-efficacy (Wahyudiati & Qurniati, 2022), and hybrid STEAM-based learning has an influence on students' critical thinking (Utomo et al., 2023).

There are differences in structural patterns between male and female students, according to the results of the correlation analysis between critical thinking components. While only Elementary Clarification and Gathering Information showed the highest correlation in male students ($r = 0.68$), the Gathering Information component acted as a center of connection ($r = 0.54$) and was quite strongly related to Advanced Clarification and Inference among female students. However, there was no statistically significant correlation between the two. Males tended to concentrate on the initial linear process (clarification–data collection), which was less connected to advanced thinking elements, while the structure of female critical thinking appeared broader and more integrative.

Conclusion

Based on the findings, this study concludes that junior high school students' critical thinking skills in environmental pollution material differ significantly by gender. Female students consistently achieved higher scores in all four indicators—elementary clarification, advanced clarification, information gathering, and inference—compared to male students. Independent *t*-test results confirmed that these differences were statistically significant ($p < 0.05$). These results highlight the need for learning strategies that address the diverse characteristics of students. In particular, efforts should be made to design learning activities that strengthen male students' abilities in information gathering and advanced clarification, while at the same time

maintaining and further developing the strengths demonstrated by female students.

Acknowledgments
Place acknowledgments, including information on grants Thank you to the first-grade students of MTs Raudhatul Azhar, East Lombok, Indonesia who were willing to participate in this research.

Author Contributions
Baiq Fatmawati's role in this research was to gather background information and identify emerging problems, design research methods, analyze, process, and present data, and discuss the research results and findings. Meanwhile, Husnul Khotimah's role was to collect and process data.

Funding
This research funding is independent because this research received no external funding.

Conflicts of Interest
Because this research is independent, there is no conflict of interest to anyone.

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