IJCE, Vol. 2, No. 2, December 2025, pp. 87-91

Indonesian Journal of Chemical Education

https://journal.uny.ac.id/index.php/ijce/index

Profile of high school students' critical thinking skills in chemistry subjects

Firdaus Anisa Utami ✉ & Erfan Priyambodo

Department of Chemistry Education, Universitas Negeri Yogyakarta, Indonesia

Article Info

Received: Dec 4th, 2025
Revised: Dec 20th, 2025
Accepted: Dec 30th, 2025

Keywords:

high school students, critical thinking skills, chemistry subjects

Abstract

Learning in the 21st century requires students to possess variouexamineds skills to compete with technological developments. This research was carried out to examine the critical thinking abilities of 10th-grade students at a high school in Sleman. The sample was obtained through a purposive random sampling method and consisted of 35 students. The instrument employed in this study was an essay test developed using Ennis's critical thinking indicators as the foundation. The collected data were analyzed using simple descriptive statistics. The research findings indicate that the critical thinking skills of 10th-grade students remain in the low range, with a score range of 13 to 88 and an average of 55.9.

✉ Corresponding Author:
Firdaus Anisa Utami
firdausanisa.2021@student.uny.ac.id

e-ISSN 2581-2645

INTRODUCTION

The development of 21st-century technology has had a significant impact on various aspects of life, one of which is education. Education plays a strategic role in improving the quality of human resources to face global competition and technological developments in the Industry 4.0 era. Law No. 20 of 2003 affirms that education is an action deliberately designed to realize learning that enables students to develop their potential optimally, for example from the cognitive, affective, and psychomotor aspects. In line with this, 21st-century learning requires students to have 4C skills (critical thinking, creativity, collaboration, and communication) as core competencies for facing the future (Anif, 2023).

However, the reality of learning in schools still presents challenges. The learning process, particularly in chemistry, often focuses on the teacher, causing students to be less involved and simply memorize concepts without understanding their relevance to everyday life. This situation contributes to students' weak critical thinking and collaboration abilities. According to Ennis (1985), there are 5 indicators of critical thinking skills, namely: (a) elementary clarification, which includes the ability to focus on questions, examine opinions or arguments, and ask and answer questions to obtain information in solving problems; (b) basic support, which is a basic skill related to evaluating the trustworthiness of information sources and reflecting on the outcomes of observations; (c) inference, which includes the ability to compile and evaluate deductive and inductive reasoning; (d) advanced clarification, in the form of the ability to identify and examine definitions and assumptions that underlie a thought; (e) strategies and tactics, which include determining actions.

Therefore, teachers must be creative in creating and/or using innovative learning models that align with the material being taught. Teachers play a crucial role in fostering students' critical and collaborative

thinking skills to enable them to compete in the challenges of the 4.0 revolution and as a graduation standard in the 21st century. Furthermore, these skills can enhance students' understanding of chemistry. Critical thinking is a cognitive process based on specific criteria and methods such as clarity, consistency, logical reasoning, and a constructive skeptical attitude toward various subjects, cases, and ideas. This process involves the ability to identify and solve problems, recognize inadequate thought patterns, and demonstrate a tendency to think deeply and reflectively. Critical thinking attitudes and skills are based on an approach that values evidence and logical conclusions (B. Hudgins & S. Edelman, 1986; Serap & Gurbuz, 2019). Collaborative skills, on the other hand, are a collaborative learning process that aims to achieve shared goals. These skills are achieved by respecting differences, perspectives, and knowledge, listening to each other, and providing input.

The use of this learning model is expected to encourage active student involvement in designing, implementing, and presenting projects, thereby fostering curiosity, critical thinking skills, and the ability to collaborate. The application of an appropriate model has the potential to provide meaningful learning experiences, develop critical and collaborative thinking skills, and motivate students to learn chemistry more contextually. Based on the explanation above, the researcher aimed to explore the critical thinking profile of 11th-grade students at a high school in Sleman in the context of chemistry learning.

METHOD

This research employed a quantitative approach to evaluate students' critical thinking abilities in addressing chemistry-related problems. The instrument utilized was a written descriptive test designed to assess the critical thinking indicators relevant to the material being examined.. The research subjects were grade XI students at a high school in Sleman Regency, with one class selected as a research sample of 35 students. Data were obtained through students' work results on the description test. Data analysis was carried out by examining students' answers, including aspects of the level of task completion (completeness and correctness of the solution steps) and the quality of the answers (depth of reasoning, conceptual accuracy, and arguments used). The critical thinking ability variable was measured based on five indicators proposed by Ennis and used in the research of Indrawati (2012) and Zubaidah (2010). These indicators include: (1) elementary clarification, (2) basic support, (3) inference, (4) advanced clarification, and (5) strategies and tactics.

FINDINGS AND DISCUSSION

Findings

The results of the analysis showed a fairly large variation in achievement scores with the highest score being 88 and the lowest score being 13, with an average of 55.9 and a median of 58. The wide variation in scores indicates that students' critical thinking abilities in the class vary widely, with a small number of students with high abilities and most in the low category. According to the established categories, of the 35 students, the following results are shown in Figure 1.

This pattern indicates that the majority of students fall within the medium to low categories, with only a few classified as having high critical thinking skills.

Discussion

The graph shows that students' overall critical thinking skills fall into the low category. This suggests that the teaching–learning process in class XIC at a high school in Sleman has not effectively supported students in engaging in activities such as analyzing, synthesizing, evaluating, creating, or applying knowledge in real-life situations. Consequently, it can be inferred that the expectations of 21st-century learning—which emphasize the importance of critical thinking—have not yet been fully achieved.

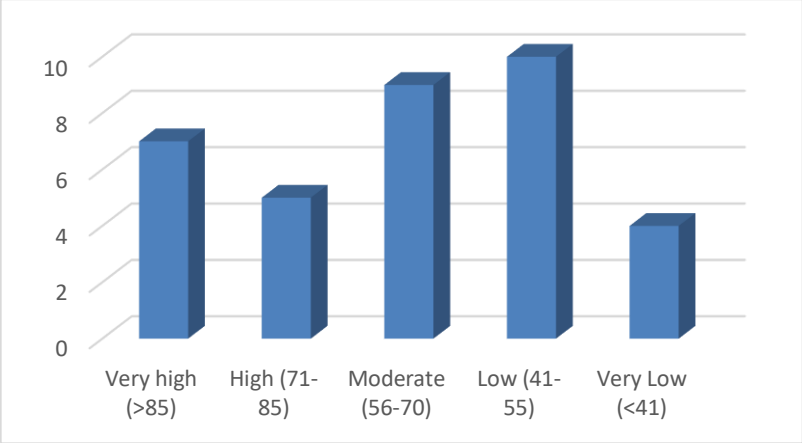

Figure 1. Student Critical Thinking Category

Critical thinking skills encompass various components of ability that include the process of interpreting, analyzing, evaluating, and drawing conclusions, as well as the capacity to maintain focus on the task being completed (Abrami et al., 2014). Such as, analyzing an opinion or argument, the evaluation process does not only consider logic, but must also be accompanied by supporting evidence, source credibility, and other relevant considerations (Murphy et al., 2014). However, in practice, students still struggle to develop critical thinking skills. This occurs because the development of critical thinking skills has not been implemented consistently. Challenges often faced by students include: (1) difficulty in constructing arguments; (2) not being able to rewrite the contents of the original source using sentences resulting from their own thoughts; (3) not being optimal in processing existing material; and (4) lack of flexibility in solving problems (Repo & Hyytinen, 2017).

Table 1. Critical Thinking Indicator Values

Indicator	Values	Category
Elementary Clarification	10,918	Low
Basic Support	10,449	Low
Inference	6,979	Low
Advanced Clarification	4,836	Low
Strategies and Tactics	6,755	Low

When viewed from each critical thinking indicator adapted from Ennis's (2011) framework, all aspects showed low results. The highest average scores were found in elementary clarification (10.9184) and basic support (10.449), while the indicator with the lowest average was managing strategies and tactics (4.83673). This indicates that students' abilities are still limited to basic thinking aspects such as answering factual questions or remembering concepts, while higher-level skills such as formulating problem-solving strategies, evaluating evidence, and drawing conclusions have not yet developed optimally.

These results align with those of Sari, Anggraini, & Mahardika (2022), who found that the critical thinking abilities of high school students in chemistry were generally low in the analysis and conclusion-drawing indicators. The study explained that low levels of critical thinking skills are often due to conventional learning approaches that provide limited opportunities for students to explore ideas, analyze problems, and develop scientific arguments. In the context of this study, this condition is evident in the low achievement of indicators for organizing strategies and tactics and drawing conclusions.

Furthermore, these results are supported by research by Fitriani & Subagia (2021), which found that most 11th-grade C students still had low levels of critical thinking, with an average achievement below 60%. They attributed this to chemistry learning, which is still oriented towards solving routine

problems and memorizing formulas, rather than scientific reasoning and reflection. The same trend is evident in the research data, where students were better able to answer simple questions but less able to explain reasons, interpret data, or relate concepts to real-world contexts.

In the 21st century, the massive flow of information through various digital media, known as big data and social networks, poses a challenge to advancing the quality of education. This situation demands the ability of individuals to critically evaluate information sources to recognize implicit biases that may arise as readers (Hughes, 2014). Nowadays, information can be easily obtained anytime and anywhere. Therefore, to ensure that the information received can be utilized positively and avoid negative impacts, a filter is needed to sort each incoming piece of information. This filter is a critical thinking skill that every individual must master. Through this ability, a person can consciously and carefully decide in deciding whether to accept or dismiss information (Haryani, 2011).

According to Hidayat and Asy'ari (2020), critical thinking involves the skill to logically review and consider the quality of information, which requires continuous practice and stimulation through active learning activities. Therefore, students' low critical thinking skills are likely linked to the lack of integration of Higher Order Thinking Skills (HOTS) into classroom learning processes. Teachers still focus on achieving lower-level cognitive aspects, while higher-order thinking skills such as analysis, evaluation, and creation have not yet become a major issue.

In terms of indicators, low scores on the strategy and tactics aspect indicate that students are not yet accustomed to systematically designing steps to solve chemistry problems. This is likely due to a lack of open-ended problem-solving exercises that encourage students to determine strategies and evaluate their results. Meanwhile, the low conclusion-drawing indicator indicates students' weak inferential abilities in constructing scientific arguments based on empirical evidence. This condition indicates the need to implement learning models that can foster higher-order thinking activities, such as Problem-Based Learning (PBL), Project-Based Learning (PjBL), or Inquiry Learning, which have been proven to measure improvements in critical thinking skills in science learning (Suprapto et al., 2023).

Overall, these findings support previous research showing that critical thinking skills among Indonesian high school students are still generally low. This requires teachers to modify their teaching strategies to emphasize reasoning, discussion, reflection, and contextual problem-solving. Furthermore, formative assessments based on critical thinking indicators are crucial for continuously monitoring student development.

Therefore, it can be concluded that the critical thinking profile of 11th-grade students falls into the low category for all indicators. This low achievement indicates that chemistry instruction has not fully developed higher-order thinking skills. Learning innovations that encourage students to actively participate in scientific activities, explore problems, and reflect on their own thinking processes are needed to effectively develop critical thinking skills.

CONCLUSION

Research data shows that the critical thinking abilities of 11th-grade students are comparatively low. This is evident in the average score of only 55,0. This finding indicates that the learning process in this class does not fully support students in engage in activities such as analyzing, reorganizing information, making decisions, generating ideas, and applying new knowledge in real-world contexts.

REFERENCES

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, A., & Persson, T. (2014). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research*, *85*(2), 275–314. https://doi.org/10.3102/0034654314551063

Ennis, R. H. (2011). *The nature of critical thinking: An outline of critical thinking dispositions and abilities*. University of Illinois.

Fitriani, N., & Subagia, I. W. (2021). Analisis kemampuan berpikir kritis siswa SMA dalam pembelajaran kimia. *Jurnal Pendidikan Sains Indonesia*, *9*(2), 85–94.

Haryani, D. (2011). Pembelajaran matematika berbasis pemecahan masalah untuk mengembangkan kemampuan berpikir kritis siswa. *Prosiding Seminar Nasional Penelitian, Pendidikan, dan Penerapan MIPA*, 121–126.

Hidayat, S., & Asy'ari, M. (2020). Pengaruh Pembelajaran Inkuiri terhadap Kemampuan Berpikir Kritis Siswa SMA. *Jurnal Pendidikan IPA Indonesia*, 9(1), 11–20.

Hudgins, B., & Edelman, S. (1986). Teaching critical thinking skills to fourth- and fifth-grade students through teacher-guided small-group discussions. *Journal of Educational Research*, *79*(6), 333–342.

Hughes, C. (2014). Theory of Knowledge aims, objectives, and assessment criteria: An analysis of critical thinking descriptors. *Journal of Research in International Education*, *13*(1), 30–45. https://doi.org/10.1177/1475240914528084

Lubezky, A., Dori, Y. J., & Zoller, U. (2004). HOCS-promoting assessment of students' performance in an environment-related undergraduate chemistry course. *Chemistry Education Research and Practice*, *5*(3), 265–280. https://doi.org/10.1039/B4RP90019G

Murphy, P. K., Rowe, M. L., Ramani, G., & Silverman, R. (2014). Promoting critical analytic thinking in children and adolescents at home and in school. *Educational Psychology Review*, *26*, 561–578. https://doi.org/10.1007/s10648-014-9281-3

Repo, S., & Hyytinen, H. (2017). Prior education of Open University students contributes to their capability in critical thinking. *Journal of Adult and Continuing Education*, *23*(1), 61–77. https://doi.org/10.1177/1477971417693416

Riwu, R., Budiyasa, I. W., & Rai, I. G. A. (2018). Penerapan pendekatan SETS (Science, Environment, Technology, and Society) untuk meningkatkan hasil belajar biologi siswa. *Jurnal Edukasi Matematika dan Sains*, 162–170.

Sari, W. P., Anggraini, R., & Mahardika, I. K. (2022). Profil kemampuan berpikir kritis siswa SMA pada materi larutan elektrolit dan nonelektrolit. *Jurnal Ilmiah Pendidikan Kimia*, *6*(3), 145–154.

Setiawan, A., & Sari, D. P. (2020). Penerapan model pembelajaran berbasis masalah untuk meningkatkan kemampuan berpikir kritis siswa. *Jurnal Pendidikan Sains Indonesia*, *8*(2), 155–164.

Suprapto, N., Setiawan, A., & Nurhadi. (2023). The effect of project-based learning on senior high school students' critical thinking in chemistry. *Journal of Technology and Science Education*, *13*(1), 78–91.