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Characteristics of Critical Thinking Skills of Class XI Senior High School on Stoichiometry Material

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Abstract

This research aims to break down the characteristics of students' critical thinking skills on Stoichiometry in class XI at SMA Negeri 1 Sindue. This research is descriptive quantitative, and the sample consists all students from class XI of SMA Negeri 1 Sindue, which includes three classes: XI MIA 1, XI MIA 2, and XI MIA 3. The data in this study were obtained through a test of students' critical thinking skills in the form of essays with as many as five items. Three essential thinking indicator items are interpretation, analysis, and inference. The results of data analysis for students' critical thinking skills for indicators of interpretation, analysis, and inference showed that class XI MIA 1 obtained the percentage results for the interpretation indicator 40,5 % in the low category, the analysis indicator obtained by the percentage of 35 % was included in the low category, and indicator inference obtained a percentage of 17 % who are in the very low category. Class XI MIA 2 obtained the percentage result on the interpretation indicator 46 %, which is in the low category. In comparison, the analysis indicator obtained a percentage of 59.5 % who are in the low category, and indicators inference obtained a percentage of 25,5 % who are in the low category. Whereas in class XI MIA 3, the percentage of interpretation indicators was 44 % in the low category, the analysis indicators obtained a percentage of 57,5 % who were in the low category. The inference indicator obtained 23,5 % who were in the very low category. Based on the research results at these schools, it can be seen that the critical thinking skills of class XI students of SMA Negeri 1 Sindue are still very low.

Keywords: Critical thinking skills, stoichiometry

Introduction

Thinking critically is essential and functions effectively in all aspects of life. Therefore, it is crucial and must be instilled early in school, at home, and in the community. Active thinking is required to achieve optimal results in the learning process. This means that an optimal learning process requires the learner to think critically. Therefore, critical thinking is crucial in learning activities (Ahmatika, 2017).

Critical thinking is needed in learning activities. Students are expected to be able to make well-founded decisions, and these decisions can solve the problems they face (Nuryanti et al., 2018).

Critical thinking involves the rational evaluation of information prior to making a decision or taking action, gathering as much information as possible about the information (Karim & Normaya, 2015). According to Nugrahaeni et al. (2017), Critical thinking is an intellectual process when individuals consciously evaluate the quality of their reasoning. Intellectuals employ introspective, independent, lucid, and reasonable thought processes.

Critical thinking skills are the ability to think at a high level, which students must have to face future problems, not only in the learning process in the classroom (Ernawati et al., 2015).

In reality, the teaching and learning process generally does not encourage the achievement of critical thinking skills (Afifah & Retnawati, 2019). Two factors prevent critical thinking from developing during education. First, the curriculum is generally designed with broad material targets so that teachers are more focused on completing the material, prioritizing material completion over student understanding of material concepts. Second, classroom learning activities that teachers have carried out are the delivery of information (lecture method) by activating the teacher more while students passively listen and copy, where occasionally the teacher asks questions and occasionally students answer. Then, the teacher gives examples of problems by giving routine practice questions and not training in critical thinking (Ahmatika, 2017).

This aligns with Permen Pendidikan dan Kebudayaan No. 81A 2013 regarding the use of curriculum, which asserts that future competency

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requirements for students include the abilities to speak creatively and analyze critically. The critical thinking abilities of pupils in Indonesia, particularly high school students, require enhancement. The application of the learning model has not enhanced students' critical thinking abilities (Arfianawati et al., 2016).

According to Ratman et al. (2019), the effectiveness of using the guided inquiry learning model with an active dimension learning style (IGT-DiA) with the learning concept of styles to improve the reaction rate concept. This approach can cultivate students' propensity for active engagement in discerning optimal knowledge through self-directed inquiry, thereby assessing and enhancing their critical thinking abilities in problem-solving scenarios.

Critical thinking skills must be developed in the learning process because they can train students to obtain accurate information, increasing their understanding. For example, critical thinking skills can increase students' understanding of the information in chemistry learning, which requires students to think more actively to solve existing problems and understand interrelated concepts (Selly et al., 2018).

Research conducted on the fundamental essence of the chemistry learning model was developed or applied in the form of presenting authentic and meaningful chemical problems to students to be solved through a fundamental study process to help improve higher-level thinking skills. Comprehending the concept, pupils will be encouraged to engage more actively in the learning process (Afadil et al., 2016).

Stoichiometry chemistry learning material is one of the important topics in chemistry subjects at the senior high school level. If you look at (Khumairah et al., 2014), stoichiometry is one of the initial topics in the sequence map of SMA / MA chemistry topics. This identifies that stoichiometry is one of the basics for students to understand other chemical concepts (Anugrah, 2019).

Thus, students' understanding of the topic must be ensured so that it does not become an obstacle for students to understand other concepts. A thorough comprehension is essential for pupils, along with advanced analytical skills to construct and connect the provided legal concepts. Stoichiometry material includes Basic laws of chemistry, relative atomic and relative molecular mass, mole concept, chemical calculations, and reaction equations. The concepts of all the laws studied are interconnected, so if the concept of one law is not understood correctly, students tend to have difficulty with other legal concepts. Judging from the national exam questions, 16 % of stoichiometry material is included (Norjana et al., 2016).

Observations and preliminary interviews at SMA Negeri 1 Sindue indicated persistent issues with student comprehension in the classroom, as the chemistry learning process necessitates active student participation, with the teacher serving as a facilitator. The teacher provides opportunities for students to explore information from the material to be studied. One is the lack of student understanding of stoichiometry material, which can be seen from the data on student exam results, where students mostly get standard scores (45.65). Moreover, according to the chemistry teacher at the school, stoichiometry material is considered difficult for students because many still have low scores on stoichiometry material. Generally, learning chemistry at school is memorizing formulas, and students tend only to accept the material taught without wanting to examine further formulas. This significantly affects pupils' deficient critical thinking abilities, complicating the process of identifying formulas and resolving mathematical difficulties (Zakiyah et al., 2018).

This study aims to determine students' critical thinking skills. The critical thinking indicators analyzed are interpretation, analysis, and inference. Students who think critically can identify a problem, analyze related information, draw the correct conclusions to solve it and evaluate the results obtained (Tresnawati et al., 2017).

The purpose of this study was to describe the critical thinking skills of class XI students of SMA Negeri 1 Sindue on Stoichiometry Material.

Methods

The type of research used is quantitative descriptive research. The descriptive research method is a research method that contains exposure or depiction of something. The object studied using descriptive methods tries to be shown as it is then described at length in detail.

This research was conducted at SMA Negeri 1 Sindue (Sindue District). The population in this study were all students of class XI MIA SMA Negeri 1 Sindue with a total of 85 students with an age range of 14 - 15 years of male sex there are one person and three women and an age range of 16 - 17 years of male sex there are 25 people and 56 women, with an average age of 16.5 years. The average number of male students is 26, and the number of female students is 59. The participants in this study comprised all XI MIA class students from SMA Negeri 1 Sindue, totaling 85 students across XI MIA 1, MIA 2, and MIA 3.

The research instruments used in this study were the critical thinking ability test and the critical thinking ability rubric. The instrument to measure students' critical thinking skills is an instrument adapted from Facione in Afadil et al. (2016), which consists of 6 indicators, namely (1) Interpretation, (2) Analysis, (3) Inference, (4) Evaluation, (5) Inference, and (6) Self - knowledge. The indicators used in this study are Interpretation, Analysis, and Inference. The questions used in this study were first validated by an expert with the result data,

which included the aspects assessed in this validation in the form of material, construction, and language. Data on the results of question validation can be in the following **Table 1**:

Table 1. Results of question validation analysis

Number	Criteria	Category
1	1	Very high
2	0.8	Very high
3	1	Very high
4	1	Very high
5	0.8	Very high
6	1	Very high
7	0.5	Very low

Based on the data from the expert's validation of the instrument's feasibility, it is declared very feasible/valid with an average score of 1 with a very high category. The results of the validity analysis in the table above 7 question items show that the items support the validity of the test so that they are declared feasible or valid for use. Researchers only used five of the seven items to identify students' critical thinking skills (Hasan et al., 2020).

The objective of assessing students' critical thinking skills is to evaluate their proficiency in stoichiometry, which involves the integration of concepts and mathematical computations. Therefore, a thorough comprehension of pupils and a detailed analysis are required to establish and connect the legal concepts, as stoichiometry is a fundamental topic in chemistry education. Students enhance their cognitive skills to effectively solve issues and acquire precise knowledge, while improving their comprehension of the content. (Ramadan et al., 2018). Critical thinking ability is measured based on critical thinking indicators adapted from Facione (2011). Where this indicator uses three indicators, namely:

Interpretation

Interpreting involves comprehending and articulating the meaning or importance of diverse experiences, circumstances, data, events, judgments, habits, customs, beliefs, rules, procedures, or criteria.

Analysis

The analysis delineates the intended and real inferential links among assertions, questions, concepts, descriptions, or other representational forms aimed at conveying beliefs, judgments, experiences, reasons, information, or views.

Inference

Inference means identifying and deriving the elements necessary to make reasonable conclusions, making relevant conjectures, and inferring consequences from data, situations, questions, or other forms of representation.

Students' critical thinking skills are deemed satisfactory if they fall within the medium and high levels (Afadil et al., 2018). The assessment of critical thinking skills is conducted by comparing students' scores with the established levels of achievement in critical thinking skills as follows:

85 % ≤ N < 100 % = Very High
75 % ≤ N < 85 % = High
60 % ≤ N < 75 % = Medium
40 % ≤ N < 60 % = Low
0 % ≤ N < 40 % = Very Low

The students' answers in this study describe the measurement of their critical thinking skills. The equation determines the overall category of students' critical thinking skills by calculating the total percentage of students.

$$N = \frac{assesment\ score}{maximum\ score}\ x\ 100\ \% \quad (1)$$

Results and Discussion

To achieve this goal in this study, an identification test of students' critical thinking skills was carried out using a test that an expert had previously validated to determine the validity category of each aspect in the test item and had been declared suitable for use to identify students' critical thinking skills.

Students' critical thinking skills are measured based on indicators adapted from (Facione, 2011): interpretation, analysis, and inference. Students' critical thinking skills are measured in the subject matter of Stoichiometry material. This stoichiometry material is mathematical material, where we know that Stoichiometry comes from Greek, namely the word Stoicheion, which means element, and Metron, which means measure. Stoichiometry discusses the mass relationship between elements in a compound (compound stoichiometry) and between substances in a reaction (reaction stoichiometry). This stoichiometry material must require an understanding of the concept and mastery of the material because stoichiometry is one of the most fundamental topics in chemistry that studies the quantitative aspects of chemical reactions or chemical formulas obtained through measuring mass, volume, quantity and so on, which are related to the number of atoms, ions, molecules, or chemical formulas, as well as their relationship in a chemical reaction. Students have difficulty solving problems related to chemical reactions and chemical calculations in stoichiometry material due to difficulties understanding the material, which lowers their critical thinking skills (Ariyanti et al., 2017).

Comparison of the results of students' critical thinking ability tests on Stoichiometry material in class XI MIA SMA Negeri 1 Sindue is as follows:

Table 2. The results of the analysis of critical thinking skills of students in class XI MIA 1

No	Indicators of critical thinking skills	Percentage	Category
1	Interpretation	40.5 %	Low
2	Analysis	35 %	Very Low
3	Inference	17 %	Very Low

Table 3. Results of critical thinking ability analysis of students in class XI MIA 2

No	Indicators of critical thinking skills	Percentage	Category
1	Interpretation	46 %	Low
2	Analysis	55.5 %	Low
3	Inference	25.5 %	Very Low

Table 4. Results of critical thinking ability analysis of students in class XI MIA 3

No	Indicators of critical thinking skills	Percentage	Category
1	Interpretation	44 %	Low
2	Analysis	57.5 %	Low
3	Inference	23.5 %	Very Low

Research on the characteristics of critical thinking skills on Stoichiometry material was conducted at SMA Negeri 1 Sindue with a research sample of all XI MIA classes. This study aimed to describe students' critical thinking skills on Stoichiometry material. To achieve the goal, the identification test of students' critical thinking skills is carried out by processing data obtained through data sources based on students' written tests, which an expert has previously validated to determine the validity category of each aspect in the item. The purpose of validation is to show an instrument's validity level. This is the opinion (Arikunto, 2010).

An instrument is declared to have high validation if the measurement instrument and its measurement results follow the measurement's purpose (Arikunto, 2010).

Based on this, the instruments used in the study have been declared suitable for identifying students' critical thinking skills.

After conducting a test to identify students' critical thinking skills about Stoichiometry material, which consisted of 3 indicators of critical thinking skills, each indicator obtained different achievements in each class.

The interpretation indicator can understand and express the meaning or significance of various experiences, situations, data, events, judgments, habits, customs, beliefs, rules, procedures, or criteria (Facione, 2011).

Interpretation is measured so students can understand, explain, and give meaning to data or information. The results obtained by students in the interpretation ability were 40.5 % for class XI MIA 1, and the results obtained were 46 % for class XI MIA 2, and for class XI MIA 3 obtained 44 %. In this rarity, students can write down known information. However, they cannot describe conditions based on the attached data, showing that students in class XI MIA SMA Negeri 1 Sindue do not have good critical thinking skills. This is per the opinion of (Fisher, 2009), which explains that critical thinking requires the ability to interpret and evaluate observations of communication and other sources of information.

The capacity to assess indicators involves recognizing both intended and real inferential links among statements, concepts, descriptions, or other representations aimed at conveying beliefs, judgments, experiences, reasons, facts, or views (Facione, 2011). Analysis is measured so that students can analyze statements and questions. The results obtained by XI MIA 1 class students were only 35 % in the very low category, XI MIA 2 class students scored 59.5 % in the low category, and XI MIA 3 class students scored 57.5 %, which was in the low category. At this stage, students can identify the relationship between the concepts needed in problem-solving so that some are correct and some are less precise. The analysis indicator is in a low category because it gets a percentage value ≤ 60 %. Based on the attached data illustrates that students in class XI MIA SMA Negeri 1 Sindue do not have good critical thinking skills (Carson, 2007). Even though students know a concept, they cannot necessarily apply how to use it; many students are unaware and confused about applying their knowledge and concepts to solve a problem, so their ability in the analysis indicator is in the low category.

The inference indicator can identify and obtain the elements needed to make conjectures and hypotheses, consider relevant information, and infer consequences from data, situations, statements, or other forms of representation (Facione, 2011).

Inference is measured so that students can make conclusions from observations and analyze them. The results obtained by students in the inference ability for class XI MIA 1 obtained a value of 17 %, which is in the very low category; the acquisition of values in class XI MIA 2 is 25.5 %, which is in the very low category, and for class XI MIA 3 obtained a value of 23.5 % which is in the very low category. The results obtained in the whole class are very low because the percentage obtained is ≤ 40 %. In this rare case, students are less able to make conclusions, so they are not following the context of the problem. The attached data illustrates that class XI MIA SMA Negeri 1 Sindue students do not have good critical thinking skills. This is under the opinion of (Kheng, 2009). Inference ability identifies and guarantees the elements needed to describe the reasons in the form of conclusions, make predictions and/or hypotheses, and organize tactics and strategies by considering information in the form of data, statements, principles, and concepts.

The results obtained from the three classes given the critical thinking skills test showed differences in the percentage of students

responding to each indicator. Analysis of the critical thinking skills of students in class XI MIA SMA Negeri 1 Sindue obtained a percent on the Interpretation indicator ≤ 40 %, which is in the low category, while the analysis indicator obtained a percent of ≤ 60 % is in the low category, and the inference indicator obtained a value of < 40 % is in the very low category. Based on the results of the analysis of critical thinking skills of class XI students of SMA Negeri 1 Sindue on Stoichiometry material, they do not have good critical thinking skills. Students' critical thinking skills can reach each indicator's medium or high category. Experts assert that not all individuals achieve proficiency in all critical thinking capabilities, as humans tend to compartmentalize their life, resulting in critical thinking being more pronounced in certain cognitive abilities. But this does not mean that it is impossible for all to fully master critical thinking skills if critical thinking development continues to be applied in curriculum development (Nugraha et al., 2017).

The results of this study describe how students' thinking skills and the conditions experienced by students who only think short-term and cannot determine the way to be critical can affect how they solve the problems they face in everyday life. This is also influenced by the fact that the average respondent is 15 - 17 years old, in adolescence, and still only thinks short without thinking long for the future. In addition, many students have difficulty learning chemistry; this also directly or indirectly affects students' interest and motivation in chemistry subjects, and as a result, teachers have much difficulty focusing students' attention on the learning process. This causes low student interest and motivation to study chemistry, resulting in low-quality learning processes and outcomes, especially critical thinking.

Students' interests and talents also affect their thinking patterns. Children interested in their lessons will always be motivated to discover what they do not know, while students who are not interested in the subject must be lazy to learn the lesson.

Conclusions

Based on the results of research and discussion, it is concluded that the percentage of students' critical thinking on Stoichiometry material in the aspects of interpretation, analysis, and inference indicators in class XI MIA 1 obtained 40.5 %, 35 %, and 17 %. Furthermore, in the results of the XI MIA 2 class, the interpretation indicator obtained 46 %, analysis 59.5 %, and inference 25.5 %, while in the XI MIA 3 class obtained a value on the interpretation indicator 44 %, analysis 57.5 %, and 23.5 % for the inference indicator.

Conflict of Interest

The author created this paper without any conflicts or problems from any party.

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References

Afadil, A., Suyono, S., & Poedjiastoeti, S. (2016). Effectiveness of learning based problem solving with aspect ontology, epistemology, axiology to increase critical thinking ability and understanding thermochemical concept of students. *International Journal of Active Learning*, *1*(2), 66–74.

Afadil, & Diah, A. W. M. (2018). Effectiveness of learning materials with science-philosophy oriented to reduce misconception of students on chemistry. *Proceedings of the First Indonesian Communication Forum of Teacher Training and Education Faculty Leaders International Conference on Education 2017 (ICE 2017)* (pp. 192–196). Atlantis Press.

Afifah, I. R. N., & Retnawati, H. (2019). Is it difficult to teach higher order thinking skills?. *Conference Series: Journal of Physics: Conference Series* (pp. 1–7). United Kingdom: IOP Publishing.

Ahmatika, D. (2017). Peningkatan kemampuan berpikir kritis siswa dengan pendekatan inquiry/discovery. *Euclid*, *3*(1), 394–403.

Anugrah, I. R. (2019). Telaah topik stoikiometri SMA: Miskonsepsi dan strategi pembelajarannya. *Orbital: Jurnal Pendidikan Kimia*, *3*(2), 94–103.

Arfianawati, S., Sudarmin., & Sumarni, W. (2016). Model pembelajaran kimia berbasis etnosains untuk meningkatkan kemampuan berpikir kritis siswa. *Journal of Mathematics and Science Teaching, 21*(1), 46-51.

Arikunto, S. (2010). *Prosedur penelitian pendekatan praktik*. Jakarta: Rineka Cipta.

Ariyanti, N. D., Haryono, H., & Masykuri, M. (2017). Peningkatan kemampuan berpikir kritis dan prestasi belajar siswa pada materi stoikiometri dengan menggunakan model pembelajaran problem solving berbantuan modul di kelas X MIA 2 SMA Negeri 1 Banyudono tahun pelajaran 2015/2016. *Jurnal Pendidikan Kimia Universitas Sebelas Maret*, *6*(1), 62–68.

Carson, J. (2007). A problem with problem solving: Teaching thinking without teaching knowledge. *The Mathematics Educator, 17*(2), 7–

14.

Ernawati, D., Ashadi., & Utami, B. (2015). Upaya peningkatan prestasi balajar dan kemampuan berpikir kritis siswa kelas X MIA 7 dengan menggunakan metode pembelajaran problem solving pada materi stoikiometri di SMA Negeri 1 Sukaharjo. *Jurnal Pendidikan Kimia (JPK),* 4(4), 17-26.

Facione, P. A. (2011). Critical thinking: what it is and why it counts. *Insight Assessment*, *1*(1), 1-23.

Fisher, A. (2009). *Berpikir kritis*. Jakarta: Erlangga.

Hasan, S. W., Auliah, A., & Herawati, N. (2020). Pengembangan instrumen penilaian kemampuan berpikir kritis siswa SMA. *Chemistry Education Review (CER)*, *3*(2), 185-193.

Karim., & Normaya. (2015). Kemampuan berpikir kritis siswa dalam pembelajaran dalam pembelajaran matematika dengan menggunakan model jucama di sekolah menengah pertama. *EDU-MAT: Jurnal Pendidikan Matematika*, *3*(1), 92-104.

Kheng, Y. (2009). *Science Process Skills From 2*. Selanggor: Pearson Longnam.

Khumairah, F., Suhery T., & Hadeli, M. (2014). Pengembangan modul kimia dasar termokimia berbasis keterampilan berpikir kritis untuk mahasiswa program studi pendidikan kimia. *Jurnal Penelitian Pendidikan Kimia: Kajian Hasil Penelitian Pendidikan Kimia, 1*(2), 115-125.

Norjana, R., Santosa., & Joharmawan, R. (2016). Identifikasi tingkat pemahaman konsep hukum-hukum dasar kimia dan penerapannya dalam stoikiometri pada siswa kelas X IPA di MAN 3 Malang. *Jurnal Pembelajaran Kimia (J-PEK)*, *1*(2), 42–49.

Nugraha, A. J., Suyitno, H., & Susilaningsih, E. (2017). Analisis kemampuan berpikir kritis ditinjau dari keterampilan proses sains dan motivasi belajar melalui model PBL. *Journal of Primary Education*, *6*(1), 35–43.

Nugrahaeni, A., Redhana, I, W., & Kartawan, I. M.A. (2017). Penerapan model pembelajaran discovery learning untuk meningkatkan kemampuan berpikir kritis dan hasil belajar kimia. *Jurnal Pendidikan Kimia Indonesia, 1*(1), 23–29.

Nuryanti, L., Zubaidah, S., & Diantoro, M. (2018). *Analisis kemampuan berpikir kritis siswa SMP*. Unpublished master's thesis. Malang: University of Malang.

Ramadan, A. F., Hayono., & Mulyani, B. (2018). Upaya peningkatan interaksi sosial dan prestasi belajar melalui penerapan model pembelajaran learning together (LT) dilengkapi dengan kartu pintar pada materi stoikiometri bagi peserta didik kelas X MIA 2 SMA batik 2 Surakarta tahun pelajaran 2015/2016. *Jurnal Akademika Kimia*, *7*(1), 42–47.

Ratman., Napitupulu, M., Nuryanti, S., & Afadil. (2019). The effect of implementation of ITG-DIA learning model on critical thinking ability and reaction rates learning result on chemistry students of Tadulako University. *International Journal of Multidisciplinary Research and Development*, *6*(9), 41–45.

Selly, Y., Rohiat, S., & Amir, H. (2018). Analisis kemampuan berpikir kritis mata pelajaran kimia pada siswa kelas XI IPA SMAN 1 Kepahiang. *Alotrop*, *2*(1), 33-38.

Tresnawati, T., Hidayat, W., & Rohaeti, E. E. (2017). kemampuan berpikir kritis matematis dan kepercayaan diri siswa SMA. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education*, *2*, 116–122.

Zakiyah, Z., Ibnu, S., & Subandi, S. (2018). Analisis dampak kesulitan siswa pada materi stoikiometri terhadap hasil belajar termokimia dan upaya menguranginya dengan metode pemecahan masalah. *EduChemia: Jurnal Kimia dan Pendidikan*, *3*(1), 119-134.