

## **THE CRITICAL THINKING SKILLS PROFILE OF PRE-SERVICE CHEMISTRY TEACHER ON GLOBAL ENVIRONMENTAL PROBLEMS IN THE SOCIO-SCIENTIFIC ISSUES (SSI) CONTEXT**

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Critical thinking is one of the important skills that must be possessed by every individual in the 21<sup>st</sup> century. Critical thinking skills are needed to equip pre-service chemistry teacher in preparing quality 21<sup>st</sup> century generations and be able to solve the various complex problems. The purpose of this study is to analyze the level of critical thinking skills of pre-service chemistry teacher on global environmental problems in the context of socio-scientific issue (SSI). The research type is descriptive research with a quantitative approach. The research subjects were 30 pre-service chemistry teacher. The data collection technique used a critical thinking skills test instrument based on six indicators of critical thinking skills according to Facione. The results showed that the level of critical thinking skills was still very low with a percentage of 83.33%. The average critical thinking skills of students on each indicator: 1) Interpretation 46.47 (low); 2) Analysis 31.67 (very low); 3) Evaluation 8.00 (very low); 4) Inference 25.67 (very low); 5) Explanation 68.00 (medium); and 6) Self-regulation 14.67 (very low). Therefore, it is necessary to make improvements to the lecture process in an effort to improve the critical thinking skills of pre-service chemistry teacher on environmental problems in the SSI context.

**Keywords:** critical thinking, global environmental problems, pre-service chemistry teacher

### **1. Introduction**

21<sup>st</sup> century with the developments in science and technology demands to the presence of qualified and competent human resources to be able compete globally. The characteristic of quality human resources is being able to master skills according to the demands of 21<sup>st</sup> century which are critical thinking, creativity, collaboration and communication formulated in the 4C. The US-based Partnership for 21<sup>st</sup> Century Skills (P21) stated that critical thinking skills are one of the important skills that every individual must possess in this century (Afandi et al., 2019; Liliyasi, 2009). It was because real problems in today's life are increasingly complicated and complex, high-level thinking patterns are needed in solving the existing problems (Farcis, 2019; Mutakinati et al., 2018).

Critical thinking is a mental activity that helps a person to think rationally, logically, reflectively, and evaluatively in overcome the problems at hand and develop the effective and efficient solutions to these problems (Alghafri & Ismail, 2014; Haryani & Prasetya, 2021).

Someone who has critical thinking skills will be able to answer the various problems well with logical thinking and can make decisions about what to do or what to believe (Susilawati et al., 2020). Thinking skills are the provisions for someone to compete in the globalization era (Syafitri et al., 2021).

Facione (2015) stated that critical thinking is basically a thought that has the goal of proving something, interpreting what means and problem solving based on contextual evidence and concepts. Related to the Hassoubah's statements (2007) which stated that critical thinking is an activity of reasoned and reflective thinking with an emphasis on making decisions based on what to believe and do. There are six indicators of critical thinking skills involved in the critical thinking process according to Facione (2015), those are consist of : 1) interpretation; 2) analysis; 3) assessment; 4) inference; 5) explanation; and 6) self-regulation. Each of these indicators has its own sub-indicators as presented in Table 1:

Table 1 Indicators and Sub-Indicators of Critical Thinking Skills (Facione, 2015)

<b>Number</b>	<b>Indicator</b>	<b>Sub-Indicator</b>
1.	Intrepetation	a. Grouping or Categorizing b Define c. Clarity of meaning
2.	Analysis	a. Test ideas b. Recognizing arguments c. Analyze arguments
3.	Evaluation	a. Assessing the credibility of the statement b. Assess the quality of arguments or opinions made with inductive and deductive considerations c. Make and determine the results of considerations
4.	Inference	a. Assess the quality of the statement b. Guess the alternative c. Describing/drawing conclusions
5.	Explanation	a. Declare results b. Support procedure c. Presenting the argument in full
6.	Self Regulation	a. Self monitor b. Self improvement

Six critical thinking skills in Table 1 can be measured that using an instrument developed through sub-indicators and questions that refer to the critical thinking skills (Nuraini,

2017). This is also stated by Ennis (1985) that to measure a person's critical thinking skills, the instruments can be used in the form of reasoned multiple choice tests, skill tests, and description tests that are adjusted to the critical thinking indicators that have been set.

Critical thinking skills are very important for students, especially students who are pre-service chemistry teachers. In the lecture process, in addition to having master basic concepts of chemistry, pre-service chemistry teacher must have the ability to think logically and critically, because these abilities will assist prospective teachers greatly in preparing a quality 21<sup>st</sup> century generation and be able to solve the various problems, ranging from problems simple to complex problems in the future, through organized learning activities (Snyder & Snyder, 2008).

Basically every subject studied by chemistry education students requires critical thinking skills, including environmental chemistry courses. The environmental chemistry course discusses and examines chemical concepts in the environment, chemical transformations that take place in the environment, and various activities that cause environmental pollution and its prevention. This course will greatly assist students in overcome the problems that occur in the environment. Especially in the globalization era, environmental problems have become a complicated problem in people's lives (Santi et al., 2018).

Environmental problems are closely related to social issues, considering that environmental damage had a direct or indirect impact on human survival, so the learning context that can be used in environmental chemistry courses is Socio-Scientific Issue (SSI). SSI emphasizes on controversial issues that concern on social fields and real problems in the world community (Sadler, 2011), such as the genetic engineering issues (gene therapy, cloning), nuclear energy and environmental problems such as environmental pollution, global warming, and climate change (Sadler & Zeidler, 2005). The SSI context must be current, controversial, relevant to students, related to science content, and allow for open discussion (Hancock et al., 2019; Hofstein et al., 2011; Presley et al., 2013).

Efforts to overcome the environmental problems in the SSI context can be realized through critical thinking. By using critical thinking activities, students are directed from understanding the problems or environmental issues that occur to providing the best solutions in overcoming these problems. Therefore, as a form of debriefing for pre-service chemistry teacher to have critical thinking skills, environmental chemistry lectures should raise issues related to environmental damage and pollution that require students to think and make the right

decisions in overcome the problems given. This is also done as a form of environmental awareness which is one of the important goals in today's educational context (Hadzigeorgiou & Skoumios, 2013).

Based on the description above, this research was conducted with the purpose to knowing how the profile of critical thinking skills of pre-service chemistry teacher on global environmental problems. It can be used as consideration in designing lectures so that students are equipped with a better critical thinking skills, especially in overcome the global environmental problems in the context of socio-scientific issue (SSI).

## 2. Research Methods

The methodology of this research is a descriptive research with a quantitative approach. Descriptive research describes what about a variable, symptom, or situation (Arikunto, 2012). This study will describe how the profile of the critical thinking skills of prospective teacher students on environmental problems in the SSI context.

The research subjects used were students of Chemistry Education in 4th semester of the 2021/2022 academic year with the respondent total 30. The collecting data technique for students' critical thinking skills uses a test instrument with a description type question, which consists of 25 questions. The description questions developed are in accordance with the indicators of critical thinking skills according to Facione (2015) which included of: 1) intrepertation; 2) analysis; 3) evaluation; 4) inference; 5) explanantion; and 6) self regulation.

The data analysis technique of students' critical thinking skills test results on each indicator is analyzed by the following formula (Supriyati et al., 2018):

$$\text{Percentage Score} = \frac{\text{Gain Score}}{\text{Maximal Score}} \times 100\%$$

The percentage gain is interpreted into several categories which are presented in Table 2:

Table 2 Critical Thinking Score Category

<b>Score Range (%)</b>	<b>Category</b>
81,25 < X ≤ 100	Very High
71,00 < X ≤ 81,25	High
62,50 < X ≤ 71,00	Medium
43,75 < X ≤ 62,50	Low
0 < X ≤ 43,75	Very Low

To find out the percentage of student achievement in each indicator, it is calculated by processing the final score using the following formula:

$$P = \frac{f}{N} \times 100\%$$

Description:

P : Student Achievement Percentage

f : The Number of Frequencies in The Percentage

N : Frequency Total

### 3. Result and Discussion

This research produced an overview of the critical thinking skills of pre-service chemistry teacher on global environmental problems including global warming, depletion of the ozone layer, and acid rain in the context of SSI (Socio-Scientific Issue). Nuraini (2017) explained that the objectives of critical thinking skills assessment include: 1) diagnosing students' critical thinking skills; 2) provide feedback on their critical thinking skills; and 3) motivate students become a better critical thinkers.

In this study, the assessment of critical thinking skills was carried out using description test questions totaling 15 questions referring to 6 critical thinking skills according to Facione (2015) consist of interpretation, analysis, evaluation, inference, explanation, and self-regulation. The test questions were given to 30 students of the Chemistry Education Study Program. The result of data test is calculated and analyzed to determine the average level of critical thinking skills. The percentage level of students' critical thinking skills is presented in Table 3:

Table 3. Percentage of Students' Critical Thinking Skill Level

Category	Colleger Total	Percentage (%)
Very High	0	0
High	0	0
Medium	0	0
Low	5	16,67
Very Low	25	83,33
<b>Total</b>	<b>30</b>	<b>100</b>

Based on Table 3, it can be seen that the average level of critical thinking skills of pre-service chemistry teacher students on global environmental problems was in very low categories. As many as 83.33% of students or 25 students out of a total of 30 students had a very low level of critical thinking skills. While the other 5 students with a percentage of 16.67% had low critical thinking skills. The level of critical thinking skills is obtained based on the calculation and data analysis of students' critical thinking skills test scores on each indicator. The average score of critical thinking skills tests in every indicator is presented in Table 4:

Table 4. Average Score of Students' Critical Thinking Skills

No.	Indicator	Average Score	Category
1.	Intrepetation	46,47	Low
2.	Analysis	31,67	Very Low
3.	Evaluation	8,00	Very Low
4.	Inference	25,67	Very Low
5.	Explanation	68,00	Medium
6.	Self Regulation	14,67	Very Low
<b>Average</b>		<b>36,00</b>	<b>Sangat Rendah</b>

The average score of the student's critical thinking skills test can be expressed in a graph as shown in Figure 1:

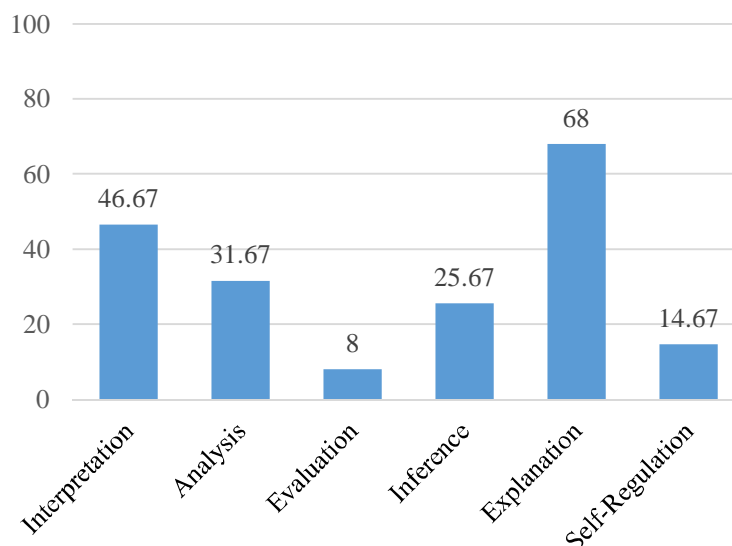


Figure 1 Graph of the Average Score of Students' Critical Thinking Skills

Table 4 and Figure 1 show the level of students' critical thinking skills varies on each indicator. The highest average score was found in the explanatory ability of 68 (medium). The second highest average score was the ability to interpretation 46.47 (low), the ability to analyze 31.67 (very low), the ability to inference 25.67 (very low), the ability to self-regulate 14.67 (very low), and finally the smallest average value was in the ability to evaluate which is 8.00 (very low).

The first indicator is interpretation which gets an average score of 46.67 in the low category. According to Zhou, et al. (2013) interpretation is the ability to categorize problems, define characteristics and clarify meaning well. This low score indicates that most students have not been able to clearly understand the meaning of the given problem. The percentage of student achievement in solving critical thinking skills questions with interpretation indicators can be seen in Table 5:

Table 5. Percentage of Interpretation Indicators Achievements

Category	Colleger Total	Percentage (%)
Very High	0	0
High	0	0
Medium	6	20
Low	11	36,67
Very Low	13	43,33

The second indicator is the analysis that got an average score of 31.67 with a very low category. Analysis can be interpreted as a student's ability to identify the intent or information contained in a problem and conclude the relationship between the concepts used to solve the problem (Puspita et al., 2021). The percentage of student achievement in solving the critical thinking skills questions with analytical indicators can be seen in Table 6:

Table 6. Percentage of Analysis Indicators Achievements

Category	Colleger Total	Percentage (%)
Very High	0	0
High	2	6,67
Medium	1	3,33
Low	7	23,33
Very Low	20	66.67

The third indicator is the evaluation that got the lowest average score of 8.00. Evaluation can be interpreted as the ability of students to evaluate or assess the credibility of a

statement by using the logic of the relationship between statements or concepts. This very low mean score indicates that most students are still unable to judge whether or not an argument or statement contained in the question was true (Andraini et al., 2021). The percentage of student achievement in solving critical thinking skills questions with evaluation indicators can be seen in Table 7:

Table 7. Percentage of Evaluation Indicators Achievements

<b>Category</b>	<b>Colleger Total</b>	<b>Pecentage (%)</b>
Very High	0	0
High	0	0
Medium	0	0
Low	4	13,33
Very Low	26	86,67

The fourth indicator is inference which got an average score of 21.67 with a very low category. It shows that there were still many students who have not been able to identify and determine the things or elements needed to draw a conclusion in solving a problem (Lestari et al., 2019). The percentage of student achievement in solving critical thinking skills questions with inference indicators can be seen in Table 8:

Table 8. Percentage of Inference Indicators Achievements

<b>Category</b>	<b>Colleger Total</b>	<b>Percentage (%)</b>
Very High	0	0
High	1	3,33
Medium	0	0
Low	3	10
Very Low	26	86,67

The next indicator is explanation which got the highest average score compared to the other five indicators, which was 68.00 in the medium category. It shows that students were capable enough to be able to explain logically or describe the steps used in solving a problem that given in the problem (Puspita et al., 2021). The percentage of student achievement in solving critical thinking skills questions with explanatory indicators can be seen in Table 9:



Table 9. Percentage of Explanation Indicators Achievements

Category	Colleger Total	Percentage (%)
Very High	12	40
High	0	0
Medium	0	0
Low	14	46,67
Very Low	4	13,33

The last indicator is self-regulation with an average score of 14.67 in the very low category. Self-regulation indicators mean the ability of students to monitor their own abilities in analyzing and evaluating and applying their skills as an effort to improve themselves (Facione, 2015). This very low mean score indicates that there were still many students who are less able to direct their abilities and determine appropriate actions in solving problems. The percentage of student achievement in solving critical thinking skills questions with self-regulation indicators can be seen in Table 10:

Table 10. Percentage of Self-Regulatory Indicators Achievements

Category	Colleger Total	Percentage (%)
Very High	2	6,67
High	0	0
Medium	0	0
Low	4	13,33
Very Low	24	80

Based on the data analysis result that has been carried out, it shows that the critical thinking skills of prospective teacher students on global environmental problems in the SSI context still need to be improved. This is related to the researched by Wijayanti (2020) that students' critical thinking skills in each indicator need to be improved in order to achieve optimal thinking results. Andraini, et al. (2021) stated that the ability to think critically can develop if it continues to be trained. The form of training provided can be in the form of solving problems associated in daily life (Defiyanti, 2019; Lestari et al., 2019).

Farcis (2019) in his research stated that critical thinking skills are strongly influenced by the learning experiences obtained by students. Learning activities that train critical thinking skills, it will affect the improvement of critical thinking skills greatly. Therefore, learning process in lectures should be designed in such a way that includes activities that can develop the critical thinking skills of pre-service chemistry teacher. Critical thinking leads students to

be able to interpret, analyze, evaluate, infer, explain, and have the ability to self-regulate by being able to find alternative solutions to problems and also make the right decisions.

Critical thinking skills are very important to the pre-service chemistry teacher, because in addition to demands in the current globalization era, critical thinking is also needed to equip students in preparing the next 21<sup>st</sup> century generation to be competitive and solve the various problems or challenges in the future.

#### 4. Conclusion

Based on the research result and data analysis that has been carried out, it shows that the critical thinking skills of pre-service chemistry teacher on global environmental problems in the SSI context were in the very low category (83.33%). The skills of analysis, evaluation, inference and self-regulation were still very low with an average score of 31.67; 8.00; 25.67; and 14.67. Skills in interpretation are classified as low with an average score of 46.47, while explanatory skills are included in the medium category with an average score of 68.00.

The profile of students' critical thinking skills as a result of this study can be used as a reference for designing and developing learning processes in problem-based environmental chemistry lectures in the SSI context that can improve critical thinking skills of pre-service chemistry teacher.

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