

# Identification of Students' Critical Thinking Skills Topic Classification of Materials and Its Changes

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**Abstract.** This study aimed to identify students' critical thinking skills pattern on the topic of classification of materials and its changes. Critical thinking skills becomes the main competency in facing challenges and global changes. This ability is needed in the 21st century in education and include of learning ability and innovation. Students are trained in critical thinking to be able to make appropriate and logical decisions. Someone who thinks critically is able to interpret, analyze, evaluate and create wise decisions. This topic about classification of solid, liquid, gas; elements, compounds, and mixtures; acids, bases, salt; density; physical changes and chemical changes. Research subjects were amounted to 92 junior high school students in Surakarta. The research method was test, using the form of essay questions consisted of 8 items. Indicators was adapted from Facione. The descriptive qualitative analysis was used in this study as research technique. The results showed that students' critical thinking skills varied based on indicators: inference was 61.53% (good category), self regulation was 57.43%, explanation was 49.06%, evaluation was 47.14%, analysis was 45.54% (moderate category) and interpretation indicators 39.75% (low category). From the results, it is required that students need to get training, changes in methods of teaching inquiry and contextual discussion.

**Keywords:** Materials and Its Changes, Critical Thinking, Junior High School.

## 1 Introduction

The development in education today brings us to the 21st century learning as an important goal in the field of advanced education. The 21st century learning prioritizes students to be active and innovative to suggest and participate more in learning process, not only as a receiver but also as a giver. There are three kinds of skills in the 21st century learning, namely 1) learning ability and innovation; 2) information, media and technology capabilities; and 3) life and career abilities. The world of education emphasizes the ability known as 4C, namely the ability to critical thinking and problem solving, communication and collaboration, as well as creativity and innovation [1]. The importance of learning in the 21st century is as an effort to deal with the rapid development of the times, being able to balance technological and information advancements, as well as adjusting changes in fast-paced situations.

Critical thinking including higher order thinking skills (HOTS). Higher order thinking as hereafter is referred as HOTS allows students to overcome problems in generating ideas and to insisting what they know about new insight. Through HOTS implementation on students, learning process can be more challenging as students' thinking is guided to produce various alternatives, ideas, actions, solutions and designs [2]. The speed of information and global

competition now requires a higher level of thinking ability and problem solving that cannot be predicted in advance [3]. Developing critical thinking skills is the main goal of education throughout the world and is an early part of the learning process [4,5]. Critical thinking is the basis of the three other types of abilities, namely the ability to think creatively, problem solving, and decision making. Based on these aspects of the critical thinking necessary, it is needed to own before reaching into the mindset of HOTS in learning. Critical thinking trains students to be responsive and quick in solving and solving problems.

Many experts define critical thinking. Ennis explained that critical thinking is logical, reasonable, and reflective thinking with a focus on decisions that are trusted or carried out [6]. Someone who thinks critically will consider every information obtained, examine, consider the truth, and rationality of information. Critical attitude is shown by finding errors then analyzing [7]. Critical thinking is the process intellectually active and skilled in conceptualizing, translating, interpreting, analyzing, synthesizing and evaluating the information obtained for students to do further action [8,9]. Human ability to think critically is shown to be able to identify assumptions, check validity, examine various perspectives from various directions, and make decisions based on information [10]. According to Facione, critical thinking is a thought process that has the purpose of proving, interpreting meaning and solving problems [11].

The benefits of practicing critical thinking skills are being able to make solutions to individual or social problems, expand creativity and be useful in the application of science in society through the developed era of education nowadays [12], [13], [14], [15]. Moreover, it can develop the ability to think, prepare for complex global societies, deepen the quality of understanding and the application of knowledge to new situations [16]. This ability also influences social abilities in a group where people gather and discuss [17]. The rapid development of all fields requires people who have the ability to make the right decisions, wise and skilled. One of the fields is learning science.

Critical thinking skills are six types of indicators used in learning, namely 1) interpretation, is the ability to understand the meaning of an experience, situation, data, event, assessment, conversion, belief, rules, procedures, or criteria; 2) analysis, namely identifying arguments to state principles, principles, judgments, beliefs, opinions, concepts, reasons and information; 3) inference, which is identifying and determining aspects to make conclusions, hypotheses, and consider information; 4) evaluation, namely assessing the credibility of an idea; 5) explanation, is the ability to express a reasoning, confirmation, and provide a logical argument; 6) self regulation, is a person's ability in awareness to understand cognitive thinking processes, results developed to analyze, evaluate, question, confirm, validate, and correct reasoning [11].

## 2 Method

This research is a qualitative descriptive study with a test method. The test method is used to represent the percentage of critical thinking skills of junior high school students in Surakarta, Jawa Tengah, Indonesia in the academic year 2019/2020. The samples used in this study were 92 students from two junior high state schools in Surakarta. Students were given essay tests, consisting of 8 items of question. Each answer has an answer score in one to four categories. The topic tested was the classification of material and its changes.

Data analysis uses descriptive percentages and analyzed by equations:

$$P = \frac{\text{score average}}{\text{score maximum}} \times 100\%$$

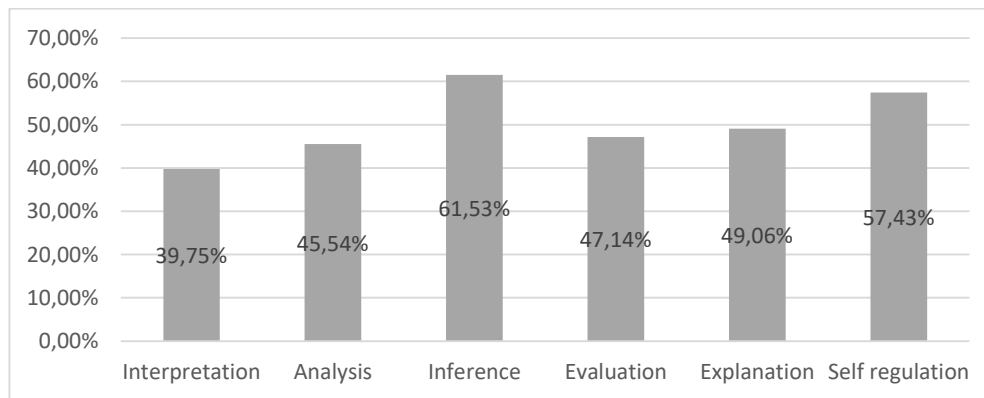
The instrument used in the essay test is as follows

**Table 1.** Instrument of the Test

Indicator Critical Thinking by Facione	Question of the Test	Number of Item
Interpretation	Interpreting the solubility of a substance	1
Analysis	Analyze foods and drinks that include acidic or alkaline solutions	2
Inference	Conclude about the causes of rusted fences	3
Evaluation	Evaluating from the statement of making cassava tapai as a process of chemical change	4
	Assessing a metal which is gold through density calculation	5
Explanation	Explain the importance of checking the pH of water quality in drinking water companies	6
	Explain a reasoning for using antacid as a stomach ulcer drug	7
Self regulation	Correcting the results of the classification of objects including physical changes	8

### 3 Results and Discussion

The results in Figure 1 show that there is only one indicator with a good category, namely inference 61.53%. The indicator of analysis is 45.54%, evaluation is 47.14%, explanation is 49.06%, and self regulation is 57.43% categorized in moderate category. The low category is in the interpretation which is 39.75%. The achievement in the topic classification of materials and its changes were converted to the criteria on Table 2.



**Fig. 1.** The Percentage of the Students Critical Thinking Skills

**Table 2.** The Category of Achievement in Critical Thinking Skills

Achievement (%)	Category
81 – 100	Very good
61 – 80	Good
41 – 60	Moderate
21 – 40	Low
0 – 20	Very low

The lowest indicator is interpretation. Interpretation is the ability to understand the meaning of an experience, situation, data, event, judgment, conversion, beliefs, rules, procedures or criteria [11]. As the results taken, the 60.25% of students have not been able to provide an explanation of everyday phenomena clearly and detailed. The phenomenon of the solubility of an ingredient in water has not been able to be explained and is related to science. Students seemed to be confused to determine the soluble materials and puzzled in holistically explaining.

**Table 3.** Example Student's Answer

Question Number 3	The Student's Answers																								
<p>2. Pada suatu percobaan kandungan jenis larutan yang dilakukan oleh Dimas, larutan yang diuji menghasilkan data sebagai berikut.</p> <table border="1"> <thead> <tr> <th>No.</th> <th>Jenis larutan</th> <th>Lakmus merah</th> <th>Lakmus biru</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Soda</td> <td>Merah</td> <td>Merah</td> </tr> <tr> <td>2.</td> <td>Jus jeruk</td> <td>Merah</td> <td>Merah</td> </tr> <tr> <td>3.</td> <td>Air detergen</td> <td>Biru</td> <td>Biru</td> </tr> <tr> <td>4.</td> <td>Cuka</td> <td>Merah</td> <td>Merah</td> </tr> <tr> <td>5.</td> <td>Air kapur</td> <td>Biru</td> <td>Biru</td> </tr> </tbody> </table> <p>Berdasarkan data diatas, jenis larutan manakah yang termasuk dalam larutan asam dan larutan basa? Bagaimana cara membedakan larutan asam dan basa berdasarkan hasil tersebut?</p> <p>Larutan asam: Soda, jus jeruk, cuka.  Larutan basa: Air detergen &amp; air kapur.  * Larutan asam rasanya asam, menimbulkan korosi, sedangkan larutan basa rasanya agak pahit, licin di pipi.</p>	No.	Jenis larutan	Lakmus merah	Lakmus biru	1.	Soda	Merah	Merah	2.	Jus jeruk	Merah	Merah	3.	Air detergen	Biru	Biru	4.	Cuka	Merah	Merah	5.	Air kapur	Biru	Biru	<p>Acidic solution: soda, orange juice, and vinegar  Alkaline solution: detergent water and lime water  Acidic solutions have an acidic taste, corrode, while alkaline solutions taste bitter and slippery on the skin</p>
No.	Jenis larutan	Lakmus merah	Lakmus biru																						
1.	Soda	Merah	Merah																						
2.	Jus jeruk	Merah	Merah																						
3.	Air detergen	Biru	Biru																						
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No.	Jenis larutan	Lakmus merah	Lakmus biru																						
1.	Soda	Merah	Merah																						
2.	Jus jeruk	Merah	Merah																						
3.	Air detergen	Biru	Biru																						
4.	Cuka	Merah	Merah																						
5.	Air kapur	Biru	Biru																						

**Fig. 2.** Incorrect Answer**Fig. 3.** Correct Answer

The second lowest indicator is analysis. The ability of analysis owned by students is 45.54%. The results showed that there are students who still have difficulty to make a connection between concepts, ideas and evidence. Students have difficulty analyzing solutions that include acids and bases. Analysis relates to principles, evidence, judgment, beliefs, opinions, concepts, reasons, and information [11]. The ability to analyze leads to face certain conditions, problems of objects, determine the decisions and efforts made [18]. Students' strategies in learning by memorization make it difficult to develop logic, think critically and analyze [19]. Though memorization is not powerful enough to enhance understanding in

learning science, students tend to do it with the purpose of emergence questions on the final test. Analytical indicators attribute existing information with concepts and problem solving. The learning process requires concepts and strategies in understanding concepts. Students are given assignments as projects related to daily life [20].

In the example of students answer number two in Figure 2, students have been able to distinguish a solution that is classified as acidic or alkaline. The solutions mentioned are correct but students cannot interpret based on the results of the experiment in the table. Students understand acidic or alkaline solutions based on previously owned experiences. The student statement does not correspond to the question. While, students' answers in Figure 3 have been correct, students are mentioning acidic or alkaline solutions appropriately. Students are also able to interpret data based on the results of the table.

The evaluation indicator is the third lowest indicator of 47.14%. Students have not been able to evaluate chemical changes in a food marked by no assessment and logical relationship between relationships is not right. The results of this achievement are because students have not been trained in assessing a statement. Evaluation as a form of evaluation of a statement or opinion of someone who answers a logic of the statement. The process of evaluating is done by examining each step of action, reviewing information, and verifying referential and supporting evidence [21]. Evaluation indicators are used so that students are able to update information, remember to work systematically and carefully [20].

The explanation indicator with the results of 49.06% ranks fourth in the category moderate. In this indicator students have begun to be trained in providing explanations of phenomena or ideas through giving ideas or opinions. Explanation is closely related to the reasoning, confirming and providing a logical argument in science learning. The ability of students in the category is enough to explain about the use of ulcer drugs for patients with ulcers and checking the pH content in water quality in drinking water companies. Many students can answer and explain the use of antacids in ulcer drugs. Students explain that when stomach ulcers increase in stomach acid content, basic antacids are needed to neutralize stomach acid. While for checking drinking water, students can explain if the drinking water is not controlled for its quality, it can be dangerous, contain bacteria or pollutants.

The inference indicator has the highest achievement compared to other indicators at 61.53%. Sub indicators include asking for evidence, guessing alternatives, and concluding [11]. Students are able to make conclusions from a phenomenon that occurs precisely about the corrosion events on metals such as tire and gatehouses. The ability to inference is best because students are accustomed to concluding events, close to daily life, and already have previous concepts. Students who have the ability to deduce more experienced and mastered in describing, guessing according to reality, principles, proof, beliefs, concepts and other forms of representation [22].

The ability to think critically can be influenced by genetics, self-regulation, anxiety, emotional, culture, it can also be due to physical conditions, motivation, and anxiety factors [23,24]. Students who use higher-order thinking processes can easily accept concepts or analyze, including critical thinking. Students with low critical ability can occur due to lack of training from the teacher, limited resources, and time [25]. The topic of material classification and its changes is a close topic in student life because students are directly involved, but are still not aware of the event. This topic covers the classification of substances; elements, compounds, mixtures; the nature of the acid, base and salt solutions; and changes in physics and chemistry. Critical thinking skills training can (1) determine learning objectives, (2) inquiry, (3) practice, (4) review, improve, and increase understanding and (5) provide feedback and assessment [26].

## 4 Conclusion

The result of achieving critical thinking of junior high school students in Surakarta is 50.07% enough category. The lowest indicator is interpretation 39.75% low category while the highest yield at the indicator inference 61,53% good category. Based on these findings, it is necessary to improve students' critical thinking skills and conduct learning activities that integrate critical thinking and give critical thinking questions, contextual discussion and methods of inquiry. The student can increase critical thinking then the teachers develop learning that prioritizes critical thinking processes. The topic classification materials and its changes can be taught using experimental activities so that the ability to reason and critical in finding concepts.

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