The Analysis of Students' Critical Thinking Based on the Concept of Flowmap on Chemical Bond

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Abstract: Education in the 21st century requires students and teachers to master various skills including critical thinking skills. Critical thinking is an aspect that has been researched in recent years with the aim of seeing the thinking skills and cognitive abilities of teachers and students. Therefore this study aims to analyze students' critical thinking in answering questions about chemical bonding topic. The sample of this study was 171 high school students in Pekanbaru. Data were analyzed using SPSS 21.0 by looking at the frequency of students in answering questions and elaborating on the answers. The results of the study showed that students were still at a low critical thinking stage based on the frequency of students in explaining and answering the questions given. Based on the results of this study was expected to provided information for teachers to be able to improve cognitive thinking and critical thinking of students and develop a variety of critical thinking questions so that students have a lot of experience in describing problems and understand well the concept of chemical topics.

Keywords: critical thinking, flow map, chemical bonding, chemical learning

1. Introduction

Education is a systematic and gradual systematic process where new developments occur. Learning will be more meaningful if students experience what they learn. In order to improve the quality of education, the quality of learning needs to be improved. Readiness of knowledge and attitude is a significant element in determining the willingness of a teacher to accept and implement changes in education (Habib, 2005). Improvement of learning can be done in various ways, including through the use of assessment results. With the results of the assessment, a teacher gets a picture, which material should be given more attention and which material is sufficient. According to Yamtinah and Budiyono (2015) education is a learning process in which there are three basic elements of interrelated activities, namely learning goals, learning experiences and assessment procedures.

The 2013 curriculum has a variety of objectives including that students master high-level thinking. According to Rosmaiyadi (2017) high order thinking or HOT is the embodiment of critical thinking, and creative. Attitudes and thinking skills of students influence the course of teaching sessions in the classroom. In the process of teaching and learning, techniques for regulating knowledge in the mind, and the existence of knowledge are very important for the formation of new knowledge. Learning involves an active process in which students build meaning by linking new ideas with their existing knowledge (Naylor & Keogh, 1999). Therefore, this is very important in the teaching and learning process to have a better understanding of "how to determine pre-existing knowledge" and "how we learn" to build new

knowledge. In addition, using appropriate cognitive assessment. Teachers get a picture that learning must be adjusted to the cognitive level of the questions given to students.

Structured knowledge (cognitive structure) provides stability and an organized framework to build new knowledge. Well-organized ideas also facilitate problem solving by giving orders a series of generalizations and principles that can be mobilized efficiently and applied to new problem situations (Anderson, Randle & Covotsos, 2001). The cognitive structure is an indication of an individual concept in memory and the relationship between them (Oskay & Dincol, 2011). Development of cognitive structures in students can provide brightness in the learning process. By exploring the cognitive structure of students, educators can understand students' conceptions, the relationship between concepts, and scientifically wrong understanding, namely misconceptions, and therefore, to help students to improve their learning outcomes. By investigating the cognitive structure of students. Thus, educators can plan learning better.

Based on preliminary research that has been conducted, there are some misconceptions found in students in chemistry learning. As in the chemical bond material, each material in a chemical bond is a material that is interrelated to each other, if there is an error in the concept of chemical bonding, the student experiences a misconception in understanding the next concept, such as: chemical equilibrium, thermodynamics, molecular structure and chemical reactions (Özmen, 2004). Interviews carried out on some can be concluded that among students' misconceptions in understanding chemistry is that "all symmetric molecules will be non-polar"

Among the ways to identify student misconceptions is to use a flow map. With the use of flowmap misunderstandings that occur in students can be explained through the cognitive structure of students. A number of quantitative variables such as breadth of knowledge, amount of knowledge, integration and misconceptions represent cognitive structures, can be obtained from flowmap analysis (Yang, 2004). The breadth of knowledge shows the number of statements that are in the flow map, the amount of knowledge shows the number of recurring linkages in science and integration provides a proportion of recurrent linkages.Based on the explanation above, the purpose of this study is to analyze students' critical thinking skills in solving problems of understanding chemical bonds based on flowmap structure

2. Methodology

Planning is the first thing a researcher must do before research begins. The research design is described as a map or blue print of how the research will be carried out. This study uses a structured survey approach involving high school students in the city of Pekanbaru using questions about understanding chemical bonding material based on the Flow Mapping concept. The population and sample of this study were 171 high school students in Pekanbaru.

The strength of a study lies in research instruments and research data collection methods. This research instrument used comprehension questions in the form of descriptions that are analyzed using the critical thinking rubric of Finken and Ennis (1993) and Siti Zubaidah, AD. Corebima, Mistianah (2015).

Table 1. description of the assessment of students' critical thinking

Score	Description
5	a) All concepts are true, clear and specific b) All descriptions of answers are true, clear and specific, supported by strong, correct, clear arguments c) Good thinking, all concepts are interrelated and integrated d) Grammar is good and right e) All aspects appear, proof is good and balanced
4	a) Most of the concepts are true, clear but not specific b) Most of the descriptions are correct, clear, but not specific c) The flow of good thinking, most of the concepts are interrelated and integrated d) Grammar is good and right, there is a small mistake e) All aspects appear, but not yet balanced
3	a) A small part of the concept is true and clear b) A small portion of the answer is correct and clear but the reasons and arguments are not clear c) The flow of thinking is good enough, a small part is interrelated d) Grammar is good enough, there are errors in spelling e) Most aspects that seem right
2	a) The concept of lack of focus or excessive or doubtful b) The description of the answer does not support c) The flow of thinking is not good, the concept is not interrelated d) Good grammar, incomplete sentences e) A small part of the aspect that seems right
1	a) All concepts are incorrect or insufficient b) The reason is incorrect c) The flow of thinking is not good d) Grammar is not good e) Overall aspects are not sufficient
0	There are no answers or wrong answers

Based on table 2, shows the indicators of students' critical thinking assessment which are categorized based on the score of the analysis of the answers given. This assessment is divided into six indicators with scrutiny such as "0" which means that students do not give answers or answers given completely wrong. "1" with the meaning of scrutiny that students give an overall answer is not sufficient, grammar is not good, the flow of thinking is not good, reason or explanation is not correct and all concepts given by students are insufficient. The score "2" means that students have a bad thinking flow, the concept described does not relate to the expected answer to the concept of lack of focus or doubt. The score "3" shows that the groove thinks students are good enough, and partly related. In addition, students have a description of the answers that are less clear in their arguments. The score "4" describes students' critical thinking in explaining clear answers, has shown the correct answer but is still less specific. There is a score of "5" explaining that at this stage students have been able to explain the answer well, specifically and be added with the right argument. In addition, at this stage students have provided a good flow of thinking with precise and accurate explanations.

Figure 1. Explain the flow map structure which is the basis for researchers in making student understanding problems. Flowmap structure can explain the cognitive level of students in understanding the material given in class. By following this flow map structure, the teacher can see the limits of students' understanding of concepts in a subject matter.

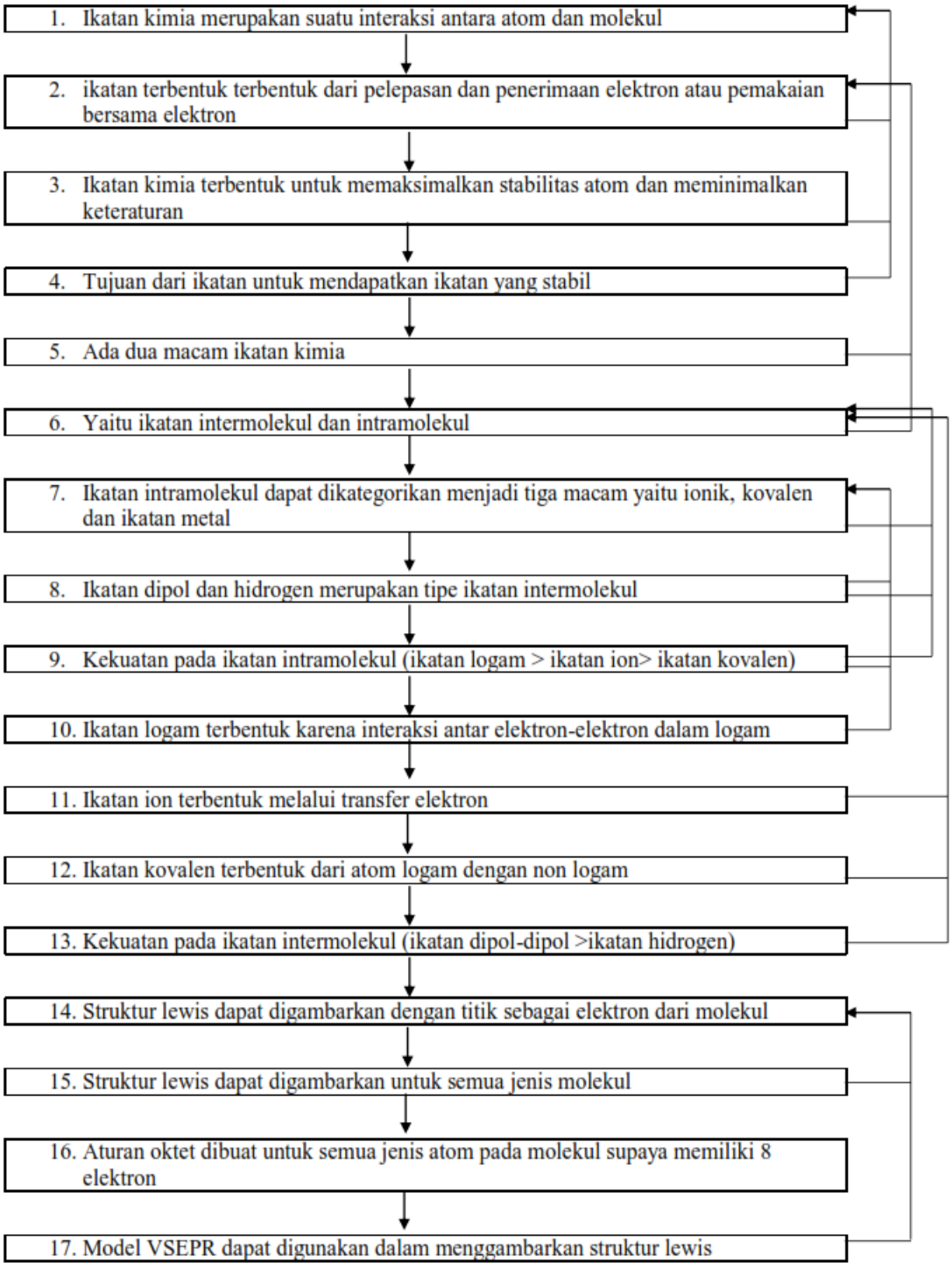

Figure 1. Flowmap of the concept of chemical bond

3. Results and discussion

This study aims to look at the level of students' critical thinking in understanding the concept of chemical bond material taught in high schools in Pekanbaru. Table 1 shows a sample profile of 70 (40.9%) male students and 101 (59.1%) female students from three high schools in Pekanbaru.

Table 2. Profile of samples

Demografi	Frequency	Percent
Male	70	40.9
Female	101	59.1
Total	171	100.0

Student's Critical Thinking Based on Chemical Bonding Topics

Descriptive analysis is carried out to see the level of students' critical thinking on the material learned in class X, which is about chemical bonds. The following are described some stages of students' critical thinking based on test questions that have been given to students.
Three essay questions with the demands of the answers the researchers wanted 9 categories with accurate explanations in accordance with the critical thinking assessment rubric. Table 3 shows the results of students' critical thinking level analysis in the first question which asks students to answer questions regarding the determination of molecular formulas in chemical bonds.

Table 3. Critical thinking students determine the formula of bond molecules

Skor	Frequency	Percent
0	51	29.8
1	16	9.4
2	69	40.4
3	26	15.2
4	9	5.3
Total	171	100.0

Based on table 3 shows that as many as 51 people (29.8%) students did not answer and or some student answers were wrong in answering the questions given. Whereas as many as 69 people (40.4%) students answered questions but each answer given showed a description of answers that did not support so that the answers of these students included in the score category 2. Only 9 people (5.3%) students answered with the level of thinking Critical students who are on score 4. This shows that students still have backwardness in explaining the questions given to them, so that no student can explain the item questions with a score of 5, where at this stage students can explain the concept clearly and specifically.

Table 4. Critical thinking students determine the shape of bond molecules

Skor	Frequency	Percent
0	108	63.2
1	9	5.3

2	14	8.2
3	38	22.2
4	2	1.2
Total	171	100.0

Based on table 4. Shows that as many as 108 people (63.2%) students did not answer and or some student answers were wrong in answering the questions given. Whereas as many as 38 people (22.2%) students answer questions but each answer given shows a description of the answers that a small portion of the answers are correct and clear even though the flow of thought is not interrelated. Only 2 people (1.2%) students answered with the level of critical thinking of students who were on score 4 where most students answered the concept correctly and clearly with the flow of good thinking and related concepts.

Table 5. Levels of critical thinking students determine hybridization and geometric shapes

Skor	Frequency	Percent
0	127	74.3
1	11	6.4
2	11	6.4
3	22	12.9
4	0	0
Total	171	100.0

Based on table 5. Shows that the level of students 'critical thinking in determining hybridization and bond geometry shapes as many as 127 people (74.3%) students did not answer and or some students' answers were wrong in answering the questions given. While as many as 22 people (12.9%) students answer questions but each answer given shows a description of the answers that a small portion of the answers are true and clear even though the flow of thought is not interrelated. 11 people (6.4%) students who answered with critical thinking levels of students who were in scores 1 and 2 where students for each category answered the concept incorrectly and lacked focus and doubted in explaining so that the flow of thinking was not good. As for category 4 where students mostly answer the concept correctly and clearly with the flow of good thinking and related between concepts is 0 which is meaningful for this third problem students do not reach critical thinking by understanding the concept correctly.

4. Conclucion

Based on the results of the study it can be concluded that students' critical thinking to understand the concept of chemical bonds is still very low. This can be seen from the number of students who choose not to answer and or answer with the wrong answer.

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