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The use of multi representative learning materials: definitive, macroscopic, microscopic, symbolic, and practice in analyzing students' concept understanding

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Abstract. This research aims to compose learning material which contains definitive macroscopic, microscopic and symbolic to analyze students' conceptual understanding in acid-base learning materials. This research was conducted in eleven grade, natural science class, senior high school 1 (SMAN 1) Karangtengah, Demak province, Indonesia as the low level of students' conceptual understanding and the high level of students' misconception. The data collecting technique is by test to assess the cognitive aspect, questionnaire to assess students' responses to multi representative learning materials (definitive, macroscopic, microscopic, symbolic), and observation to assess students' macroscopic aspects. Three validators validate the multi-representative learning materials (definitive, macroscopic, microscopic, symbolic). The results of the research show that the multi-representative learning materials (definitive, macroscopic, microscopes, symbolic) being used is valid in the average score 62 of 75. The data is analyzed using the descriptive qualitative method. The results of the research show that 72.934 % students understand, 7.977 % less understand, 8.831 % do not understand, and 10.256 % misconception. In comparison, the second experiment class shows 54.970 % students understand, 5.263% less understand, 11.988 % do not understand, 27.777 % misconception. In conclusion, the application of multi representative learning materials (definitive, macroscopic, microscopic, symbolic) can be used to analyze the students' understanding of acid-base materials.

1. Introduction

Chemistry has certain characteristics. One of them is the interrelated concepts. The understanding of one concept affect another one, that is why the concept must be mastered properly [1]. The certain concept cannot be explained without analogies or models which takes a high order reasoning ability in learning chemistry. Moreover, chemistry is continuous which means there are connections among concepts. Students mostly interpret a complex concept their own based on the concept they already acquired. In some cases, this interpretation does not confirm the concepts agreed upon experts. The different concept interpretation is called misconception [2].

Students who have difficulty in understanding concepts make their interpretation as an attempt to overcome their learning difficulties[3]. Sometimes their interpretation doesn't confirm the scientific concept according to the experts [4]. Students misconceptions are caused be the incompatibility concept [5]. This misconception derived from the students experience in interacting with nature.

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Misconceptions in students' will affect their ability to understand materials. Misconceptions in one material will lead to difficulties in learning the other materials.

Learning sources have an important role in the learning process. Based on the prior observation, the school facilities condition has met the criteria to support the learning process. But in fact, the chemistry class of eleven grade, Natural Science Class, Senior High School State 1 (SMAN 1)Karang Tengah, Demak province, Indonesia has not reached its maximum performance. It is indicated by the results of the study which are floating on the low level of the table. There are only 36.84% students who pass the mid-semester exam. That is why the teaching-learning process in this research proposes multi representative materials to have an overview of students understanding.

The use of learning materials in science is a must because it provides a foundation to think conceptually, to motivate students to learn and to imagine [6]. The attempt in controlling the quality of printed learning materials has to be done [7]. The quality of learning materials should be preserved to help the students in learning chemistry concepts'. The representative is the student's ability to convey the mathematics ideas they have learned in specific ways [8]. The multi representative is the use of two or more representation to draw a picture of a system or actual process. The multi representative can distinguish different aspects [9]. Multi representative supports various observations [10]. Representation aims at assisting students in solving the abstract mathematics matter to a more concrete [11].

Learning materials play an essential role in the learning process. So far, the existing learning materials only cover the definitive aspect only. This leads to low student understanding or tends to misperception (misconception). Early learning materials contain only definitive and macroscopic elements only. This leads to a lack of understanding of student concepts or misconceptions. The application of multi-representation learning materials (definitive, macroscopic, microscopic, symbolic) and the practicum is expected to analyze students' conceptual understanding.

The purpose of this study is to compose learning materials that include definitive, macroscopic, microscopic, and symbolic aspects of understanding student concept analysis.

2. Methods

The subjects of the study were the students of eleven grade, natural science class, senior high school 1 (SMAN 1) Karangtengah, Demak province, Indonesia which amounted to 77 students. The research is a case study. This research applied to Eleven grade, Natural Science Class, Senior high school 1 (SMAN 1) Karangtengah, Demak province, Indonesia.

The research begins with observations made in eleven grade, natural science class aims to identify existing problems. This study was conducted on acid-base and applied to two experimental classes. The first experimental class was treated with the application of multi-representation learning materials for all students. The first experimental class was treated with the application of multi-representation learning materials for some students.

Data collection method in this research is by test, observation, and questionnaire. The test method uses an unquestioned explanatory test instrument used to retrieve student conceptual understanding data. The validity of instrument test is done by expert judgment method and reliability using Cronbach alpha formula. [12]. The observation sheets are used to extract the student skill score data. The observation sheet validated by using the content validity. Reliability of observation sheet using Inter raters reliability formula. The student's questionnaire sheets were used to determine the student's response to the multi-representative materials used. Validate student questionnaire responses using expert validation and reliability with Cronbach alpha. The analysis of the research results is descriptive-quantitative.

3. Results and discussion

The Learning materials used for research through various stages. The first step is the making stage, then the suggestion revision of the supervisor, and the revised suggestion from the validator. The recommendations include clarifying the multi-representation aspects of learning materials,

microscopic images must be correct in order not to cause misconceptions, and there are examples of problem exercises in each sub-chapter of the material. The difficulty in making these learning materials is to link the multi-representation aspects of each sub-chapter of the material.

The validator validates the multi-representation resource used. Validator A with score 61, validator B with a score of 62, and validator C with a score of 63. The average validation score of 62 out of a total score of 75 and learning materials is said to be valid.

The observation sheet was used to measure the experimental skills of both experimental classes. The first preliminary class reliability is 0.973. Second experimental class religiosity 0.906. This indicates that the observation sheet used for the research is reliable.

Questionnaire student response to learning materials used validated by experts and tested reliability using Cronbach-α. Questionnaire response students filled by first experimental class, with the number of respondents as many as 39 students. The results of the questionnaire responsiveness of students to learning materials are 0.751. This indicates that the questionnaire responses students to reliable learning materials, and can be used for any time. Student responses to multi-representational learning materials are presented in Table 1.

Table 1. Student Response to Learning materials

Grain	Response Students	
	Very Good	Good
1	25	14
2	21	18
3	24	13
4	14	24
5	21	18
6	19	19
7	19	20
8	7	30
9	21	18
10	7	32
11	21	18
12	13	24
13	14	25
14	20	19
15	15	24

The written test used in this study is a questionable explanation. Written tests were conducted on two experimental classes. The first experimental class through evaluation has been done, and it is known that the percentage of the number of students who understand the concept of acid-base is presented in Table 2.The first experimental class through evaluation has been done, and it is known that the percentage of the number of students who understand the concept of acid-base is presented in Table 3.

Table 2. Percentage of Number of Students Knowing the Acid-Base Concept

No	Presentence of Understanding				Information on Understanding Concept
	Understanding Concept	Less Understanding	Do not Understand	Misconceptions	
1	25.641	48.717	0	25.641	10 of 39
2	100	0	0	0	39 of 39
3	100	0	0	0	39 of 39
4	69.230	7.692	0	23.076	27 of 39
5	79.487	0	20.512	0	31 of 39
6	79.487	15.384	0	5.128	31 of 39
7	15.384	0	56.410	28.205	6 of 39
8	89.743	0	0	10.256	35 of 39
9	97.435	0	2.564	0	38 of 39
Average	72.934	7.977	8.831	10.256	28 of 39

Table 3. Percentage of Number of Students Knowing the Acid-Base Concept

No	Presentence of Understanding				Information on Understanding Concept
	Understanding Concept	Less Understanding	Understanding Concept	Misconceptions	
1	34.210	36.842	5.263	23.684	13 of 38
2	76.315	0	2.631	21.052	29 of 38
3	76.315	2.631	21.052	0	29 of 38
4	73.684	0	0	26.315	28 of 38
5	86.842	0	7.894	5.263	33 of 38
6	28.947	5.263	2.631	63.157	11 of 38
7	15.789	2,631	34.210	47.368	6 of 38
8	34.210	0	21.052	44.736	13 of 38
9	68.421	0	13.157	18.421	26 of 38
Average	54.970	5.263	11.988	27.777	21 of 38

The means of understanding student concept analysis presented in Table 4.

Table 4. How to Understand Understanding Concept point 1

Combination Answer		Answer Category Problem
Answer	Reason	
$8 \leq x \leq 10$	3 or 5	Understand the concept
$4 \leq x \leq 6$	2	Understand the concept
$8 \leq x \leq 10$	0 or 1	Misconceptions
$0 \leq x \leq 2$	0 or 1	Do not understand the concept

Based on Table 2, and Table 3 it can be seen that the experimental class has a different understanding of concepts and misconceptions for each item. The average understanding of the first experimental class concept is 72.934%, while the average understanding of the second experiment class concept is 54.970%.

First experimental class, item 1 misconceptions 25.641%. The misconception number in point 1 is quite high because some students have not been able to determine the conjugate acid-base pair.

Problem 2 and 3 understands the concept 100%, and this happens because the problem adapted from the exercise questions during the learning process takes place. The problem of item 5 misconceptions is 23.076%, this is because. The problem of item 7 misconceptions of 28.205%, this happens because students' mathematical understanding of negative forces is still lacking.

Second experimental class, about 6 misconceptions of 63.157%. The number of misconception in point 6 is high because some students have not been able to determine the conjugate base acid pair of the two reactions. Problem point 7 misconceptions 47.368%, this happens because students' mathematical understanding of the negative power is still lacking.

The macroscopic level is real and contains visible and visible chemicals. For example the change of color of the natural material indicator and litmus paper. Through the experiment, students can determine the acidity and alkalinity of a solution based on the color change indicator used. This experiment uses litmus paper indicators and various natural material indicators. Students look directly at the color change that occurs on each indicator when used to test a sample solution. For example, red litmus paper turns blue when dropped by a soap solution, and blue litmus paper stays blue when dropped by a soap solution. Another example is a purple cholesterol extract indicator at first blue, turning pink when it is dropped by vinegar and turning green when depressed with a lime solution.

Students analyze the acidity and alkalinity of a sample solution based on the indicator color change. Through this lab, students can see the color change of a solution directly. This experiment strengthens the long-term memory of the macroscopic aspects of the student. This is proven by the result of written test about item 8 about the examination of several sample properties using natural indicator percentage of concept 89.743%.

Multi-representation learning materials are used for the analysis of students' concept understanding, the result of students who understand the concept of 72.934%, less understanding of the concept of 7.977%, not understanding the concept of 8.831%, and misconception 10.256% while research results states that the use of submicroscopic diagram as well Its relationship with problem-solving ability to analyses student concept understanding with percentage 46.67% concept conception, 30,33% understand some concept, and 20% do not understand concept. Multi-representation learning materials get positive responses from students, and this is following Widarti's research results, a multiple representation learning models with cognitive dissonance strategy. Practical activities facilitate students in studying chemicals. Practicum provides students opportunities to examine and test directly so that theories and concepts will be more meaningful in the cognitive domain of students [13].

4. Conclusion

In conclusion, the application of multi representative learning material is valid with a score 62 of total score 75. The multi representative learning material can be applied in analyzing the acid-base concept understanding on Eleven grade, Natural Science Class, Senior high school 1 (SMAN 1) Karangtengah, Demak province, Indonesia. The conceptual understanding of the treated experimental class are as follows; 72,934% understand, 7,977% less understand, 8,831% do not understand, and 10,256 % misconception.

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