

## IDENTIFY MISCONCEPTION ON REACTION RATE CONCEPT USING FOUR-TIER MULTIPLE CHOICE (4TMC) DIAGNOSTIC TEST INSTRUMENT

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**Abstract.** *The aims of this study to identify the profile of students' conceptions and misconceptions on the concept of reaction rate using a four-tier multiple choice diagnostic test instrument reported in the form of misconception profiles consisting of students' conceptions, students' misconceptions and the causes of misconceptions experienced by students. Based on the results of the study shown (1) the students' conception profile is as much as 78% understand the concept, 21% misconceptions and 1% do not understand the concept, (2) the profile of student's misconceptions in each sub-material that misconceptions on sub-material of concentration 16%, temperature 19%, surface area 41% and catalyst 24% and as many as 1 student (3%) including the high misconception category, 22 students (67%) included in the medium misconception category and 10 students (30%) were in the low misconception category. Students' misconceptions vary in different causes such as; associative thinking 59%, preconceptions 25%, incomplete reasoning 13%, humanistic thinking 2% and incorrect intuition 1%.*

**Keywords:** *four-tier multiple choices, misconception, reaction rate*

### INTRODUCTION

According to Permendikbud No 20 Year 2016 regarding graduate competency standards, the dimensions of knowledge that must be possessed by SMA/MA/SMALB/Package C students are factual, conceptual, procedural, and metacognitive knowledge at the technical, specific, detailed, and complex levels. High school students required to have the ability of conceptual knowledge dimensions. One of the sciences related to conceptual knowledge is chemistry.

Chemistry is a branch of science that studies various things (composition, structure, properties, changes and accompanying energy) of a material developed by the scientific method and based on scientific attitude. Understanding the concepts in learning chemistry is very important because between one concept with another concept has a related relationship. The concept in chemistry is the important thing for students as a strong foundation to be able to do the next applicable learning. This is in line with Jean Piaget's

thought (Suparno, 2001) which states that when students build their own understanding through the process of assimilation, namely the incorporation of old concepts with new concepts in cognitive structures, students often experience difficulties or even failures. This raises a variety of different understandings of a concept and the potential for misconception.

Misconceptions are wrong ideas or views about a concept of someone who has different from the scientific concepts according to the experts right consider. The wrong view of students is usually resistant and persistent (Ibrahim, 2012). Therefore, misconceptions must be detected from the beginning because misconceptions can interfere with students' understanding of new concepts to be learned later (Treagust, 2006).

The topic of reaction rates includes chemistry topic that are important and require high mastery of concept (Siswaningsih, et.al, 2014). Therefore, rate of reaction is one of the topics in chemistry that contains many concepts that interconnected with each other so that it has the potential to cause

misconceptions in students. Based on Siswaningsih et al (2014), found as many as 35 students' misconceptions on the reaction of rate concept which includes collision theory and factors that influence the rate of reaction (concentration, temperature, surface area and catalyst). Based on the results of the pre-study of 36 students of class XI Science in one of the state high schools in Gresik, it was found that as many as 58% of them considered the reaction rate material to be difficult to understand. In addition, as many as 61% of students consider concentration factors to be material that is difficult to understand in terms of factors that influence the rate of reaction. Then what is considered difficult is the catalyst factor, temperature and surface area with a percentage of 56%, 47% and 33%, respectively. In addition to students' assumptions that the reaction rate material is difficult, in this case also found students' misconceptions. Students were identified as having a misconception on the concept of a concentration factor of 14%, on a temperature factor of 39%, on a surface area factor of 40% and on a catalyst factor of 26%. The existence of this misconception must certainly detected so that it can fixed immediately. Meanwhile, according to the results of an interview with one of the chemistry teachers at the school explained that so far the teacher only uses daily tests and oral questions to students to check students' understanding of concepts. Thus, the teacher never used a diagnostic test to detect the misconception.

One way to find out misconceptions in students is by diagnostic tests. Diagnostic test as a test can be used to determine the weaknesses and strengths of students (Depdiknas, 2007). Thus, the results of diagnostic tests used as a basis for providing follow-up in the form of appropriate treatment and in accordance with the weaknesses of students. The use of diagnostic tests at the beginning and at the end of learning can help teachers find students' misconceptions on the material being studied (Lin, 2004).

This four-tier multiple choice diagnostic test instrument is organized based on four levels of questions. The first level is a multiple choice question with four options and one key answer that students must choose. The second level is the level of confidence of students in choosing answers. The third level is the reason

students answer questions, in the form of four reasons for option and one reason for the correct answer. The fourth level is the level of confidence of students in choosing reasons.

## METHOD

The subjects in this study were 33 students of class XI Science 1 of SMAN 1 Driyorejo who had received reaction rate material and with heterogeneous ability levels. Students are given diagnostic tests to know the level of conception and misconception they experience. The answers of students are interpreted according to table 1 below.

**Table 1.** Interpretation of the Results of Students' Combination of Answers Using the Four-Tier Multiple Choice Diagnostic Test Instrument

The answer	Confidence level of answer	Reason	Confidence level of reason	Criteria
Right	High	Right	High	Understand the concept
Right	Low	Wrong	High	Misconception
Right	High	Wrong	High	
Wrong	High	Right	Low	
Wrong	High	Right	High	
Wrong	High	Wrong	Low	
Wrong	Low	Wrong	High	
Wrong	High	Wrong	High	
Right	Low	Right	Low	Not understand the concept
Right	High	Right	Low	
Right	Low	Right	High	
Right	Low	Wrong	Low	
Wrong	Low	Right	Low	
Wrong	Low	Wrong	Low	
Right	High	Wrong	Low	
Right	Low	Right	High	

(Fariyani, et.all., 2015)

Answers that have been given by students in doing four-tier multiple choice diagnostic tests are interpreted as misconceptions where concepts are understood, conceptual or conceptual misconceptions.

The test results shown a basic in determine the conception level categories of students according to Table 1. Determination of the percentage of each of these categories can use the following equation

- 1) Percentage of conception level categories for all students

$$P = \frac{nx}{ns} \times 100\%$$

Information:

P : percentage of students' answers

nx: number of answers categorized as understanding concepts, not understanding concepts and misconceptions

ns: total number of answers

- 2) Percentage of conception level categories for each students

$$P = \frac{nx}{ns} \times 100\%$$

Description:

P: percentage of students' answers

nx: number of answers categorized as understanding concepts, not understanding concepts and misconceptions

ns: total number of answers

From the calculation of the percentage of misconceptions, the sample of students further categorize into 3 levels of misconceptions. The criteria for each of misconception level categories is determined by Arikunto (2005) is as follows:

- High misconception level category  
 $(X) \geq (Mi + SD)$

Information:

X : percentage of misconception (%)

Mi : ideal mean

SD : standard deviation

- Medium misconception level category  
 $(Mi - SD) \leq (X) < (Mi + SD)$

Information:

X : percentage of misconception (%)

Mi : ideal mean

SD : standard deviation

- Low misconception level category  
 $(X) < (Mi - SD)$

Information:

X : percentage of misconception (%)

Mi : ideal mean

SD : standard deviation

As for calculating the ideal mean and standard deviation, the equation is used

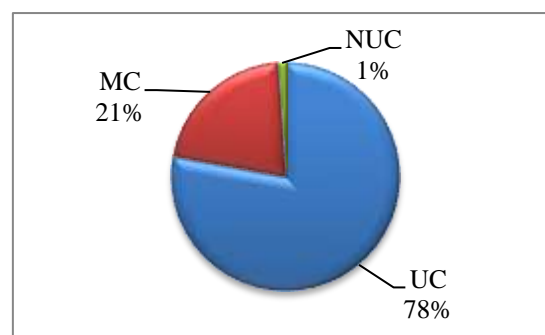
$$Mi = \frac{1}{2} (\text{highest score} + \text{lowest score})$$

$$SD = \frac{1}{3} (\text{highest score} - \text{lowest score})$$

## RESULT AND DISCUSSION

### Student Conception Profile Class XI Science 1

Based on the results of trials that have been done, the data result in the form of a combination of answers from each student. The combination of answers consists of 4 components, namely: (1) answers, (2) confidence level of answer, (3) reasons and (4) confidence level of reason. Furthermore, each combination of answers interpreted includes: (1) Understanding Concepts (UC), (2) Misconceptions (MC) and (3) Not Understanding Concepts (NUC). According to the data results on 33 students of class XI Science 1, the profile of students' conception in general shown in Figure 1.

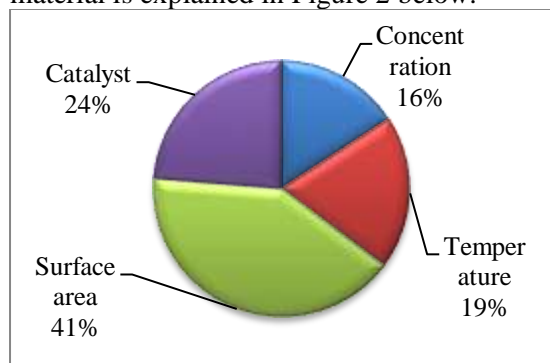


**Figure 1.** Student Conception Profile Class XI Science 1 on the Reaction Rate Concept

Based on Figure 1 above, the largest percentage of students' conceptions of XI Science 1 is Understanding Concepts (UC), which is 78%. Next, the percentage order from the biggest to smallest is Misconception (MC) of 21% and Concept Understanding (NUC) of 1% respectively. Most students categorized in the Understanding Concept (UC) category which has both correct answers and reasons also confident of the answers and reasons given. This is in line with the result of the study of Pajaindo et al [10], that most high school students of grade XI Science have sufficient understanding of the concept reaction rate. As many as 21% of students experience Misconceptions (MC) on the concept of this reaction rate in which students believe the answers and reasons are wrong. Meanwhile, only a small proportion of students who do not understand the concept (NUC) where students are not sure of the answers and reasons given.

### Profile of Misconceptions for Each Class XI Science 1 Student

Students of XI Science 1 mostly experience misconceptions on the whole sub-material reaction rate, namely concentration, temperature, surface area and catalyst. Percentage of students' misconceptions per sub material is explained in Figure 2 below.



**Figure 2.** Percentage of Students' Misconceptions for each Sub Material

According to Figure 2, the largest percentage of misconceptions of students in XI Science 1 is in the sub-surface area of 41%. While the smallest percentage of misconception is the sub-material concentration of 16%. While the temperature and catalyst sub material students of class XI Science 1 experienced misconceptions of 19% and 24%.

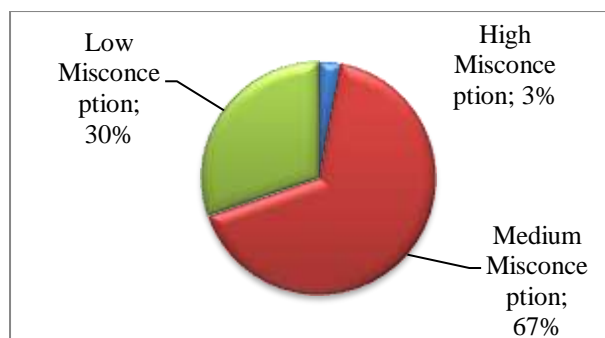
Students' conception categorized according to the percentage value of their misconceptions ranging from high misconceptions, moderate misconceptions and low misconceptions as in Table 2 below.

**Table 2.** Recapitulation of Percentage of Conception of Students Based on Sequence of Misconceptions and their Categories

No	Student's name	Conception Percentage (%)			Misconception Category
		UC	MC	NUC	
30	TIR	25	60	15	High
13	LEO	60	40	0	Medium
25	SET	65	35	0	Medium
27	STE	55	35	10	Medium
28	SUR	60	35	5	Medium

No	Student's name	Conception Percentage (%)			Misconception Category
		UC	MC	NUC	
1	ABD	70	30	0	Medium
6	BAY	70	30	0	Medium
11	FAD	65	30	5	Medium
19	PUT	70	30	0	Medium
20	RAH	70	30	0	Medium
29	THO	70	30	0	Medium
4	ALF	75	25	0	Medium
5	ANA	80	20	0	Medium
12	KHA	80	20	0	Medium
14	MAZ	80	20	0	Medium
23	RIK	80	20	0	Medium
33	ZEF	80	20	0	Medium
15	MIA	85	15	0	Medium
16	ALI	85	15	0	Medium
21	RAM	85	15	0	Medium
22	RAT	85	15	0	Medium
24	SEP	85	15	0	Medium
31	YUS	85	15	0	Medium
2	ABR	90	10	0	Low
3	ADH	90	10	0	Low
7	BEL	90	10	0	Low
8	DEL	90	10	0	Low
9	EKA	90	10	0	Low
17	NAD	90	10	0	Low
18	NUR	90	10	0	Low
26	SIS	90	10	0	Low
32	YUV	90	10	0	Low
10	EMA	95	5	0	Low

Based on the recapitulation of misconception categories, the pie chart shown on the Figure 3 below.

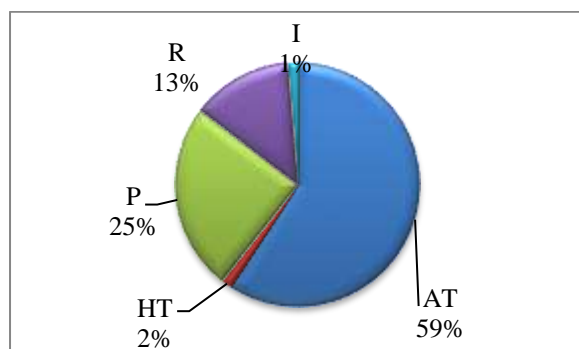


**Figure 3.** Diagram of percentage of students' misconceptions in class XI Science 1

Based on the diagram, only 3% or 1 students categorized as high misconceptions, 67% or 22 students categorized as moderate misconceptions and the remaining 30% or 10 students classified as low misconceptions.

### Causes of Class XI Science 1 Student Misconceptions

The causes of students' misconceptions vary several factors, such as the teacher, learning media, and also from the students themselves. The specific causes of students' misconception which originating from themselves can be vary such as: (1) Associative Thinking (AT), (2) Humanistic Thinking (HT), (3) Preconception (P), (4) Incomplete reasoning (R) and (5) Incorrect intuition (I). Overall, the distribution of causes of misconceptions of XI Science 1 students shown in Figure 4 below.



**Figure 4.** Causes of class XI Science 1 students' misconceptions on the concept of Reaction Rate

Based on Figure 4, the biggest cause of misconception of students comes from associative thinking that is equal to 59%. Associative thinking is a thought that considers a concept the same as another

concept. Students often associate one concept with another concept that actually gives rise to misconceptions. This way of thinking can occur because of the similarity of terms and errors in understanding the relationship between concepts.

## CLOSING

### Conclusion

Students' misconception profiles can be known using instruments that have been developed.

1. The conception profile of students class XI Science 1 on the concept of reaction rate is 78% understood the concept, 21% misconceptions and 1% did not understand the concept.
2. Profile of misconceptions of students of XI Science 1 for each sub-material, which are misconceptions on sub-material concentration of 16%, temperature 19%, surface area 41% and catalyst 24%. A total of 1 students (3%) included in the high misconception category, 22 students (67%) were in the moderate misconception category and 10 students (30%) were in the low misconception category.
3. The biggest cause of misconception of students is due to associative thinking as 59%. Then preconception 25%, incomplete reasoning 13%. The causes of misconceptions from humanistic thinking and incorrect intuition are 2% and 1%, respectively.

### Suggestion

The teacher in the learning process has to emphasizes on sub-surface area material to minimize the potential for misconceptions experienced by students.

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