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IDENTIFICATION OF STUDENT MISCONCEPTION ON REDUCTION-OXIDATION REACTIONS USING THE FOUR TIER DIAGNOSTIC TEST INSTRUMENT

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ABSTRACT

[Identification of Student Misconception on Reduction-Oxidation Reactions using The Four Tier Diagnostic Test Instrument] This research aims to identify students' misconceptions on redox reaction material using the Four Tiers Diagnostics Test. The four tiers/stages are selecting answer, affirmation of the chosen answer, selecting reason of the chosen answer, and the affirmation of the selected reason. The diagnostic was carried out at SMAN (senior high school) 5 Bengkulu. The trial of the diagnostic test was conducted to students of class X MIPA 3 and the misconception diagnostic was conducted to students of X MIPA 2. The results show that the percentage of student misconceptions regarding the redox reaction material was 35% (medium category), while 40% of students understand the concept, and 25% of students do not understand the concept. The highest misconception occurs in the sub-concept of reduction and oxidation reactions (42%), follows by dispropornation and conpropornation reactions, (38%), oxidizing-reducing agents (37%), change in oxidation number from element to compound (24 %)
Keywords: *Four Tier Diagnostic Test, Redox, Misconception*

INTRODUCTION

Students' understanding of concepts in the current curriculum focuses on active, cognitive, and constructive processes carried out in a meaningful learning process. The active learning process directs students to become active agents who choose and interpret a concept based on the student's personal views. The results of students' personal concept construction can be different from experts' concepts, this is based on differences in the initi conception of each student in learning activities [1]

One of the subjects that has a fairly high level of complexity is chemistry, this is because there are some concepts that are quite abstract to understand [2]. One of the class X chemistry concepts that has a high level of difficulty in learning is oxidation-

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reduction reaction material. The difficulty percentage of redox reaction material according to class X MIPA students of SMAN 5 Bengkulu City is 35% compared to other chemical materials such as stoichiometry (21 %), atomic structure (6 %), chemical bonds (19 %) , and electrolyte and non-electrolyte solutions (19 %) . Learning outcomes on redox material which are still low can be seen from Table 1.

Table.1 Average Grade X Chemistry Score at SMAN 5 Bengkulu City FY 2021/2022

Class	Main Material
	Redox
X MIPA 6	52,67
X MIPA 7	65,59

Table 1 shows that the average achievement of students' daily test scores on redox material is still below the minimum criteria of mastering learning, namely 76. Students' difficulties in understanding the redox concept are also in line with the results of an interview with one of the chemistry teachers at SMAN 5 Bengkulu City who stated that, students consider the redox concept difficult because there are several rules for oxidation numbers, so it takes more time to understand it. According to chemistry teachers, students are also unable to learn the concept completely, which can trigger misconceptions.

The possibility of a misunderstanding the concept is also in line with the percentage of class X students of SMAN 5 Bengkulu City who take additional tutoring, which is 40.6%. Diverse learning resources allow the concepts learned to be conveyed by various methods, learning with some of these methods can trigger misconceptions if not properly synchronized by the teacher.

Misconceptions are an important problem because all misconceptions are errors, but not all errors in understanding concepts are misconceptions [3]. The possibility of misconceptions on redox material is triggered by how material is difficult to follow and various learning methods outside classroom that are difficult to synchronize. The misconception can be ascertained by carrying out a diagnostic test. Based on interviews with chemistry subject teachers, diagnostic tests have never been carried out to measure students' conception categories as a whole.

According to [4], a diagnostic test is a test that can be used with the aim of knowing and ascertaining exactly the strengths and weaknesses of students when they learn a concept, so that the results obtained can be used as a reference for follow-up learning improvement. Diagnostic test used as an attempt to see the profile of students' conceptions with the scores produced in the test must be valid and reliable [5].

The diagnostic test that has been considered valid for use is the Four tier diagnostic test , which is a diagnostic test in the form of a four-level multiple choice, where at the first level it is a multiple choice question with several answer choices that are deliberately intended to deceive and one correct answer key, at the second level it contains questions about students' confidence in their answer choices, the third step contains students' reasons for choosing answers and the fourth step is the level of students' confidence in choosing these reasons [6]. The use of the four-tier diagnostic test is considered more effective compared to other diagnostic tests because it can classify students' conception profile categories based on

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the collaboration of answers in each tier [7].

The application of technology can be one of the new efforts that can be made to change learning and tests in learning to be easier, efficient and flexible, without leaving the element of seriousness in the process. One of the applications of technology in carrying out tests on learning is to use sev Socrative application is a type of application that can be used to carry out tests in learning. The selection of the Socrative application in this study is supported by the statement that the Socrative application has the advantage of being an online student response system that makes it easier for teachers to produce a quiz or other educational exercise that can monitor student progress in real time [8].

METHOD

Research design.

The type of this research is quantitative descriptive research. This research describes the misconceptions experienced by class X MIPA students at SMA N 5 Bengkulu City. Meanwhile, in describing the level of analysis of students' misconceptions, the development of an instrument in the form of a four-tier diagnostic test is carried out first, in which the development of this instrument uses the Plomp model.

The population in this study were students of class X MIPA 1- X MIPA 4 at SMAN 5 Bengkulu City for the 2022/2023 academic year. The sample of this study were members of class X MIPA 2 and X MIPA 3 at SMAN 5 Bengkulu City. The sampling technique is random sampling, or all individuals are given the same opportunity to be selected as sample members [9]. This research was conducted at SMAN 5 Kota on May 22 - May 30, 2023, in class X MIPA SMAN 5 Bengkulu City for the 2022/2023 academic year, even semester.

The instruments used in this study were the four tier diagnostic test and an expert validation sheet regarding the suitability of the instrument in terms of content, construct, and language. The instrument was assisted by Socrative application.

Data collection and analysis technique

The data collection technique used in this research consisted of a diagnostic test using four tier diagnostic test questions. As well as collecting non-test data in the form of interviews. Test the validity of the test instrument using a scale of 1-3 according to the validation scale according to Sugiyono. Validation of the test instrument per item is calculated using equation (1)

$$\overline{X}=\frac{\sum X}{N} \quad (1)$$

$\overline{X}$= Average score of item validation
$\sum X$= total number of item scores from all validators
N = number of validators

The results of the calculations obtained will be grouped by category according to Table 2.

Table 2 . Classification of Validation Results

Average Score (X)	Category
$X \geq 2.34$	Valid
$1.67 < X < 2.34$	Less Valid
$X \geq 1.67$	Invalid

Instrument questions that have been developed and declared valid will then be revised based on suggestions from expert validators. The next step is to carry out trials that will produce empirical data as a basis for empirically analyzing the feasibility of the instrument. The feasibility analysis carried out is a validity test, reliability test of the questions, test of the level of difficulty of the questions, test of the

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distinguishing power of the questions and analysis of distractors on the questions.

The results of the diagnostic tests that have been obtained can distinguish between students who experience misconceptions, negative misconceptions, positive misconceptions, do not understand concepts and students who experience conceptual understanding [10]. As for the combination of answers on Four tier diagnostic test can be seen in accordance with Table 3. The percentage value of misconceptions can be categorized based on the criteria in accordance with Table 4.

Table 3. Combination of Student Answers to Diagnostic Test Questions

Combination Answers				Category
Tier I	Tier II	Tier III	Tier IV	
T	S	T	S	U
T	S	T	NS	DU
T	NS	T	S	DU
T	NS	T	NS	DU
T	S	W	S	PM
T	S	W	NS	DU
T	NS	W	S	DU
T	NS	W	NS	DU
W	S	T	S	NM
W	S	T	NS	DU
W	NS	T	S	DU
W	NS	T	NS	DU
W	S	W	S	M
W	S	W	NS	DU
W	NS	W	S	DU
W	NS	W	NS	DU

S = wrong; B= True; Y = Sure; TY= Not sure PK = Understand the concept; BPK = Don't understand the concept; M = Misconceptions MP = Positive Misconceptions; MN = Negative Misconceptions

Table 4 . Percentage of Misconceptions

Misconception Percentage Range (%)	Category
0< Misconceptions ≤ 30	Low
30 < Misconceptions ≤ 60	Currently
60 < Misconceptions ≤ 100	Tall

RESULT AND DISCUSSION

Expert validation of the Four Tier Diagnostic Test instrument was carried out by a lecturer from the chemistry education study program, Faculty of Teacher Training and Education, Bengkulu University and one of the chemistry subject teachers at SMAN 5, Bengkulu City. Expert validator assessments for Four tier diagnostic instruments are in place in the range 2.38 – 3, meaning that all question items are categorized as valid because they have an average rating above 2.34 according to the data interpretation formula used.

eral types of websites and applications. The instrument trial was carried out in class X MIPA 3 SMAN 5 Bengkulu City with a total of 34 students taking the test. The purpose of conducting trials is to determine the suitability of the question items in terms of empirical data. The number of questions applied at the trial stage was 16 questions with a processing time of 50 minutes. The results of the analysis of the feasibility aspects of the instrument can be seen in Table 5.

The reliability test on this question item assisted by the SPSS application produced a Cronbach ' alpha value of 0.727 and was included in the high reliability category. The empirical validity and reliability of good question items can be influenced by several factors, namely question items that are developed in accordance with development procedures, question items that are developed in accordance with the sub-material whose misconceptions will be measured, question items that have been content validated, and empirical testing of questions on students is carried out. in earnest [11]. In the analysis of the differentiating power test, there were 3

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questions in the poor category with differentiating power criteria below 0.20. The discriminating power of questions that are low or in the poor category can still be used, this is because diagnostic tests are not to differentiate students' abilities but to find out whether the learning material has been understood well by students or not.

The results of the trial on the questions resulted in 12 questions which were continued as the Four Tier Diagnostic Test instrument to identify misconceptions in redox material. The questions that were not used were questions 5, 7, 8 and 10 which did not meet the valid category on empirical validity and questions 7 and 10 which had distractors that could not be used.

Table 5. Results of Question Item Analysis

No	Aspect	Category	Number	Amount
1	Validity	Valid	1; 2; 3; 4; 6; 9; 11; 12; 13; 14; 15; 16	12
		Invalid	5; 7; 8; 10	4
2	Difficulty Level	Currently	4; 5; 6; 7; 8; 11; 12; 13; 14; 15; 16	12
		Easy	1; 2; 3;	3
		Hard	9	1
3	Differentiating Power	Very good	9; 10	2
		Good	1; 4; 6; 12; 13; 14; 15; 16	8
		Enough	2; 8; 11	3
		Bad	3; 5; 7	3
4	Distractor	Used	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16	14
		Not used	7;10	2

Implementation was carried out in class X MIPA 2 SMAN 5 Bengkulu City with 30 students taking the test. The test process was assisted by using the Socrative application which students can access online. The implementation of the test with the Socrative application runs directly and in one direction, so that students cannot change the answers that have been answered. The time allocation used for the diagnostic test is 50 minutes.

Students' misconception profiles can be identified based on a combination of students' answers when answering test questions based on a combination of student answers. The percentage results of students' conception profiles from the four tier diagnostic tests that have been implemented can be seen in Figure 1.

Based on Figure 1 is known that the overall percentage of students who experience an overall misconception is 35% which is categorized as a moderate level of misconception. Students who experience misconceptions are situations where students believe a concept is wrong, this is experienced by more students compared to students who still do not understand the concept. Students who do not understand the concept as much as 25%, which shows that students do not believe in the concepts being studied, so there is still a chance to understand the concept correctly. Students who have understood the meaning of the concept can answer questions correctly and believe that they get the highest percentage, namely 40%.

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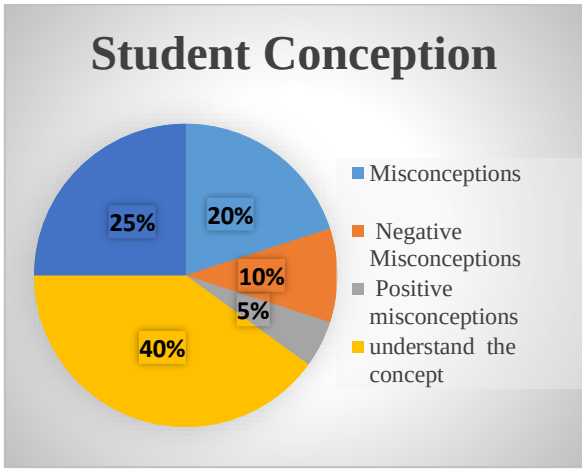

Figure 1. Percentage of Student Conception

The students' highest misconceptions are in the sub-concept of reduction and oxidation reactions (Table 6). Mistakes in distinguishing between the concepts of reduction and oxidation reactions based on the release and binding of electrons are the factors causing students to choose the wrong answer. The results of student interviews stated that the redox concept taught focused more on the binding and release of oxygen than on the acceptance and release of electrons, so that students tended to think more of the same between redox concepts based on oxygen and electrons. Misconceptions in the sub-concept of oxidizers, reductants are caused by students who mostly answer" reductors are only found in one of two reactions when there should be two reductants in two reactions". The reasons mentioned by students also incorrectly interpret reductants as species that experience a decrease in oxidation number and reduce other compounds. The same error also occurs in the question of oxidizing agents.

Misconceptions in the sub-concepts of disproportionation and comproportionation reactions. Most students' answers to questions about auto redox or disproportionation reactions are oxidation reactions or an increase in the oxidation number, with the reason that they adjust, namely stating that an auto redox reaction is a reaction that experiences an increase in the oxidation number. The results of student interviews stated that they tended to be mistaken in determining the oxidation number so that they identified the reaction presented in the question as only experiencing an increase in the oxidation number. Misconceptions in the sub-concept of oxidation numbers occur because students still assume the number of oxidation numbers is zero in ionic compounds. The results of student interviews stated that they were not yet fully able to understand the difference between reduction and oxidation reactions based on oxidation numbers, so they believed in the concepts that came to mind when taking the test spontaneously.

The results of student interviews stated that there were several factors that caused misconceptions among students. One of the possible student misconceptions is student preconceptions, this is based on several concepts that must be mastered well before students learn a new concept. The prerequisite concepts in redox material are several previously studied concepts, such as the concepts of the periodic system of elements, chemical bonds, and simple reaction equations [12]. Based on the results of student interviews, students stated that they would tend to memorize concepts that they did not understand, this could possibly come from an incomplete understanding of prerequisite concepts which made students' conceptions unable to continue well which could trigger the emergence of misconceptions in students.

Factors that cause other misconceptions that are known from the results of interviews include learning

methods that are not adapted to the learning material to be studied, the results

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of student interviews state that teachers tend to convey material contained in textbooks only. More complex redox concepts require a variety of learning methods to support student understanding of concepts well. Another external factor is a variety of learning resources that are not well synchronized . The causes of the misconceptions described above can vary according to the condition of a sample being diagnosed. Misconceptions are caused by five major groups namely students, teachers, textbooks, context, and teaching methods.

Table 6. Categories of Misconceptions of Question items

Sub-Concepts	Question Number	Misconceptions Category (%)
The concept of reduction and oxidation reactions	1	46.6%
	2	63.3%
	3	16.6%
Average		42%
Change in the oxidation number of an element in a compound or polyatomic ion	4	43.4%
	5	13.2%
	6	16.6%
Average		24%
Oxidizing agents, reducing agents , and the products of reduction and oxidation	7	46.6%
	8	29.9 %
	9	39.9%
	10	20%
Average		38%
Disproportionation and conproportionation reactions	11	33.2%
	12	39.9%
Average		37%

CONCLUSION

Four tier diagnostic test instrument for redox reaction material that was developed with 16 questions was declared valid with revision by an expert validator. Empirical data was obtained from the test results, namely that there were 12 valid questions and 4 invalid questions.

The redox sub-concept consisting of the reduction and oxidation reaction sub-concept at 42%, the oxidizer and reductant sub-concept at 38%, the disproportionation and conproportionation reaction sub-concept at 37%, and the oxidation number sub-concept had the lowest misconception profile which is 24%.

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