Instrument Design Of Remedy Test Assisted By Multiple Representations Using Computer-Based Test Model On Redox Materials

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Abstract. This study discusses the mastery of students' learning outcomes who join the remedy program using the test instruments based on multiple representations arranged in Computer-based Test (CBT) model.CBT used in this study using the Beesmart application. The multiple representations studied include three levels of representation, namely macroscopic, microscopic, and symbolic on redox learning. Research subjects are 100 students of X grade of natural science class in MAN 2 Semarang (Islamic senior high school 2 Semarang). The test instrument was validated by 3 instrument experts with a mean score of 38.7 from a maximum score of 44, and 2 media experts obtained a mean score of 24.5 with a maximum score of 32 with a decent category tested. The level of completeness of student learning outcomes who join the remedy program is calculated using the percentage of mastery. The results showed that the level of ability of students' learning outcomes that followed remedy was 83%.

1. Introduction

Chemistry is a field of study which is part of natural science. One of its discussion coverage is an interaction between atoms that make the explanation tends to be abstract [1]. In addition to its abstract characteristic, concepts in Chemistry also include mathematical calculation so that it needs a mathematics skill to complete chemical problems [2]. Based on Gilbert research that the discussed various issues which frequently happen during the process of teaching and learning chemistry [3]. The problems are the abundant chemistry materials which load diverse representations and the process of delivering chemical concepts at school, which was opposing the fact on the field.

Based on the observation result in MAN 2 Semarang, chemistry materials taught at school only covered some concepts which are concrete (macroscopic), for example through the experiment of burning wood, which turns into charcoal. Students know the process of burning wood is an example of an oxidation reaction. Students will be confused if asked to write a reaction or are asked to describe interactions between molecules in the oxidation reaction. Students were not accustomed to expressing

a macroscopic phenomenon from an experiential practice into a microscopic phenomenon which could be represented by a pictorial visualization or symbols.

There were several types of research which had been done previously, which also revealed that students were still finding difficulties in understanding macroscopic representation into microscopic and symbolic representation [4-10]. Johnstone believed that difficulties which are frequently faced by students in learning chemistry are combining the three level of chemical representations consisting of macroscopic, microscopic, and symbolic [6-10]. Chemistry concepts understood by the students had not been overcome yet if they were not skillful enough in doing the mathematical calculation. The problems of students' transforming chemical representation level aforesaid were caused by the multiple-representation based teaching of chemistry, which has not been taught yet to students at school [7-11]. Thus, it can be concluded that chemistry teaching and learning should be taught by using multiple representation models so that students could thoroughly understand the materials.

Multiple representations is a chemical representation which covers several aspects such as macroscopic, microscopic, symbolic, and mathematics [2,3,6-10]. Kozma defined multiple representations as a kind of representation which combines text, picture, or graphics. Through multiple representation learning, it is expected to assist the students in understanding chemistry concepts from the four levels of representations, either macroscopic, microscopic, symbolic, or mathematics level [12].

Macroscopic is a chemical representation which is acquired from real experience or experiment [13]. The evident form of macroscopic representation can be what we can see, touch, and feel [6]. On the other hand, microscopic is defined as a chemical representation in the form of visualization of an atom, ion, molecule in a chemical reaction [14]. The existence of microscopic representation is expected to give a complete description of a chemical reaction [15].

Talanquer defined symbolic representation as a chemical representation which comprises the symbol itself or icon as a medium to describe the symbol of the atom, characteristics, phase, and the equation of chemical reaction [16]. Symbolic description in an instrument was expressed through written symbols of unsure, compound, substance phase, graphics and table representation, as well as the written chemical reaction, which is equal. The next representation level is a mathematical representation. Mathematical representation is defined as a representation which covers a chemical calculation. Mathematical calculation represented in chemistry benefits the understanding of the basic concept of chemistry in problem-solving [2].

Chemistry concepts which are based on multiple representations can be implemented appropriately in the teaching and learning process as well as in the evaluation of students' learning result. Profile of students' multiple-representation skill can be measured by using an instrument of the multiple-representation based chemistry test. The instrument being arranged should meet valid criteria that can have absolute measurement when measuring things that are wanted to be measured and to be reliable (consistent or stable) in assessing what should be assessed [17]. Multiple-representation based chemistry test aimed to make the test being arranged represents the four chemical representations level, i.e., macroscopic, microscopic, symbolic, and mathematics.

The students' inability to connect the levels of representation makes students often encounter conceptual errors which result in the low learning outcomes. Based on the observation results in MAN 2 Semarang, students who achieve the mastery of learning outcomes in the redox materials are 54%. Students with low learning outcomes should join remedy to achieve the mastery of learning outcomes. The remedy conducted in MAN 2 Semarang employs the method of repeating the test without reinforcing the concept so that often there is no increase in the learning outcomes. Moreover, the remedy is not structured, or only giving the questions to have it finished at home because of the time constraints, so that the remedial program is less effective. Remedial learning should be used as an additional effort to overcome and help students who have not achieved learning mastery.

The current remedial test is in the form of a PBT (Paper-Based Test). The remedial test in the form of PBT takes a longer time to check if the checking of test results is conducted only by one person. An alternative to the problem is by using the remedial test based on CBT (Computer-based Test). CBT is

a method of presenting a test so that the students' response to the test can be saved and analyzed electronically as well as used widely. In other words, the Computer-based Test is conducted using the help of computer software [18].

2. Methods

This research used a quantitative descriptive research design. The subjects of this study were 100 students who joined the remedial program in MAN 2 Semarang. The mastery level of students' learning outcomes was measured using the test instruments based on multiple representations, which were proved valid and reliable. The test instruments consist of 20 multiple choice items (two-tier test) because of the medium difficulty level. The analysis of instruments feasibility was measured using the ideal assessment criteria presented in Table 1.

Table 1. Ideal criteria of profile assessment

No.	Score Range	Category
1	$\vec{X}_i + 1{,}8\ SB_i < X$	Very feasible
2	$\vec{X}_i + 0{,}6\ SB_i < X \leq \vec{X}_i + 1{,}8\ SB_i$	Feasible
3	$\vec{X}_i - 0{,}6\ SB_i < X \leq \vec{X}_i + 0{,}6\ SB_i$	Rather feasible
4	$\vec{X}_i - 1{,}8\ SB_i < X \leq \vec{X}_i - 0{,}6\ SB_i$	Less feasible
5	$X \leq \vec{X}_i - 1{,}8\ SB_i$	Not feasible

3. Result and Discussion

The remedial test instruments with the CBT model used before are validated by the expert with the feasible category. The recapitulation results of instruments validation meet the feasible criteria for each assessment item with the minimum score 1 and the maximum score 4 obtain the average score 38.7 out of the maximum score 44 which shows that the response is good and the questions are feasible to use. The remedial test media, which is arranged in the CBT model based on the validation results obtains the score 24.5 out of the maximum score 32, which shows that CBT media is feasible to use. The feasibility of remedial test instruments with the CBT model gains a positive response from the Reviewer. The review from the Reviewer on the remedial test instruments with the CBT model is presented in Table 2.

Table 2. Review from the reviewer based on feasibility aspects

The Feasibility Aspects	Feasibility Percentage (%)	Category
Test display	86	Very high
Image clarity	83	High
Language use	82	High
Materials suitability	91	Very high
Test model suitability	85	Very high
Usage guidelines	79	High
Test practicality	87	Very high
Accuracy of measurement	81	High

The mastery of students' learning outcomes that join remedy is measured using mastery percentage and calculated classically with the average percentage of 83%. The chart of the increase in the mastery of students' learning outcomes classically is presented in Figure 1.

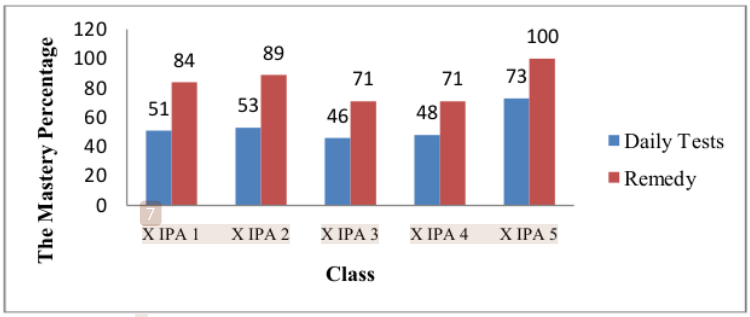
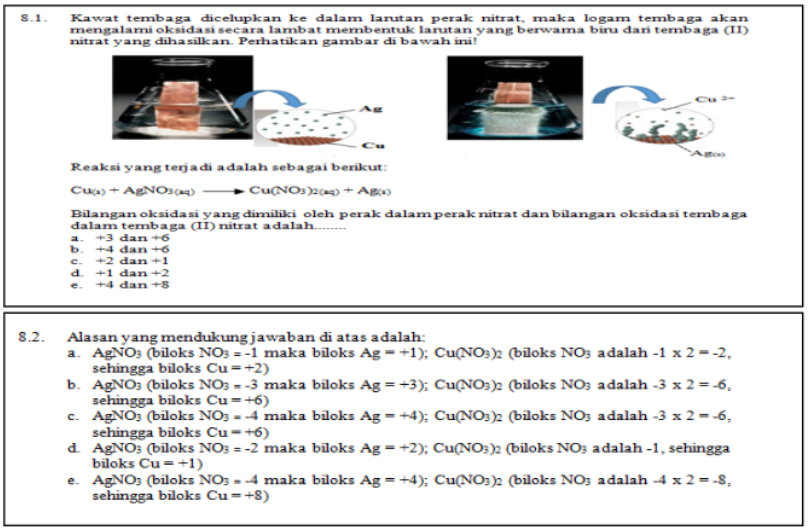


Figure 1. The mastery percentage of students' learning outcomes

The discussion of this research includes 2 phases, and they are the remedial test instruments based on multiple representations with the CBT model and the mastery of students' learning outcomes that join the remedial program. The design of remedial test instruments based on multiple representations involves three aspects of representation, *i.e.,* macroscopic, microscopic, and symbolic. The CBT media used *Beesmart* application. The mastery of students' learning outcomes is calculated using mastery percentage.

3.1. Remedial Test Instruments Based on Multiple Representations with CBT Model

The remedial test instruments used in measuring the mastery of students' learning outcomes are in the form of multiple choice tests because of (two-tier test) for redox materials based on multiple representations. The redox materials are selected because it contains chemistry representation macroscopic, microscopic, and symbolic. The example of test instruments used is presented in Figure 2, and CBT design presented in Figure 3.



8.1. Kawat tembaga dicelupkan ke dalam larutan perak nitrat, maka logam tembaga akan mengalami oksidasi secara lambat membentuk larutan yang berwarna biru dari tembaga (II) nitrat yang dihasilkan. Perhatikan gambar di bawah ini!

Reaksi yang terjadi adalah sebagai berikut:

$Cu_{(s)} + AgNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + Ag_{(s)}$

Bilangan oksidasi yang dimiliki oleh perak dalam perak nitrat dan bilangan oksidasi tembaga dalam tembaga (II) nitrat adalah.....

a. +3 dan +6
b. +4 dan +6
c. +2 dan +1
d. +1 dan +2
e. +4 dan +8

8.2. Alasan yang mendukung jawaban di atas adalah:

a. $AgNO_3$ (biloks NO_3 = -1 maka biloks Ag = +1); $Cu(NO_3)_2$ (biloks NO_3 adalah -1 x 2 = -2, sehingga biloks Cu = +2)
b. $AgNO_3$ (biloks NO_3 = -3 maka biloks Ag = +3); $Cu(NO_3)_2$ (biloks NO_3 adalah -3 x 2 = -6, sehingga biloks Cu = +6)
c. $AgNO_3$ (biloks NO_3 = -4 maka biloks Ag = +4); $Cu(NO_3)_2$ (biloks NO_3 adalah -3 x 2 = -6, sehingga biloks Cu = +6)
d. $AgNO_3$ (biloks NO_3 = -2 maka biloks Ag = +2); $Cu(NO_3)_2$ (biloks NO_3 adalah -1, sehingga biloks Cu = +1)
e. $AgNO_3$ (biloks NO_3 = -4 maka biloks Ag = +4); $Cu(NO_3)_2$ (biloks NO_3 adalah -4 x 2 = -8, sehingga biloks Cu = +8)

Figure 2. The example of test instruments used

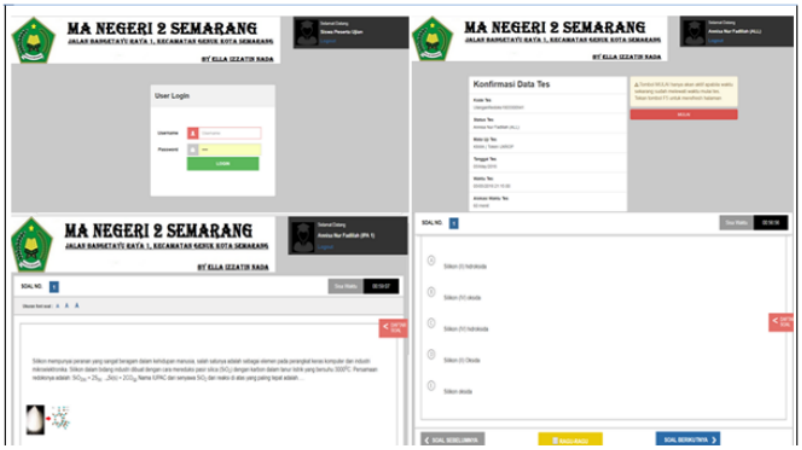


Figure 3. CBT design

3.2. The Mastery of Students' Learning Outcomes

This study is conducted to analyze the mastery percentage of students' learning outcomes who join the remedial program of redox materials. Based on the results of the analysis, mastery has a relationship with students' conceptual understanding; mastery is in line with students' conceptual understanding, the more the number of students who achieve the mastery, the more the number of students who understand the concept. It is supported by the statement of Oluwatosin that in general, students' conceptual understanding is presented in their mastery [19]. A student is considered a master if the student's scores in all test indicators achieve ≥ 75. The percentage of students who meet the mastery in redox quiz is 54%, while the percentage of students who have not to meet the mastery is 46%, it means that most of the students have not understood the concept. The occurrence of conceptual misunderstanding is because the concepts underlying redox materials are not understood by the students well and correctly so that the students tend to have difficulties in understanding the next concepts. This is in line with one of the chemistry characteristics mentioned by Chandrasegaran et al. (2007) that the chemistry concept is sequential and tired so that students encounter difficulties which result in the misunderstanding of connecting knowledge [20]. The results of the analysis are in line with the research conducted by Li and Arshad who stated that the chemistry representation of grade 10 students in Kuala Lumpur is considered low because the majority of students find it difficult to link the chemistry concept of redox materials at the representation level [13].

Ainsworth stated that chemistry learning based on multiple representations could be applied both in the learning and in the evaluation of students' learning outcomes [21]. The concept of multiple representations applied in the evaluation of chemistry learning can be realized through the test based on multiple representations. The remedial test for students who do not meet the mastery can use the test instruments based on multiple representations, and this is because the test provides easiness for students to understand the abstract concept in chemistry. It is in line with the research by Talanquer that the learning using multiple representations is more effective in developing the model for students' mental, where the students with low ability will be able to compete with the students with high or medium ability [16]. The test will be more effective and efficient if conducted using CBT model. The advantage of the test using CBT is the practicality both in arranging and checking. Also, the test can be performed anytime and anywhere because the test does not depend on time [22]. The remedial program is not conducted recently because of the time constraints so that it is only conducted the re-test with the same questions is less effective in increasing the percentage of students' mastery. The

cognitive assessment based on multiple representations with CBT can be an alternative for the remedial program. Based on the study results, classical mastery tends to increase up to 83%.

4. Conclusion

Based on the study results, it can be concluded that the mastery of students' learning outcomes tends to increase up to 83%. The instruments of the remedial test used are the instruments of the remedial test based on multiple representations which contain macroscopic, microscopic, and symbolic aspects. The test instruments consist of 20 test items with the reason (two-tier test). The test instruments are arranged in the CBT model to make the remedial program more effective and efficient because the remedial test is not conducted recently because of the time constraints.

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