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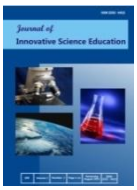

Instrument Design Diagnostic Test Three-Tier Multiple Choice Redox Material with Redox Diagnostic Test Software (RDT)

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Abstract

This study aims to design a diagnostic test instrument misconceptions of Reduction and Oxidation reaction (redox) methods of Three-Tier Multiple Choice by developing Redox Diagnostic Test (RDT) software. The use of RDT can produce diagnostic test results of students' understanding immediately after the process of testing work. The understanding profiles experienced by the students in each class can be automatically captured so that the understanding of students' understanding time becomes shorter than the manual way. Although the testing work is done online, students cannot access the software outside the school computer lab so as to avoid the student dishonesty in the test. The research method used is Research and Development (R & D). The research model adopted in the Four-D development model with the research stage that is, define, design, develop, and dissemination. The result of content validation gets a score of 47 is on a very feasible criterion, so also media validation get score 28,5 is at very reasonable criteria. The results of the analysis of the level of understanding show that the test instrument using RDT software can diagnose understanding students well. Based on the small and large scale test set 19 item questions used in the test instrument. The result of instruments reliability test on the large-scale test by using KR-21 formula is 0,72 which belongs to a good category.

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INTRODUCTION

The development of science and technology should be utilized in various fields of life, including in the field of education. The process of education can take advantage of technology in achieving its goals. Technology provides convenience ranging from learning plans, learning process to the evaluation of learning. In addition, technology can also be one solution in the learning process time efficiency. One of the utilization of computer technology in learning is as an instrument for the assessment of student learning outcomes in the form of tests, known as Computer Based Test (CBT) system. The CBT system can also be used to diagnose misconceptions in students more quickly.

CBT is the use of the computer in the test and assessment of learning outcomes of students (Bull & McKenna, 2004). In other words, computer-based tests are carried out using the help of computer software. Along with the development and advancement of educational technology than found a new format of the computer-assisted exam (Balan et al., 2017). Students will be able to know the test results quickly, while the teacher will not have trouble in correcting and giving feedback to each student because all analysis activities have been done by the system (Salma et al., 2016). Riley & Carle (2012) concluded that CBT provides several advantages over the execution of tests with paper and pencil test models such as automatic scoring system and reducing the burden of respondents or test participants because it is easier to do the questions in the form of a computer-based test than the paper pencil test.

Balan et al. (2017) produce a valid, effective and effective Adobe flash CBT-based CBT system for Vocational High School learning. Ardiansayah & Bahriah (2016) indicates that Microsoft Office Excell is one software that can be used to diagnose misconception on students well. The study will develop Redox Diagnostic Test (RDT) software to diagnose misconceptions.

Tayubi (2005) conveyed that misconception is a conception or cognitive structure that is firmly and firmly attached to the minds of students who are in fact deviating from the conceptions advanced by the experts, which can mislead the students in understanding the scientific phenomenon. The misconception is a student's understanding of different scientific concepts with scientifically accepted concepts (Irsyad et al., 2018; Kirbulut & Geban, 2014).

Chemistry is one of the subjects that have abstract concepts, meaning that can not be directly seen by the visible. This requires visualizing the concept and explanation of the submicroscopic process. Chemical materials that often cause misconceptions are chemical bonding, chemical equilibrium, and oxidation-reduction reactions (Barke et al., 2009).

The subject of oxidation-reduction reactions (redox) is a material that is considered difficult for students. Redox reactions are one of the basic chemical materials with abstract concepts such as the concept of redox reactions based on electron transfer, the process of release and acceptance of electrons that can not be seen with the eye but can only be imagined. In this oxidation-reduction reaction, there is a connection between concepts, for example in determining redox reactions students need to understand the concept of determining the oxidation number. This can lead to misconceptions of students in understanding the concepts of redox reactions.

The results of Hono et al. (2014), which aims to evaluate (prevent) the occurrence of misconceptions of class X high school students, especially on the concept of redox reactions indicates that all concepts in redox reaction material potentially cause misconceptions. Among them on the concept of redox reaction in terms of electron changes, oxidation numbers, redox reactions in terms of oxidation numbers, and nomenclature of inorganic compounds according to reviews of oxidation numbers. The Hastuti (2014) study aimed at reducing the misconceptions of students on the concept of redox reactions using the ECIRR model also indicates a misconception of the overall concept of redox reactions and to all students following the Three-Tier Multiple Choice diagnostic test.

Based on previous studies, this study used all the indicators on redox reaction material.

Misconceptions in chemistry lessons will be fatal because chemical concepts are interrelated with each other, so the concept's mistakes at the beginning of the lesson will have an effect on later learning, this will lead to low-ability students and not complete learning (Nazar et al., 2010).

Several previous studies to find out the understanding of students include using interview methods (BouJaoude, 1991; Preston, 1992), concept maps (Rich, 2008; Ingeç, 2009), Two-Tier Multiple Choice diagnostic tests (Tan et al., 2002) , test him a gnostic Three-Tier Multiple Choice (Gurel et al., 2015; Milenković et al., 2016) and Four-Tier Multiple Choice (Sreenivasulu & Subramaniam, 2013; Gurel et al., 2015). This research will design diagnostic test instruments misconception of Three-Tier Multiple Choice methods with CBT system using Redox Diagnostic Test (RDT) software.

METHODS

The design of this study is using Research and Development (R & D) method. The research model adopts the 4-D (Four-D) development model with the research stage, define, design, develop, and disseminate. The steps taken in the define stage is the collection and analysis of information in the form of interviews of chemistry subject teachers in SMAN 1 Mandirancan, SMAN 1 Cilimus, SMAN 1 Pasawahan and SMA PUI Ciwedus located in Kuningan regency of West Java. Next Competence Analysis of Core and Competence Basic redox reaction material as a reference for making the item.

The steps taken in the design phase is to design a grid problem, designing items about Three Tier Multiple Choice, and designing software RDT. Analysis of the misconceptions of students based on answers to the concepts asked reasons and levels of confidence of students that refers to the research Arslan et al. (2012) can be seen in Table 1.

Table 1. Analysis of Three Tier Multiple Choice Diagnostic Test Results

First tier	Second tier	Third tier	Categories
Correct	Correct	Certain	Scientific knowledge
Correct	Incorrect	Certain	Misconception (false positive)
Incorrect	Correct	Certain	Misconception (false negative)
Incorrect	Incorrect	Certain	Misconception
Correct	Correct	Uncertain	Lucky guess, lack of confidence
Correct	Incorrect	Uncertain	Lack of knowledge
Incorrect	Correct	Uncertain	Lack of knowledge
Incorrect	Incorrect	Uncertain	Lack of knowledge

The steps taken in the develop resistance are:

Validation by experts

Validation is a validation of content and software. Content validation is done to determine the suitability between the items that have been developed with the target concept. The item is said to be "appropriate" if the item correctly developed can detect misconceptions. Validation of content is done by experts in the field, namely experts who are lecturers of chemistry education and chemistry subject teachers. Media validation aims to determine the feasibility of software developed to detect misconceptions. Validation of software is done by experts in the field, namely experts who are lecturers of Information Technology Learning courses IPA and ICT subject teachers.

Small-scale test

Small-scale trials aim to know the application of research instruments before they are tested on a larger scale and gain input from the use of instruments to correct deficiencies in all instrument components. Items that have been validly tested on students to determine the value of reliability. Problems tested amounted to 27 questions with 35 students as test subjects. After the instrument test, the revision of the instrument referring on assessment results and analysis results during the small-scale test.

Large-scale trial

A large-scale trial aims to determine the extent to which the Three Tier Multiple Choice diagnostic test instrument developed using RDT software can be used to detect misconceptions found in students. Large-scale test using as many as 108 students who become subjects try. This test is performed on students who have received redox reaction material. Large-scale trials are also used to analyze the reliability of the instrument. Subsequently revised and obtained the final product of the Three-Tier Multiple Choice diagnostic test instrument developed using RDT software.

The dissemination stage aims to inform the diagnostic test instrument product of the Three-Tier Multiple Choice methods with the CBT system using RDT software on the redox reaction material to the public so that it can be used as comparative information from several methods to detect misconceptions in the student. The spread of this instrument is done by making an article published in the journal.

RESULTS AND DISCUSSION

Stage Define

The results obtained from the interviews of chemistry teachers of high school class X SMA in SMAN 1 Mandirancan, SMAN 1 Cilimus, SMAN 1 Pasawahan and SMA PUI Ciwedus District Kuningan West Java. The respondents said students have difficulty in understanding redox material (100%); 100% of respondents stated that the concept is difficult to understand students is in determining the oxidation number, 80% of respondents said the determination of the oxidizing agents and determine the redox reaction is also a concept that is difficult to understand students. The respondents stated that the cause of understanding difficulties is lack of mathematical mastery and lack of exercise questions (60%); 80% of respondents had never conducted diagnostic tests of students' comprehension and 60% of respondents stated that the constraint in diagnostic tests was limited time availability with large bill of materials, 40% of respondents stated that the diagnostic test required a long analysis time.

The results of data collection daily test redox reactions of 2017/2018 school year in 4 schools, there are 44.35% of students complete in the daily test of redox reactions. This means that 55.65% of students have not been completed in the four schools above. This information gathering and analysis step demonstrate the need for diagnostic tests on students because of difficulties in understanding the concepts of redox reactions and using the right instrument due to limited time problems in the process of chemistry class X high school. One alternative solution is to use computer-based diagnostic test instruments.

The following is a syllabus analysis which includes Core Competence and Basic Competence of redox reaction material as reference for making the item. Syllabus analysis yielded 13 indicators on the redox reaction material to be used as a reference in the design of the test lattice grid.

Stage Design

Designing a grid of questions

Preparation of the lattice problem refers to the indicator items that have been established based on the results of syllabus analysis and conceptual understanding indicators. This study produces a grid of problems based on indicators of achievement of competence and grid problems based on indicators of conceptual understanding. Grid problems based on indicators of achievement of competence

contains basic competencies, indicators, number of questions, number of questions and cognitive level. This study assigned 27 spreading questions to 2 or 3 items in each indicator with cognitive level C2, C3, and C4. The grid problem based on the conceptual understanding indicator contains the conceptual understanding indicator, the number of questions and the number of questions. The items that have been set in the grid of questions based on the indicators of competency achievement are designed to spread on each concept indicator grid consisting of 7 indicators of understanding.

Designing items about Three Tier Multiple Choice

The items that were successfully formulated to diagnose the students' understanding of the class X redox reaction material of SMA 27 items using the Three Tier Multiple Choice models. Each item consists of three steps. The first step contains 5 choices answer questions, the second step contains 5 choices of reasons from the first step answer and the third step contains confidence in determining the answer and the reason for the answer in the first and second step.

Designing RDT software

Figure 1 shows the initial display that will appear when the RDT software is started. The initial view contains two choices of space, namely the teacher room and student room. For students who will do diagnostic tests, the comprehension should enter the student room by clicking on the student room option.

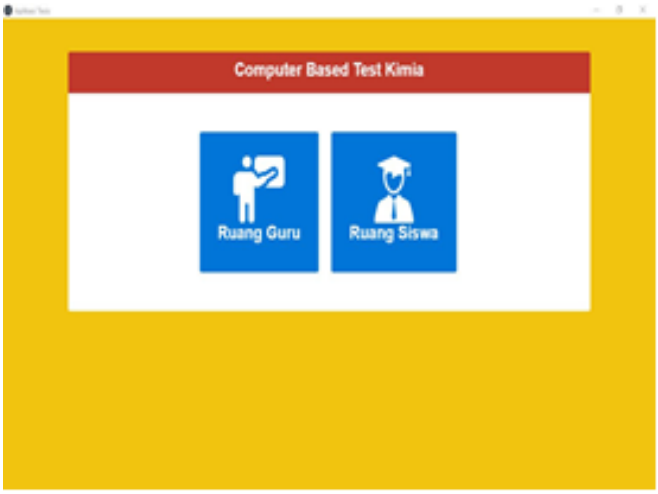

Figure 1. Initial view on RDT

After the choice of student space is clicked, will show instructions workmanship that must be considered students during the test. Students who will do the test must fill in the name and class identity first. Figure 2 shows the display of the identity of the student who will perform the test.

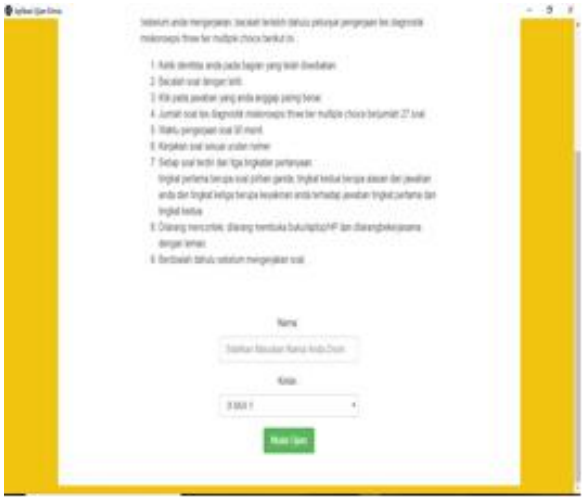

Figure 2. Display identity of the students

Click start, will show matter number one. Figures 3 and 4 illustrate the display of RDT diagnostic tests on question number 21. The available items do not all use picture-dependent purposes for the purpose of making each item. After reading the question and selecting the correct answer by clicking the provided section, will show the choice of reason from the answer. After clicking the reason that is considered correct, will display a choice of beliefs, then students can click to continue to the next number.

Figure 3. The appearance of item number 21

Figure 4. Advanced view of item 21

And so on until the question number 27. In each question, there is a choice back to home to repeat the input of the student's data if there is an input error of the student's identity. On question number 27, click continue. All student answer data will be exported in excel application and can be seen directly. Click back to home to start entering the student room again.

Teachers / Admin can open the app after copying the application into the computer to be cultivated. The first step teacher/admin open the RDT application by clicking the teacher room will display the form field user and password. Type user and password in the fields that have been available, click login. Will appear data menu problem, plus problem and data result. The question data contains all the questions that have been input into the application. Add a question containing the form field to add an existing matter. The result data contains a recap of all the student's answer data in the student room.

The design of RDT software aims to overcome the limited time problem in the process of learning chemistry class X SMA and the problem of the length of time required to analyze the results of diagnostic tests manually. RDT software is designed so that diagnostic tests of students' understanding can be seen immediately after the students complete the test. Teachers can also automatically reconcile the understanding profiles experienced by students in each class so that the students' understanding comprehension time becomes shorter than the manual way. The results of a diagnostic test of students are exported to Microsoft Office Excel software so that data can be processed more easily. The data export process of Microsoft Office Excel software can be seen in Figure 5.

Figure 5. Display data recap on RDT

This RDT software uses the PHP programming language and is connected to the internet network. Test work is done online, but students cannot access the software outside the specified school computer laboratory so as to avoid the student dishonesty in this diagnostic test.

Develop

Validation by experts

The results of content validation get the rating score of 47 are on very reasonable criteria so that it can be concluded the instrument can be used without revision. The results of media validation get the score 28.5 are on very reasonable criteria so that it can be concluded the instrument can be used without revision.

Small-scale test

The items that have been validly tested for students to know the value of its reliability. Problems tested amounted to 27 questions with 35 students as a test subject in class X IPA 3 in SMA Negeri 1 Mandirancan. From the results of diagnostic tests using RDT software, we get a recap of understanding of each student in class X IPA 3. The results of diagnostic tests of students class X IPA 3 can be seen in Table 2 which shows the percentage of understanding level on redox reaction material.

Table 2. Percentage of the level of understanding of class X IPA 3

No	Categories	Amount of student (%)
1	Scientific knowledge	29.21
2	Misconception (false positive)	3.28
3	Misconception (false negative)	2.64
4	Misconception	42.01
5	Lucky guess, lack of confidence	8.46
6	Lack of knowledge	14.39

Table 2 shows that developed instruments can better diagnose students' understanding of small-scale trials. The reliability of the test on a small-scale test using the KR-21 formula is 0.64. Based on data of difficulty and differentiator of the item and the result of analysis during the small-scale test, instrument revision is done by eliminating the numbers 1,7,12,16,20,22 and 24.

Large-scale trial

Large-scale test using as many as 108 students who become subjects try from class X IPA 1, X IPA 2 and X IPA 4 in SMA Negeri 1 Mandirancan. Problems tested amounted to 20 questions which is a revision of a small-scale test. From the results of diagnostic tests using RDT software, we get a recap of understanding of each student on a large scale class. Results of diagnostic tests of large-scale classroom students can be seen in Table 3 which shows the percentage of understanding levels on redox reaction material.

Table 3. Percentage of level understanding of Large-Scale Class

No	Categories	Amount of student (%)
1	Scientific knowledge	43.47
2	Misconception (false positive)	9.21
3	Misconception (false negative)	2.78
4	Misconception	28.27
5	Lucky guess, lack of confidence	4.68
6	Lack of knowledge	11.60

Table 3 shows that there was an increase in the percentage of students' understanding from a small-scale test of 29.21% to 43.47% in large-scale tests after the instrument revised. While the percentage of students who experienced misconception decreased from 47.93% to 40.26% after the instrument revised. This suggests that revised instruments can improve students' understanding compared with unrevised instruments in small-scale trials.

The reliability of the tests on large-scale tests using the KR-21 formula is 0.72 which belongs to either category. The reliability of large-scale tests is greater than small-scale tests because some of the problems with high difficulty and inadequate distinguishing features have been revised on large-scale tests. Based on the data of difficulty level and the differentiator of the item and the result of analysis during the large-scale test, the revision of the instrument is done by eliminating the number 14. So that set 19 questions will be used in the RDT instrument.

Dissemination

The dissemination stage aims to inform the diagnostic test instrument product of the Three-Tier Multiple Choice methods with the CBT system using RDT software on the redox reaction material to the public so that it can be used as comparative information from several methods to detect misconceptions in the student. The spread of this instrument is done by making an article published in the journal.

CONCLUSION

The result of content validation get score 47 is in the very reasonable criterion, so also media validation get score 28,5 reside in the very eligible criterion, so that can be taken conclusion instrument can be used without revision. Tables 2 and 3 illustrate the percentage distribution of students' level of understanding after performing diagnostic tests on a small and large scale. This suggests that the diagnostic instrument of the Three-Tier Multiple Choice methods with the CBT system using RDT software on the redox reaction material can better diagnose the students' understanding.

The small scale test resulted in the revision of the instrument by removing 7 items, namely numbers 1.7,12, 16, 20,22 and 24 to be tested again on a large scale test. In a large-scale test resulted in a revision decision instrument by removing 1 item, that is number 14 to be able to produce a better instrument. So that the instrument that is still used consists of 19 items. The instruments reliability of the Three-Tier Multi Choice Choice diagnostic test with the CBT system using the RDT software on redox reaction material on a large-scale test using the KR-21 formula is 0.72 which belongs to either category.

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