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The Development of Discovery Learning-Based Teaching Module to Support Student Concept Mastery on Redox

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Abstract. Modules are important teaching materials to be developed in the learning process. The discovery learning teaching module is one solution that can help students distinguishing between oxidation reactions, reduction reactions, oxidizing agents, and reducing agents. This study aims to develop a product in the form of a discovery learning-based teaching module to measure students' cognitive abilities on redox material. The method used in this research is R & D (Research and Development) with a 3D development model, namely Define, Design, and Development. The results obtained from the experts on the product are valid in terms of material with a percentage value of 89.17% and in terms of media with a percentage of 91.4%. The effectiveness of using the product developed was tested at Pangudi Luhur St. Louis IX Sedayu Senior High School Yogyakarta with the results of the pre-test and post-test of students calculated by the gain score formula and obtained an increase of 0.56 with moderate criteria. The results of the student response questionnaire are an average percentage of 80.13% with a good category while the teacher's response gets a very good category with a percentage of 94%. The use of discovery learning-based teaching modules on redox reaction materials is valid, effective, and practical to improve students' cognitive abilities.

INTRODUCTION

The online learning process makes students active in learning independently, discovering knowledge, and participating in finding solutions to solve a problem. According to Herawati & Muhtadi, the learning process can run according to the desired goals, if the teacher conveys the material well and provides facilities that support learning so that students understand the material [1]. The success of the learning process is influenced by the use of teaching modules. For students, the teaching module is used as a source of independent learning while for teachers, as a support in delivering material [2].

Learning is inseparable from the selection of learning models. The learning model is a guideline in designing teaching and learning activities [3]. According to Yerimadesi, the learning model contains the steps that are followed to achieve effective and efficient learning activities that refer to the characteristics of students, learning materials, available facilities and infrastructures [4]. The discovery learning model is one of the learning models which is often used today. The students act as learning center that leads to the 2013 curriculum which is applied to the learning process so that they learn actively and independently [5]. According to Tennyson & Volk, the discovery learning model is considered a more effective teaching style. The students are given the opportunity to explore, experience, relate the information obtained, and internalize abstract principles and can relate theory to the problems [6]. Briggs suggests 4 benefits when the students learn through discovery, namely an increase in intellectual potential, the development of stronger techniques for problem solving, an increase in motivation, and an increase in memory for the material studied by students themselves [7].

Research by Yerimadesi mentions that some students have difficulties in understanding redox reactions [8]. The same thing is shown in research conducted by Munajam and Suryani that many students experience errors in understanding the concept of oxidation number, oxidizing agent, and reducing agent [9][10]. Conceptual misleading

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was also experienced by students in the research results of Andriane which showed that students still experienced errors in distinguishing redox reactions and non-redox reactions and difficulties in calculating oxidation numbers in polyatomic compounds so that mastery of concepts that were less than optimal caused the cognitive results obtained students are also less than optimal [11].

The use of modules in chemistry learning on redox reaction materials and electrochemical cells based on guided discovery learning for high school can optimize student learning outcomes [8]. The student interest in the use of teaching modules is high because there are various illustrations related to the material provided so that students have high curiosity, motivated, and help in understanding the material. The use of discovery learning models can increase the activity and learning outcomes of redox and electrolysis concepts. The students show an increasing behaviour in learning process because they gain knowledge from their experiences in solving a problem independently and it is easier to memorize [12]. The main purpose of using modules in learning is to increase the effectiveness and efficiency of learning in schools. In addition, the use of modules can reduce the diversity of students' learning speed through independent learning activities [13].

Based on this description, the development of communicative and creative teaching modules based on discovery learning is expected to encourage students to actively participate in learning redox material independently. The use of the module also helps the students in understanding oxidation numbers, distinguishing between oxidation reactions, reduction reactions, oxidizing agents, and reducing agents, and also relating redox concepts in everyday life.

METHOD

This research is a type of research and development. The research design applies a 4D development model with modifications to 3D namely Define, Design, and Development [14]. The result product is discovery learning-based module on redox reaction. The first stage of research is the define stage. The define stage is carried out by analysing the needs in the field using the interview method. Based on the needs analysis, problems and solutions can be identified, as well as material collection from various relevant sources. The second stage is design, the stage of designing discovery learning-based teaching modules that pays attention to the characteristics of students in the field and the product specifications that are set. Researchers designed the initial product according to the components of the preparation of the teaching module and based on discovery learning steps. The third stage is development which consists of several steps, namely design validation, design revision, and usage trials. The developed teaching module was validated by three validators in terms of media and materials. Teaching module feasible if it has reached a minimum percentage of 61% [17].

The design of teaching modules and research instruments were validated before being used in the trial. The instruments in this research were a list of interview questions for teacher as a guide in obtaining data analysis needs, product feasibility assessment sheets both in terms of media and materials, pretest and posttest item feasibility assessment sheets, and response questionnaire sheets. The interview sheet includes aspects of 1) the curriculum used, 2) the learning model and method used, 3) the problems in learning related to redox reaction material, 4) the learning media used by the teacher, and 5) the ability of students to redox material. The validators assess the feasibility of content, language, and presentation by using a validation sheet adapted from the National Education Standards Agency (BSNP). The validation results are then analysed and revised according to the validator's suggestions so that the products have good quality and are in accordance with the objectives. The research was conducted at Pangudi Luhur St. Louis Senior High School Sedayu Yogyakarta.

The data analysis techniques used in this study are 1) descriptive on the results of the needs analysis related to the product being developed and 2) using a Likert scale in assessing product feasibility. The Likert scale used consists of 5 scales, namely Very Good, Good, Enough, Less Good, and Very Poor. The validation results were then analyzed and converted using the criteria shown in Table 1.

TABLE 1. Level of Achievement and Eligibility Quality of Teaching Module

Level of Achievement	Criteria	Description
81-100%	Very Good	Very decent, no need to revise
61-80%	Good	No need to revise
41-60%	Enough	Less feasible, needs to be revised
21-40%	Less Good	Feasible, needs to revise
< 20%	Very Poor	Very not feasible, needs to revise

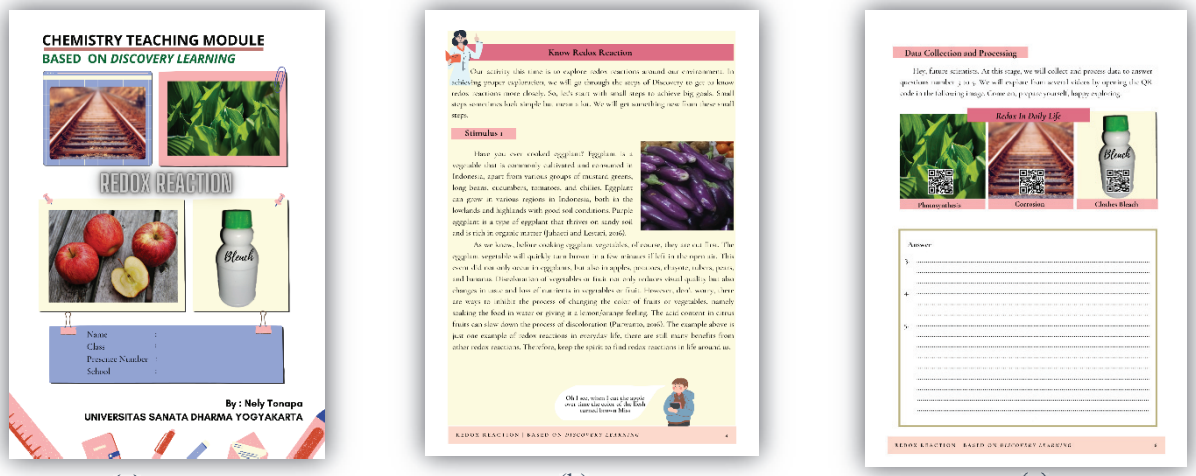
The research sample was taken using the purposive sampling technique and obtained from 30 students. They are given pre-test questions before using the teaching module and post-test questions at the end of the lesson. Then, an n-gain test was performed to find out the increase in the score of tests between before and after the implementation of the discovery learning-based teaching module. The practicality of the teaching module is also obtained by providing response questionnaire sheets to students and teachers. Suggestions, comments, and critics are also added to the teaching module to find out the responses of students and teachers.

RESULTS AND DISCUSSION

This development research was conducted to develop a valid, effective, and practical discovery learning-based teaching module to measure students' cognitive abilities on redox reaction material. The results of the interview found that students still had difficulty in understanding redox reactions, namely distinguishing between reduction reactions, oxidation reactions, reducing agents, and oxidizing agents. It is because students do not well understand the concept of oxidation number. In addition, the teacher has never designed a teaching module based on discovery learning on redox material. Teachers use chemistry textbooks, PowerPoints, and student worksheets (LKPD) in the learning process.

Researchers develop discovery learning-based teaching modules with a contextual approach so that students can understand the material well. Learners independently explore in finding knowledge through relevant learning resources. Data collection is carried out to complete the designed teaching module material. The developed teaching modules are based on discovery learning steps which include stimulus, problem identification, data collection and processing, verification, and conclusions. The teaching module is also equipped with tasks that are expected to help students in applying the material in everyday life.

The discovery learning-based teaching module is designed using an online design application, namely Canva, combined with Microsoft Office 2013. The teaching module contains 3 stimuli that contain statements about the application of redox reactions in everyday life, namely photosynthesis, respiration, and clean water management. The module is also equipped with a QR Code which aims to help students accessing videos about redox reaction phenomena in everyday life. It is in accordance with the opinion of Saleh, Saud, and Asnur that the main purpose of the QR code is to help smartphone users in accessing information [15]. The module is also equipped with a short comic that contains conversations between 2 characters related to redox. The main purpose of using the module is to determine the ability of students to understand redox material. The discovery learning-based teaching module was adapted from Daryanto "by taking into account the characteristics of the module, namely self-instruction, self-contained, stand alone, adaptive, and user friendly" [16]. At this stage, a specific and complete product design is obtained. The developed teaching module consists of an introduction, main content, and closing.



(a) (b) (c)

FIGURE 1. Display of teaching module (a) cover page, (b) and (c) content of teaching module

TABLE 2. Content Validation Results

Validator	Score Given	Max. Score	Percentage	Category
Validator I	33	40	82.5%	Very Good
Validator II	39	40	97.5%	Very Good
Validator III	35	40	87.5%	Very Good
Average Percentage			89.17%	Very Good

TABLE 3. Product Validation Results

Validator	Score Given	Max. Score	Percentage	Category
Validator I	123	140	87,8%	Very Good
Validator II	134	140	95,7%	Very Good
Validator III	127	140	90,7%	Very Good
Average Percentage			91,4%	Very Good

Based on Tables 2 and 3, it shows that the product is valid and feasible to use. The average validation results in terms of material are 89.17% and 91.4% in terms of media with a very good category. This is in accordance with the theory by Arikunto that the teaching module is feasible to use if it reaches a minimum percentage of 61% with a good category [17]. Several parts of the module were revised to achieve good quality including, improvement of concept maps, addition of syntax and stimuli to teaching modules, improvements to the rules of oxidation numbers, and improvements to standard sentences in teaching modules.

The trial of discovery learning-based teaching modules was carried out to determine the effectiveness and practicality of the developed teaching modules. The effectiveness is shown by the increasing of the student scores calculated using the n-gain formula. The average value of the pre-test is 64.13 and the post-test value is 81.87. The pre-test and post-test scores were analysed using n-gain and obtained a score of 0.56 in the medium category. Based on this score, it can be seen that there is an increase in students' cognitive abilities with the use of the developed product [18]. According to Saidah, learning with the discovery learning model involves students in the process of teaching and learning activities so that it produces meaning and affects the cognitive improvement of students [12].

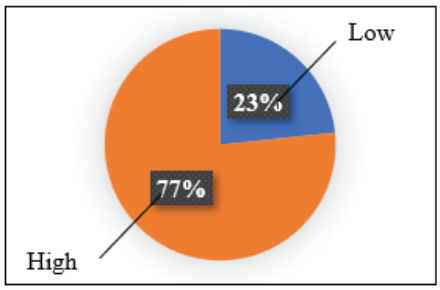


FIGURE 2. Diagram of the percentage increase in students' cognitive scores

A teaching module is said to be practical if it is easy to use in a short time. The value of practicality given by students is 80.13% in the good category and 94% by the teacher in the very good category. Based on these values, it can be seen that the modules are practically used by students and teachers. A positive response to the module arises because students are directly involved in solving problems in the stimulus. The students learn independently and also in groups to explore and analyse the problems given and the material concepts contained in the teaching module can make it easier for students to understand redox reactions. This is in accordance with research conducted by Saidah, there is an increase in learning by students through independent learning because students can gain knowledge through experience [12]. The module is also equipped with instructions and illustrations related to redox material to help students learning independently. There are also some practice questions and answers to determine the ability of students independently. Based on Figure 2, as many as 37% of students gave a very good response to the module while 60% of students gave a good response and 3% of students responded quite well. The results of the average percentage of student response questionnaire scores in knowing the practicality of using the module are categorized as good.

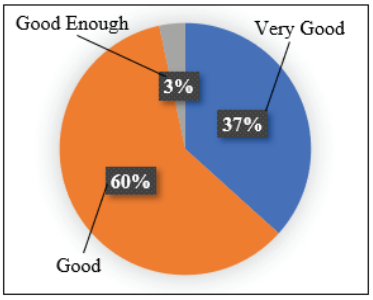


FIGURE 3. Diagrams of Students Response to Module

The product has advantages such as being able to stimulate intrinsic motivation which is known from student response questionnaires compared to learning without modules [19]. It is also equipped with a column of questions that can help students learn independently and make students active, creative, and enthusiastic in learning activities. The discovery learning model that appears in the module is systematically arranged to provide the steps that students must follow in responding to each stimulus. The stimulus given is contextual in order to help the students easily understanding the application of the concept of redox reactions in everyday life.

CONCLUSIONS

Based on the results of research and development of discovery learning-based teaching modules, it can be concluded that the product is valid, practical, and effective. The product is declared suitable for use based on the results of validation by the validator both in terms of material and media. It can improve the cognitive abilities of students which is calculated by the n-gain score and obtained a value of 0.56 with the moderate category. The product is practical to use in learning process.

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