Advances in Social Science, Education and Humanities Research, volume 446
Proceedings of the International Conference on Learning Innovation 2019 (ICLI 2019)

Development of Teaching Materials Based on Learning Cycle 5E and Enriched With Augmented Reality for Rate of Reaction Topic

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ABSTRACT
Chemistry is the study that most of the material is abstract. Many students have difficulty learning chemistry especially the reaction rate. Therefore, we need a learning model that can help students think critically, one of which is the 5E Learning Cycle and is supported by a program that can visualize aspects of the reaction rate, such as Augmented Reality. The purpose of this study was to produce Learning Cycle 5E teaching materials assisted by augmented reality on the reaction rate material. The development of teaching materials is carried out in three stages, namely (1) the analysis phase, (2) the design phase, and (3) the development phase. The results showed that the teaching material developed was included in the very feasible category with a percentage of (a) material validation of 89.7%, (b) media validation of 86%, and (c) legibility test of 90%. Based on the results of the validation and readability test, it can be concluded that teaching materials can be used as a support in the process of learning the reaction rate.
Keywords: *Rate of Reaction, Learning Cycle 5E, Augmented Reality*

1. INTRODUCTION

Most of the concepts in chemistry are abstract. Observations by the senses directly and indirectly, and are represented required to understand the chemistry [1] [2]. Understanding the concept of chemistry requires three representations include representations of macroscopic, submicroscopic, and symbolic [3]. Learning in school does not involve the third representation so that students do not understand and tend to just memorize theories that exist without understanding it. One chemical material involving three representations to understand that reaction rate. Results by Handayanti [4] showed that students' understanding at the level of sub-microscopic to the material reaction rate is the lowest when compared with other representations.

Most of the students had difficulty in learning the material reaction rate. This is shown by the data in SMA Negeri 1 Karanganyar that the average value of daily tests on the material that the reaction rate is still lower than the 68.25 completeness value of 75 on a list of values in 2010/2011 [5]. Other data obtained from SMA Negeri 1 Manyar, the result that as many as 57.7% chemistry is a difficult subject and material that is difficult is the reaction rate with a percentage of 31.43% [6]. To help overcome these difficulties required various forms of representation that can visualize the material. Their learning resources can help improve student understanding.

Teaching materials are things that contain a lot of information such as the concept of learning materials, formulas, pictures, and others. The results by Sholahuddin [7] state that class X chemistry textbooks based on didactic reduction are feasible to be used in the learning process with validated data with excellent categories and students' learning completeness classically reaches 80.2%. Kusuma and Siadi [8] also stated that student learning outcomes can be improved by applying chemo-entrepreneurship oriented teaching materials (CEP). Existing teaching materials must be adapted to the curriculum and curriculum used today, the 2013 curriculum. Learning is required to be able to achieve KI-3 where students can understand, apply, analyze factual, conceptual, procedural knowledge with the help of teachers or independently [9]. One learning model that allows students to actively investigate a phenomenon through a scientific process Learning Cycle model that can be abbreviated as LC. This model facilitates inquiry activities and helps students understand scientific processes to develop and deepen understanding of concepts [10]. The stages of learning in this model allow students to play an active role in mastering certain competencies.

The research result by Gazali [11] shows that the LC 5E can enhance students' critical thinking skills and science process skills. Research by Silaban [12] suggest that the

use of innovative teaching materials on the material chemical reaction rate provides better learning results, the average grade obtained by the 85.00 and the percent increase in learning outcomes by 76%. 5E LC-based teaching materials has been developed and demonstrated that teaching materials valid and enforceable in the school including by Setyaningsih [13] shows the results of expert lecturers validation of 3.9 and 3.2 teachers validation and validation of devices for 3 declared invalid test results, by Nuraisyah [14] shows the validation results of 92.78% student books and teacher books validation by 93.88%. Teaching materials that have been there already alluded submicroscopic level, but only indicated by a two-dimensional image is not animated so that students are still difficulties in understanding it. It is, therefore, necessary to develop teaching materials that can represent the 3D shape of the molecule.

3D shapes can be displayed using Augmented Reality (abbreviated as AR) in the application form. AR development has been done but in chemical material is still small. Research by Hafidha & Sudarmilah [15], namely the development of AR on the material Periodic System Elements yield based applications android good look, operational, and material and test results indicate that over 80% of respondents said AR application on the material Periodic System Elements excellent. By Supriono [16] showed that the application can run well, the test results portability of 96.7%, can be used on all smartphones except the resolution widened as tabs, and there are features of the periodic table that can be used directly in applications.

The purpose of this development to produce a product of teaching materials based on the AR-assisted 5E LC material reaction rate valid and feasible to be implemented in learning.

2. METHOD

The research and development model of this teaching material uses the Research & Development model proposed by Lee & Owens namely Multimedia-based Instructional Design. This model has the advantage of systematic and structured steps. The model consists of five stages: (1) assessment/analysis which includes needs analysis and front-end analysis (2) design (3) production/development), (4) implementation, and (5) evaluation [17]. The step-by-step development procedure can be seen in Figure 1.

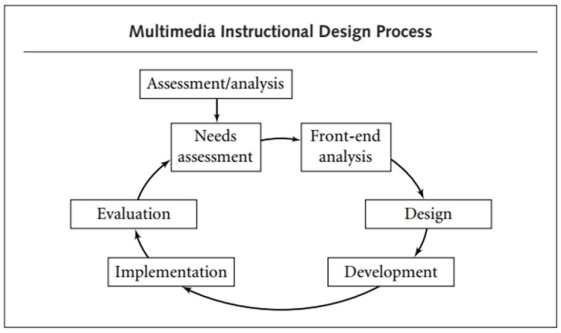

Figure 1. Development Procedure Lee & Owens (2004)

The material development procedure is carried out only until the third stage, this is due to time constraints. These stages are (1) assessment/analysis (2) design, and (3) production/development.

Data collection instruments used in the form of expert validation questionnaires and student validity questionnaires. The questionnaire was used in the form of an open questionnaire (for criticism and suggestions) and a closed questionnaire (using a Likert scale). The validation questionnaire consisted of material validation and media validation validated by one high school chemistry teacher and one UM chemistry lecturer, while the questionnaire readability was up to 20 students in class XI of UM Laboratory. The questionnaire instrument was used to obtain (a) quantitative data from the questionnaire attached in the form of students' validation and readability scores, (b) qualitative data from the open questionnaire in the form of comments and suggestions used as consideration for the revision of teaching materials. The Likert scale used was adapted from Riduwan [18] with a range of 1-5 votes. Scores obtained in the form of a percentage scale indicate that the instructional materials feasible/valid use or need to be revised.

3. RESULTS AND DISCUSSION

Teaching materials have been developed in the form of teaching materials based on the 5E Learning Cycle which is enriched with Augmented Reality technology. Teaching materials are printed in A6 (10.5 cm x 14.8 cm) pocketbooks and Augmented Reality applications with the .apk format. Teaching materials are divided into four main parts, including the pre-introduction, introduction, content section, and closing section. The pre-introduction section consists of a cover page, a student identity page, preface, table of contents, and instructions for the use of teaching materials. The introductory part consists of learning objectives, concept maps, and introductory writers and perceptions. The body part consists of two stages of the learning cycle with the 5E Learning Cycle. The concluding section consists of competency tests, sundries, notes, bibliography, and author biographies.

There are some analyzes done first. The analysis fronf-end result are student analysis consists of psychological analysis and analysis of habits. This analysis was obtained from interviews with several students. Psychological analysis about the way of thinking of students who are still concrete, is not yet abstract so teaching materials are needed that can trigger the process of abstract thinking of students so that the material learned is truly understood by students. Analysis of habits about the habits of students who more often play gadgets and in their lives cannot be kept away from technology, so that teaching materials are made that can be used simultaneously with gadgets or smartphones so that students are more interested in learning the reaction rate material.

Schools have the facilities needed to support learning using teaching materials developed, one of which is WiFi. Students are allowed to bring a smartphone that is useful as a support for learning. The types of smartphones students carry are also included in this analysis. Students use a smartphone that has a large storage space and adequate type of android for the use of certain applications so that it can support the teaching materials that are developed. Geographical location will affect the strength of the internet network that will be used to access teaching materials. The condition of the learning environment is used to determine the form of teaching materials to be developed. The situation of student learning is also conducive so that the use of teaching materials will be maximized.

Task analysis has been used as a determination of material that has been developed as teaching material. The material that has been used in the development of teaching materials is material that is abstract, so it requires a deep understanding. KD and KI assessment is also needed on the material that has been developed to be able to determine indicators and learning objectives in accordance with the 2013 curriculum. Material that is considered abstract is the rate of reaction because in understanding it takes three representations, so it needs to be reviewed about KD and KI as well as making indicators and also learning objectives so that teaching materials can improve student understanding.

Analysis of important events will be used for the manufacture of developed teaching materials. Students are more interested in matters relating to images and animations compared to the text alone so it takes teaching materials that contain images, animations and videos. The problem is that videos and animations that support learning that fit students' needs are difficult to find, so a review of the rate of reaction is needed. The purpose of developing teaching materials is to help students understand more deeply the material reaction rates, especially in some abstract parts so there is a need for videos, 3D animations that can describe the reaction rate material. The media needed for the reaction rate material are phenomena videos, experiments and microscopic shapes and 3D animations, so that the teaching material will contain these things so that they can be utilized maximally. The data available in the form of material in books, videos and some images, needed other video making and also 3D animation.

Questionnaire validation generates two types of data, namely quantitative data and qualitative data. Quantitative data obtained from the calculation of the average value of the questionnaire, while the qualitative data obtained from the comments and suggestions of the validator that is used for product revision. The validation test results consist of four main aspects, namely the feasibility of the language, the presentation of the feasibility, the suitability of the content, and the correctness of the concept.

3.1 Material Validation Result

Material eligibility consists of three aspects: the first cycle, the second cycle, and understanding tests. Thus obtained six aspects in the results of the validation test of this material with the values as follows: (1) the feasibility of language 92.5%, (2) the feasibility of representation of 85.7%, (3) the feasibility of the contents of the first cycle of 90.7% , (4) the feasibility of the contents of the second cycle 92.2%, (5) the feasibility test for the content of understanding by 7%, (6) the truth of the concept of 100%.

Table 1 Percentage of Language Feasibility Validation Results

No.	Assessment Criteria	%	information
1.	The language used is communicative and easy to understand	100	Very Valid
2.	The terms used are easy to understand and not multiple interpretations	90	Very Valid
3.	The language used is effective and efficient	90	Very Valid
4.	The use of terms and symbols is consistent	90	Very Valid
Average value		**92,5**	**Very Valid**

Table 2 Percentage of Presentation Eligibility Validation Results

No.	Assessment Criteria	%	Information
1.	The material is presented coherently and systematically	80	Valid
2.	The presentation of teaching materials can motivate students	100	Very Valid
3.	The presentation of teaching materials can encourage students to develop critical thinking competencies	80	Valid
4.	Display attractive teaching materials	80	Valid
5.	The type and size of letters make it easy for students to learn the material	90	Very Valid
6.	The steps of the activities make it easy for students to find concepts	80	Valid
7.	QR codes and question commands are placed in a place where students can easily observe by giving appropriate spacing and spacing	90	Very Valid
Average value		**85,71**	**Very Valid**

Table 3. Percentage of Understanding Test Validation Results

Number	Assessment Criteria	%	Information
1.	Conformity with Basic Competencies	90	Very Valid
2.	Conformity to the depth of the material	90	Very Valid
3.	Questions lead students to think critically	80	Valid
4.	As a race to determine students' understanding of the material	90	Very Valid
Average value		**87,5**	**Very Valid**

3.2 Media Validation Result

On the results of the media, validation test consists of two aspects which include aspects of graphics and aspects of using augmented reality. To get two values including (1) graphic of 92.3%, (2) the use of augmented reality by 80%. Based on the calculation of the overall average value, the final result obtained is a material validation value of 91 and a media validation of 83.

3.3 Legibility Test result of Student

The results of the data from the students' readability test obtained a percentage of 90.11% that met the criteria for teaching materials is very valid, so that teaching materials are very appropriate to be used in learning activities at the material and media scales. Based on the results of validation and test the readability of these students, the conclusion that teaching materials have been developed including in the category of very decent so it can be used in learning activities.

In general, students and validators give a positive response to instructional materials, including materials that can make learning a more exciting interest in learning, creative, and makes learning more fun.

4. CONCLUSION

The results of this research and development in the form of teaching materials chemistry A6 sized to print out the form on the material and the rate of reaction with augmented reality applications. The .apk format developed is used on smartphones that have Android operating system specifications. Teaching materials that contain QR Codes and markers. QR Code in the form of books connected to google, pdfs, as well as videos, and 3D animations connected to markers using the downloaded Arce application. Teaching material to get material validity is 89.7%, media validity is 86.1%, and readability is 90.1%. In the teaching material, the material consists of two cycles of learning with Learning Cycle 5E stages comprising the steps of (1) involvement, (2) exploration, (3) an explanation, (4) the elaboration, and (5) evaluation.

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