Development of Virtual Laboratory Based on Augmented Reality on Electrolysis Material for Class XII High School Students in the Covid-19 Pandemic Era

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ABSTRACT
Practicum is an activity carried out so that students understand the material. One of the high school chemistry materials that require practicum to increase students' understanding is electrolysis. This material is often considered difficult because students have difficulty understanding the reactions that occur in electrolytic cells. During the Covid-19 pandemic, teachers and students carry out online learning. Under these conditions, laboratory practicum cannot be carried out so that students do not understand the material being taught. An alternative solution that can be done to overcome the obstacles in the implementation of the electrolysis practicum is to use virtual laboratory learning media that can help students understand the concept by conducting practical simulations. The development of learning technology in Indonesia is increasingly advanced with various learning media, one of which is learning media that uses Augmented Reality technology. This virtual laboratory product was developed using a development model according to Lee & Owens, namely a multimedia design model which includes the assessment/analysis, design, development, implementation, and evaluation stages. The product of this development is an Android application based on Augmented Reality on electrolysis material. The validation test results by material expert validators and media experts, the product developed is declared valid and suitable for use for learning.

Keywords: *Virtual laboratory, Augmented Reality, Electrolysis.*

1. INTRODUCTION

One of the essential things in learning chemistry is practical activities in the laboratory. Students can understand and solve problems related to the concepts taught in class and gain a deep understanding through the scientific process in practical activities [1]. Practical activities in the laboratory play a significant role in supporting the theoretical explanation in chemistry learning [2]. There are two types of practicum, namely verification practicum, and inquiry practicum. Verification practicum is a practicum to prove a concept that has been learned in class. While the inquiry practicum is a practicum that supports students to carry out the learning process independently by applying the knowledge they already have [3]. Practical activities in chemistry learning carried out in high school are verification practicum types. Verification practicum is still used because it can perform many experiments with many students in one class and with limited time.

One of the high school chemistry materials requiring practice in the laboratory to increase students' understanding is electrolysis. This material is often considered difficult because students have difficulty understanding the reactions that occur at the cathode and anode and the processes in electrolysis cells. It is difficult to apply the concept of redox reactions in everyday life. This is what often makes students unable to understand the concepts in the material thoroughly [4].

During the Covid-19 pandemic, teachers and students carry out online learning. Learning must continue with students in their respective homes. Teachers guide online learning activities through social media or applications provided for learning [5]. Under these conditions, practical activities in the laboratory cannot be carried out. Students cannot do practice independently at home because of limited tools and materials, so that students do not understand the material being taught. The existence of a practicum in electrolysis material will make students better understand the concepts that the teacher in classroom learning has conveyed. Some cases that also

often appear in electrolysis practicums are that not all schools have chemistry laboratories which cause the practicum cannot be carried out. In addition, the electrolysis practicum cannot describe the microscopic reactions that occur, which causes students a little difficulty in understanding the microscopic reactions in the electrolysis practicum.

An alternative solution that can be done to overcome the obstacles in the implementation of the electrolysis practicum is to use virtual laboratory learning media that can help students understand the concept by conducting practical simulations. The virtual laboratory serves as a tool that can help students in pre-lab preparation, strengthen understanding of concepts, and substitute or complement a real laboratory because students can repeat practical simulations that are not understood [6].

The development of learning technology in Indonesia is increasingly advanced with the existence of various learning media [7]. This can be shown by the use of smartphones as learning media because students have a tendency to take advantage of the results of technological updates to increase their knowledge in learning [8]. One of the media that is also increasingly being developed in Indonesia is Augmented Reality technology. Augmented reality can be used by developers as an informative and interactive educational medium. 3D visuals added to the real world can make it easier for someone to absorb information so that the developer's goals and objectives can be conveyed properly [9].

This research is a virtual laboratory development research that can present a simulation of electrolysis practicum accompanied by microscopic images to improve understanding of the concept of electrolysis based on Augmented Reality that can be used as a substitute for practicum. This virtual laboratory is designed in the form of a simple game to motivate students to understand the concepts in electrolysis practicum.

2. METHODS

This product was developed using the development model according to Lee & Owens, namely a multimedia design model which includes the (1) assessment/analysis, (2) design, (3) development, (4) implementation, and (5) evaluation stages. The assessment/analysis stage is divided into two, namely, needs assessment and front-end analysis. Needs assessment is conducted by conducting interviews with high school chemistry teachers, while Front-end analysis is conducted by audience analysis, technology analysis, critical analysis, objective analysis, and media analysis [10].

The design phase includes a series of activities, such as making a schedule in media development. This stage also includes designing media specifications and designing the structure of the media material to be developed. The tools needed in the expert validation process and audience testing were also carried out at this stage. In the development stage, the researcher makes storyboards and programming based on the storyboards that have been made.

At the implementation phase, validation of media experts and validation of material experts is carried out. Validation is carried out to determine the level of validity and feasibility of the developed virtual laboratory. Validation is carried out to obtain data in the form of assessments and comments and suggestions from experts in the field of chemistry and learning media and users. The validation questionnaire includes a validation questionnaire regarding media and material using a five-level Likert scale.

Table 1. Likert Scale Rating Rules for Virtual Laboratory

Score	Information
1	Very poor/Very poor/Very Less Attractive/Very Less Clear
2	Unfavorable/Inadequate/Less Attractive/Less Clear
3	Good Enough/Fair Enough/Interesting Enough/Self-explanatory
4	Good/Proper/Attractive/Clear
5	Very Good/Very Worthy/Very Interesting/Very Clear

The data obtained were analyzed by percentage analysis technique using the following formula.

$$P = \frac{\Sigma x}{\Sigma xi} \times 100\%$$

Notes:

P : Percentage of validator ratings
Σx : Total number of validator ratings
Σxi : Total number of the highest validator scores

The results obtained based on the calculations carried out with the above formula determine the validity of the virtual laboratory learning media. The validity of the media is determined based on the interval of determining the level of validity in the table below.

Table 2. Percentage Analysis Eligibility Criteria

Percentage (%)	Information
0-20	Not feasible
21-40	Not worth it
41-60	Decent enough
61-80	Well worth it
81-100	Very worthy

At the evaluation stage, researchers evaluate the products that have been developed. Evaluation is done by analyzing data based on the results of validation and testing at the implementation stage and revising the product based on comments and suggestions obtained from the validator.

3. RESULTS AND DISCUSSION

This development research produces a product in the form of a virtual laboratory application based on augmented reality on an android smartphone. The initial section consists of cover page and menu page. The cover page contains the title of the virtual laboratory and the start button. The cover page can be seen in Figure 1.

Figure 1 Cover page.

This application has several menus, namely learning objectives, preliminary material, practicum procedures, pre-test and post-test, tools and materials, and practicum. The menu page can be seen in Figure 2.

Figure 2 Menu page.

The display of the concept map can be seen in Figure 3. The concept map contains the material to be studied and the direction of ordering the material.

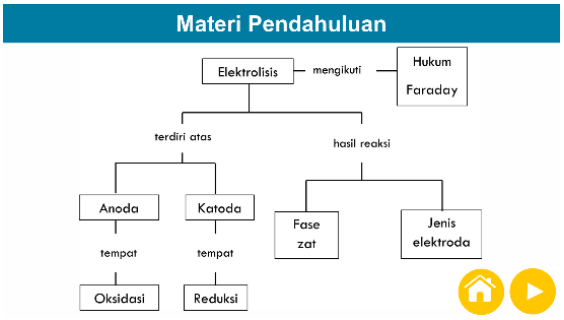

Figure 3 Concept map.

The display of learning objectives can be seen in Figure 4. Learning objectives contain descriptions obtained in learning activities.

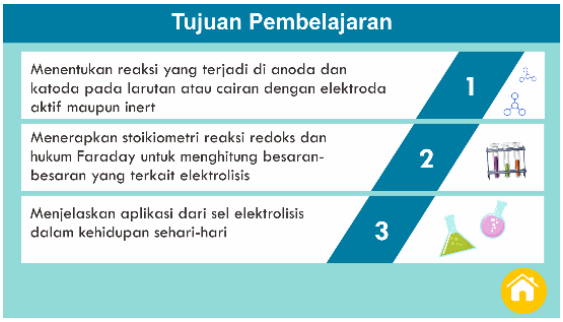

Figure 4 Learning objectives.

The preliminary material can be seen in Figure 5. The preliminary material contains electrolysis material so that students have an overview of electrolysis before conducting practicum simulations.

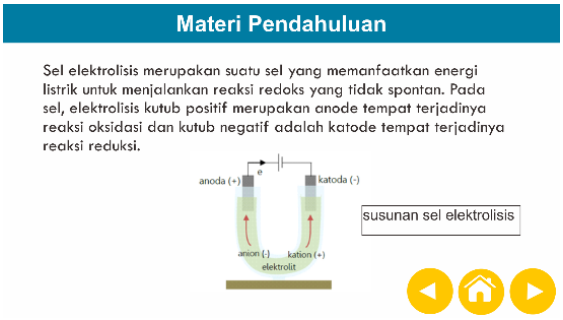

Figure 5 Preliminary material.

The electrolysis practicum procedures can be seen in Figure 6. The electrolysis practicum procedures contains the steps carried out during the practicum simulations.

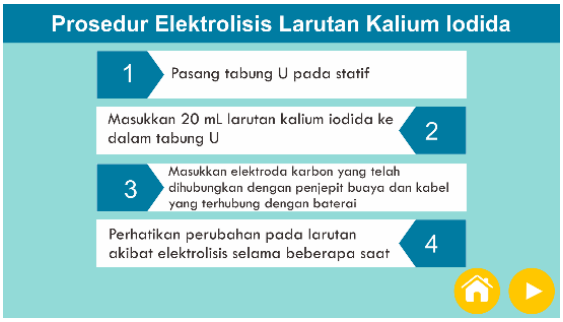

Figure 6 Practicum procedures.

4. CONCLUSION

Based on the validation results from media experts and material experts, a virtual laboratory based on augmented reality on electrolysis material that has been developed can be said to be valid and feasible, but it still needs to be validated by teachers and readability tests by students.

AUTHORS CONTRIBUTION

All authors conceived and designed this study. All authors contributed to the process of revising the manuscript, and at the end all authors have approved the final version of this manuscript.

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