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Development of Interactive Learning Media Based *Augmented Reality* Android Technology Application on Redox Reaction Materials

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Abstract: This research concerns the development of interactive media based on *Augmented Reality* (AR) as an interactive learning medium on Redox Reaction material using the Research and Development (RnD) research method and the 4-D model. The aim of this research is to design and develop this application with a focus on students' interest in Augmented Reality interactive media on redox reaction material. Research stages include define, design, development, dessaminate. Media expert validation results show that this application meets quality standards and is suitable for use with a feasibility percentage of 88.2%. The attractiveness test was carried out on a number of students to evaluate the attractiveness of the application in motivating students in learning and obtained an attractiveness percentage of 93.12% so that this media received the criteria of being very attractive in learning. This research produces interactive media that can be used as an additional learning resource in the context of chemistry learning. This media has succeeded in increasing student engagement and providing a more interactive learning experience through the use of AR technology. The practical implication of this research is that there is potential for application as an innovative learning tool in chemistry education.

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Introduction

One of the reasons why students have difficulty understanding chemical concepts well is that it creates an understanding that is different or even contradictory to the understanding of the concepts of experts (Rizki et al., 2020). The concept of chemistry is a tiered concept from simple to higher level concepts (Astutik, 2017). One of the concepts in chemistry that is tiered is the concept of Oxidation-Reduction (Redox) Reactions. The redox concept is a prerequisite material for studying the following concepts, namely electrochemistry, cell potential, and electrolysis cells (Sasmita et al., 2017). Apart from being tiered, chemistry learning is an abstract learning, so many students find it difficult to understand chemistry learning, especially redox material.

The learning process that uses media can make previously abstract material easier for students to understand (Supriyono, 2018). The redox concept involves the transfer of electrons between atoms and ions. With *Augmented Reality* (AR), students can directly see visual representations of redox processes, such as color changes, particle movements, or chemical reactions occurring around them. This allows students to visualize concepts more

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clearly and strengthen their understanding. The use of Augmented Reality in redox material can provide an in-depth learning experience. Students can explore concepts in more detail, view reactions realistically, and relate them to real-world phenomena. In doing so, they can develop a stronger understanding and be able to apply redox concepts in different contexts. The development of interactive learning media based on Augmented Reality on redox material can be an effective tool for improving chemistry learning. By presenting redox concepts visually, interactively and in depth, Augmented Reality can help students understand and master the material better.

In connection with the problems mentioned, technology-based learning media needs to be developed to facilitate the learning process in the era of industrial revolution 4.0. The focus of this research is interactive learning media in the form of sheets where AR-based interactive learning media can display three-dimensional objects through Augmented Reality from the Assemblr Edu application. The Unity application is an Android or iOS application that can be installed from the Google Play Store or App Store and operated on a cellphone. The Assemblr Edu application is an application that can create, display and share 3D objects in AR technology displays. The aim of this research is to produce interactive learning media, AR-based interactive learning media assisted by the Unity application that is feasible, effective, and gets good responses from students.

Research Method

The research method used is RnD (Research and Development) development. Development research is a process or steps to develop a new product, or improve an existing product, which can be accounted for (Sukardi 2003). The product developed is interactive learning media based on Augmented Reality technology on redox reaction material. This research adopts the 4-D model (Define, Design, Development, Dessaminate). Identification and definition stage (Define), this stage looks at the initial conditions in the field and determines the requirements for the AR-based interactive chemistry learning media that will be designed. Design Stage, the design stage consists of formulating measurable objectives, classifying students into several types, selecting student activities and selecting the media that will be developed. Development Stage (develop), the development stage includes preparing materials for students and teachers in accordance with the product specifications being developed. Dissemination or feasibility (Dessaminate), at this stage, the initial product that is ready to be made will be validated with several experts or experienced experts to assess the new product being designed.

Analysis of non-test instrument data in this study used descriptive data analysis techniques using a Likert scale. The type of data obtained from the results of this research is qualitative data analyzed using quantitative data, which is in the form of numerical data and interpreted in the form of words. The Likert scale is used to measure the attitudes, opinions and perceptions of a person or group of people about a social phenomenon. In this study, a scale of 1 to 4 was used, with a score of 1 being the lowest and a score of 4 being the highest. as follows:

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Table 1. Scoring on Student Response Sheets Based on a Likert Scale.

No	Criteria	Assessment criteria
1.	1	Not attractive
2.	2	Quite interesting
3.	3	Interesting
4.	4	Very interesting

Result and Discussion

Chemistry learning material is often considered difficult by students, one of which is redox reaction material, so sometimes students ask questions about learning material that has taken place after class time is over. In the chemistry learning process, students only use textbooks and when teachers deliver lessons at school, students do not appear to be actively involved in the learning process. The ongoing learning process is also dominated by teachers rather than students. Especially during the redox reaction learning process, there are several students who understand the learning process of the redox reaction material and there are some students who do not understand the learning process and seem to have difficulty understanding the material. This is known because after the chemistry lesson is over there are several students who ask questions. Return to the material you have just studied.

The design of this AR interactive media began by looking at the syllabus which contained KI, KD, indicators, learning objectives and learning materials that were in accordance with the 2013 curriculum. This development was carried out using references to four chemistry textbooks, namely the class XII SMA/MA chemistry student book, the chemistry book volume 2 for SMA class XII, the Chemistry XII Learning Guide book for SMA & MA, the CHEMISTRY book for SMA & MA Class Then it is compiled and adapted to the learning material. The next step is to determine learning activities that are adapted to the stages and steps in the discovery learning learning model. The discovery learning learning model is a learning model that maximally involves all students' abilities to search and investigate systematically, critically and logically so that students can be actively involved during the learning process. So this interactive media consists of basic competencies, indicators, learning objectives, instructions, material information, stimulation or providing stimulation, problem statements, data collection, data processing, verification, and generalization or drawing conclusions. In this interactive media there is also a summary of the material, an answer key. The size of this media is in accordance with ISO standards with A4 paper size (210x297mm), with 12pt and 14pt fonts, Times New Roman and Garamond fonts. This interactive media is designed and adapted to suitability assessment aspects using feasibility assessment aspects in accordance with the National Education Standards Agency (BSNP). The feasibility instrument in accordance with BSNP was then given to media experts who then validated the media by media experts, namely a lecturer and two teachers. In making Android-based AR interactive media, there are problems in the part that creates information buttons on media applications. The specifications for making AR interactive media are laptops and cannot be made via Android, but the application can be used on Android, where the laptop used should have the same specifications. have a minimum of 4 GB RAM, HDD/SSD, because you have to install heavy applications, such as Unity which is used to create AR and Blender applications (3-dimensional designs) and for 2-dimensional designs you can use Adobe Illustrator and Canva software. Criticism and suggestions given

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by media experts are then used as a reference for improving revisions to the media that has been developed so that media that is suitable for use is obtained.

The results of data analysis obtained from students showed that students' responses to the media cover design assessment indicator were obtained on average at 3.718 with a percentage of 92% which was included in the eligibility criteria of "very attractive". The average for the second assessment indicator, namely media content design, is 3.729 with a percentage of 93% which is included in the eligibility criteria of "very interesting". From these two assessment indicators, a total average of 3.725 was obtained with a total percentage of 93.12% in student responses. Based on the eligibility criteria, the results of the students' responses on Augmented Reality-based interactive media on the redox reaction material developed were included in the "very interesting" criteria. The results of the data analysis can be seen in the following diagram :

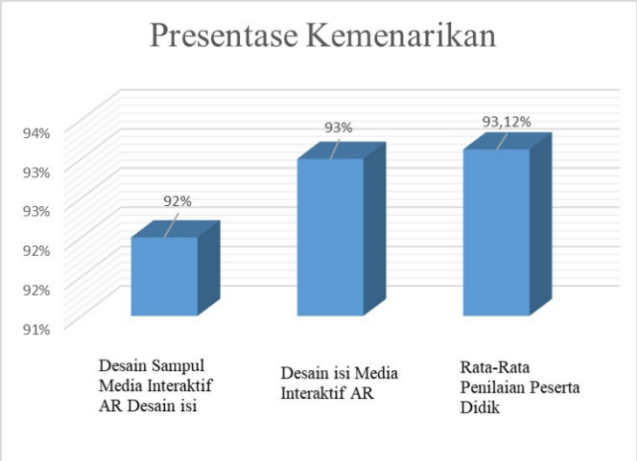

Figure 1. Chart of Percentage of Attractiveness by Students

From the graph above, it can be seen that the highest percentage of attractiveness is found in the media content design assessment indicator with an attractiveness percentage of 93%, while the attractiveness percentage in the media cover design assessment indicator is 92%. So that the total average percentage of students' responses to interactive media based on Augmented Reality on redox reaction material was 93.12% with the attractiveness criterion being "very interesting". So that interactive media based on Augmented Reality on redox reaction material that has been developed is considered very interesting by students and can be used in the learning process.

The validation results obtained from the validator are then analyzed using data analysis techniques. Validation carried out by media experts includes appropriateness of content, appropriateness of language and appropriateness of graphics. The percentage (%) per aspect in media expert validation is obtained from the score obtained (f) per aspect divided by the number of frequencies/maximum scores (N) per aspect multiplied by 100%. The average percentage is obtained from the total percentage (%) of all aspects divided by the number of aspects. Validation was carried out by media experts which included graphic feasibility with assessment indicators of component presentation, instructional quality and technical quality with a total average percentage of 88.2% with the criteria "very feasible". It is also accompanied by suggestions and input by media expert validators, who serve as references and guidelines for researchers in revising AR-based interactive media on redox reaction material, so that it can be suitable for use by students in the learning process. Based on the

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validation results carried out by media expert validators, the "very feasible" criteria were obtained for AR-based interactive media on redox reaction material that had been developed. It can be concluded that AR-based interactive media on redox reaction material is suitable for use as a teaching material in the learning process. .

The results of student responses regarding the attractiveness of discovery learning-based student worksheets on acid-base material that have been developed were carried out by 32 students in class XII Science 1 SMA Negeri 1 Pematangsiantar. Students' responses to AR-based interactive media on redox reaction material are carried out with the aim of finding out the attractiveness of the media that has been developed so that its attractiveness can be known. Students' responses to media attractiveness consist of two assessment indicators, namely media cover design and media content design with nine response criteria, responses are carried out using a Likert scale of 4 (very attractive), 3 (attractive), 2 (quite interesting), and 1 (not interesting). And a total average percentage of 93.12% was obtained with the criteria "very interesting". So it can be concluded that the AR-based interactive media on redox reaction material that has been developed is interesting and can attract students' interest in the learning process. This is in line with previous research conducted by Nua, et al (2018), it is known that the development of interactive media is said to be suitable for use as learning media. Based on previous research conducted by Kartini & Putra (2020), it is known that the interactive media in chemistry subjects that has been developed is suitable for use for learning based on assessments from material experts who obtained an increase in percentage scores from previous test results for each indicator. The aspects assessed in beta test II obtained very good average criteria with a percentage of 83.07%. The component aspect that gets the largest average percentage is the learning quality aspect. Then, the quality aspect of content and objectives in learning media gets an average percentage of 82.21%, while the technical quality aspect gets an average percentage of 82.02%. Based on this data, the interactive media developed is said to be effective and suitable for use in the learning process. This effectiveness also makes it clear that the media developed is in accordance with the indicators and learning objectives used for chemistry lessons with reference to the 2013 curriculum.

Based on research conducted by Ramadani, et al (2020), it is known that the interactive media developed obtained an average assessment score at the field trial stage for 33 students in class .00 from the ideal score of 100 with class completion of 82%; (3) the responses of students and teachers for the learning modules developed also received high and very high categories respectively with percentages of 80.38% and 100% so that the modules were said to be practical. So the conclusion is that the augmented reality-based chemistry learning module that has been developed with a 4D model is valid, practical and effective for use in learning. This shows that the developed interactive Augmented Reality-based media can improve students' problem solving abilities in learning.

Validation results by Kartini, et al (2023) on interactive media based on Augmented Reality based on the results of research by applying the development of Android-based Augmented Reality learning media on chemical molecular material at SMAK Global Tourism. Anugrah succeeded in obtaining a Good score using the SUS method test so that it can be concluded that the development Learning media can increase students' interest and understanding in learning chemical molecules by applying learning media. Where the average obtained from 29 student respondents obtained a final average score of 76. The average is based on the category of the System Usability Scale testing method to determine how far the system can be effectively used and utilized in the learning process is Good with a value range of 74 to 84

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and can be categorized as the method used. So based on the test results, the development of learning media in chemistry subjects on chemical molecules can be used to increase students' interest and understanding with a Good category score of 76. This shows that in terms of appearance and language, AR-based interactive media is good and suitable for use as a one of the learning resources in learning.

Research conducted by Fitriyana & Purwasi (2020), the discovery learning-based worksheets developed in this research were categorized as valid, practical and effective for learning. Based on the description of the data obtained, the final product of LKS based on discovery learning on the material of surface area and volume of cubes and blocks was declared valid, practical and effective, so that it can be used as a learning resource for students in understanding the material of surface area and volume of geometric figures.

Conclusion

Feasibility of developing AR-based interactive media on redox reaction material based on BSNP standards which have been validated by media experts. The total average percentage value obtained by media experts was 88.2% with the criteria "very feasible". So it can be concluded that overall the AR-based interactive media on redox reaction material that has been developed is suitable for use in the learning process, especially on redox reaction material, then Students' assessment of the attractiveness of media interactive based on AR on redox reaction material that has been developed obtained a total average percentage of 93,12% with the criteria "very interesting". So it can be concluded that overall the AR-based interactive media on redox reaction material that has been developed is interesting for students to use in the learning process, especially on acid-base material.

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