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Chemistry Learning Revolution: Interactive Multimedia E-Learning with a Problem Based Learning Approach

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Abstract
This research aims to develop interactive multimedia e-learning based on problem-based learning in chemistry learning. Research is the development of multimedia that can be a solution in the form of e-learning. Web learning is expected to function as a virtual teacher, virtual classrooms, and learning resources that can be accessed easily. The media was tested in terms of the attractiveness, ease of use, efficiency, and effectiveness. Development carried out by Lee and Owen adaptation models consisting of analysis, design, development, and evaluation. Evaluation phase is done by testing the expert to be validated. Validation is done by a designexperts, media specialist, and a chemistry expert. The products have been valid then tested on students and chemistry teachers in a small group.Based on group tests, it was found that the learning media products developed were liked and received positive responses, so they could be declared good for use as chemistry learning media.

Keywords: Development of Multimedia; E-Learning; Problem Based Learning

INTRODUCTION

The current development of information and communication technology provides new opportunities for the world of education to develop new learning models to cover the weaknesses that arise from implementing face-to-face learning (Mikre, 2011; Fahrurrozi, 2020). From a process perspective, information and communication technology can cover the weaknesses of limited space and time, while from a content perspective, information and communication technology offers an understanding of content that is easier for students to digest (Graham et al., 2012; Muttaqin, 2021). For example, complex forms of knowledge can be simplified with information and communication technology simulations so they are easy to see, large forms can be reduced so they can be brought in front of students, and dangerous activities can be presented with information and communication technology so they are not dangerous (Binkley et al. , 2012; Magdalena, 2021).

Learning through a virtual approach and based on information and communication technology provides many benefits for students, because it can increase students' tendencies to 1) apply scientific process skills, 2) scientific inquiry, 3) critical thinking, 4) conceptual understanding, and 5)

comprehensive understanding of natural science (Fitria & Indra, 2020). The birth of an e-learning based distance learning system was the beginning of the development of information technology in the education sector (Sibagariang, 2017; Gani, 2018). In e-learning, delivery and access to teaching material is done through electronic media using a web server to deliver the material, a web browser to access the learning material, and TCP/IP (Transmission Control Protocol/Internet Protocol) and HTTP (Hyper Text Transfer Protocol) as protocol for communication (Setiawardhani, 2013; Menarianti & Wibisono, 2013; Fajrian & Darqanti, 2021). Many lessons can be carried out by utilizing information and communication technology and are designed as e-learning, one of which is chemistry learning (Dina & Nugraheni, 2017; Silalahi, 2020; Hajarina, 2021). Chemistry subject matter in high school contains many concepts that are quite difficult for students to understand, because it involves chemical reactions and calculations and involves concepts that are abstract and considered by students to be relatively new material.

The chemistry learning process at school so far seems less interesting, so students feel bored and have less interest in chemistry lessons, so the class atmosphere tends to be passive, very few students ask the teacher even though the material being taught cannot be understood (Ristiyani & Bahriah, 2016 ; Rostika, 2020). In learning like this they will feel as if they are being forced to learn so that their souls are stressed. This situation creates irritation, boredom, indifference, so that students' attention, interest and motivation in learning becomes low. This will have an impact on not achieving chemistry learning objectives (Anggraini et al., 2015; Akbar, 2016).

Based on observations that have been made, it turns out that the low student learning outcomes are due to low understanding of chemical concepts and students' lack of interest in chemistry lessons. To increase students' interest and motivation in learning chemistry, teachers need to make efforts to improve the quality of learning through creative and innovative activities (Sunyono et al., 2009). From the problems expressed above, a lesson was developed which is expected to increase students' interest in the subject matter. The widespread use of the internet, even in the school environment, has its own charm. The internet and cyberspace are no longer new things for students, in fact social networks, websites or blogs have become everyday conversations and people can spend a lot of time on them (Sabiruddin, 2019; Pujiono, 2021).

Previous research regarding the development of multimedia based on problem based learning was successfully developed in the very feasible category by Mashami & Khaeruman (2020). This research is in line with previous research, which developed interactive multimedia in chemistry learning. This research creates a significant breakthrough in teaching chemistry in high schools through the development of interactive multimedia E-Learning based on problem based learning. With a focus on student engagement, this research presents an innovative approach aimed at increasing student motivation and participation in understanding complex chemical concepts. In addition, this research is a relevant solution in facing the challenges of distance learning, where multimedia technology provides a more interesting and effective learning experience. Through a problem based learning approach, this research not only aims to teach chemistry facts, but also to strengthen understanding of concepts, improve problem solving skills, and prepare students with 21st century skills that are important in academic and professional environments. Thus, this research shows the relevance and urgency in the context of a modern curriculum which emphasizes the use of technology to support more effective and efficient learning.

Therefore, an interactive multimedia e-learning was developed with a problem based learning approach. This multimedia is designed and adapted to problem-based learning. Practice questions and discussion forums are also designed and adjusted to suit the time the material is provided. This research aims to develop interactive multimedia e-learning based on problem-based learning in chemistry learning. Based on this, a web form of learning was developed with the title "Development of Interactive Multimedia e-learning Based on Problem Based Learning in High School Chemistry Learning".

RESEARCH METHODS

Research Type

Research that uses the Lee and Owens (2004) development method is a type of research that focuses on instructional development and evaluation. This method focuses on a systematic process for developing effective and efficient learning materials, as well as evaluating the results. This approach combines instructional design principles with technology to create engaging and interactive learning experiences. Through this approach, researchers can design, develop, and evaluate various types of learning materials, ranging from traditional curricula to interactive multimedia, with the aim of improving students' understanding and skills in specific learning contexts.

Data Collection Technique

In using the Lee and Owens (2004) development method, the technique commonly used for data collection is expert validation. Expert validation involves participation from experts in related fields, such as education, chemistry, and multimedia, to evaluate the suitability, clarity, and effectiveness of the learning materials developed. Experts provide input based on their knowledge and experience to ensure that the learning material is in accordance with established learning standards and can be effectively used in the intended learning context. This expert validation procedure includes reviewing and analyzing the structure, content and presentation of the material, as well as providing suggestions and recommendations for improvement if necessary. The results of this expert validation provide a valuable contribution in ensuring the quality and suitability of learning materials to the needs and characteristics of targeted learning.

Data Analysis Technique

Data analysis techniques in research using the development method Lee and Owens (2004) use qualitative analysis to evaluate the learning material development process (Ardianto, 2020; Santoso, 2020), such as content analysis to identify themes and patterns that emerge in input from education experts and multimedia developers.

Research Procedure

The design of e-learning teaching materials for chemistry subjects uses a multimedia-based learning design model developed by Lee and Owens (2004) including analysis, design, development, implementation and evaluation. In this research, the product that will be produced is a multimedia learning that is e-learning in nature.

Based on the development model of Lee and Owens (2004), the development procedure is, first, the needs analysis stage including, analysis of learning problems, analysis of the ideal situation to be achieved, analysis of student learning styles, analysis of the objectives of developing media as an alternative learning source for students, analysis of Potential as support for the use of media, analysis of the environment and organizations that influence the research subject by observing the condition and existence of students as research subjects, cost analysis by conducting a survey of domain purchases and hosting rentals and their time period.

Second, the design stage (multimedia instructional design). This stage will produce product design specifications, consisting of: creating a product manufacturing schedule, determining the project team, determining media specifications, creating material structure (content). Third, the development and implementation stage (multimedia development and implementation), this stage is the process of translating the product specifications that have been produced from the design stage into the physical form of the web, namely: determining the type of web, namely a web enhanced course that is used asynchronously. Meanwhile, the Learning Management System platform used is Moodle, with an Indonesian language package, installing the components by purchasing a domain at www.rumahweb.com with the domain name www.chems-ashilla.com, renting an Indonesian hosting server at www.rumahweb .com with 500MB space with a rental period of 1 year, installing Learning Management System using

Fantastico facilities in cPanel, installing templates and accessories, uploading content and conducting reviews.

Fourth, the evaluation stage (multimedia evaluation). The evaluation stage is carried out by validating and testing the product that has been developed. Validation is carried out by subject experts, design experts and media experts. The evaluation process is carried out to determine user reactions to the product, determine knowledge aspects, performance aspects and the impact (effectiveness) of using the product.

RESULTS AND DISCUSSION

Experts in the field of physical chemistry assess material aspects with the aspects assessed including the material substance as a whole, the material substance of electrolyte and non-electrolyte solutions, the material substance of oxidation-reduction reactions and evaluation. Even though it is included in the good category, there are several parts that need improvement. Some suggestions for improvement include unclear indicators and tools that are not in sequence, but in general, based on written opinions, the product can be used for testing with students.

Validation of this design was carried out in two stages. In stage I, there were many media deficiencies, especially for frontpage displays. The choice of themes and variations provided is too standard or rigidly follows the themes that already exist standardly in Moodle. The choice of color also greatly affects the appearance of the web so that it looks less bright and less attractive, especially for students. The lack of clear instructions regarding how to use the media can make students confused about using it so that it can lead to laziness for students in using it. After it was revised, phase II validation was carried out, based on the validator's written opinion, the product could be used for trials with students.

The validation results with media experts assessed that although it was included in the good category, there were several parts that needed improvement. There are several suggestions for improvements such as irrelevant front pages and menus, more varied displays, content and attractiveness that need to be improved, but in general, based on written opinions, the product can be used for testing with students so no re-validation is carried out.

The small group trial respondents consisted of 6 students and 5 teachers in the field of chemistry who were considered to represent the population. From the data obtained from students and teachers, it can be said that the web-based learning media product that was created was liked and received a positive response, so it can be said to be good for use as a chemistry learning medium for class X senior high school on electrolyte and non-electrolyte solutions and the concept of oxidation-reduction reactions , which was revised with additional time adjusted to the difficulty level of the questions and re-analyzing the questions given.

Based on the analysis carried out through observations, data was obtained that this interactive multimedia could be developed as a solution and fulfill students' needs in the learning process. This multimedia is then designed according to the characteristics and needs of high school students, with an attractive appearance, language that is easy to understand and a simple way of using it. This media development was carried out using LMS Moodle.

The selection of this LMS is based on Moodle characteristics and usability according to the level of high school students. Apart from that, the simplicity of Moodle as an LMS is also the basis for media development. This is what differentiates interactive e-learning multimedia media from similar media. Apart from that, the use of Moodle in this media is designed not only according to the standard Moodle display, but is modified with a more attractive and systematic menu display.

This web-based media was implemented following one of the developments in internet-based learning systems, namely web enhanced courses because this media is more of a support in the learning process with asynchronous teacher supervision where this media was developed to overcome the lack of time and face-to-face hours in class.

In developing media, there are 2 aspects that a developer must have and master, namely 1) Technically, it includes basic computer skills (Xie et al., 2020), the developer's ability to express ideas in multimedia design, the developer's ability to create varied content, the developer's ability to master Moodle in a simple way. 2) Pedagogical aspects, namely the developer's ability to recognize the characteristics of students as users (Daoudi, 2022), the developer's ability to express learning ideas, the ability to develop media in accordance with the High School Chemistry Education Unit Level Curriculum, the ability to develop educational media, the ability to develop media that can create a more communicative atmosphere , the ability to develop media that not only presents lesson material but can also accommodate and manage student grades.

In accordance with the use of media that directs students towards positive things, this media also has a good impact on students. Directly, interactive multimedia e-learning can increase student interest, motivation and learning stimulation. Apart from that, the use of this media also indirectly directs students to make better use of their free time, utilizing technology for positive purposes, not just for entertainment. A further impact on the use of interactive multimedia e-learning can improve student learning outcomes so that learning objectives are achieved.

This interactive multimedia e-learning chemistry has several advantages, namely speed of access to specific information according to the wishes of the user (student) and the presence of links that enable users to more easily search for other information that is still related to the learning material. There are clear instructions for use. Starting from instructions for students to join e-learning classes. Instructions on each menu on the homepage to clarify the contents and purpose of the menu. Instructions for uploading assignments and downloading materials that students want. Strengthen user responses quickly and as often as possible in Quiz. Every time a student finishes answering, the student can immediately find out the results in the form of the accuracy of the answer (right or wrong), the score obtained, and sentences of praise if the student did it correctly and sentences of encouragement so that the student repeats the quiz if the answer is still wrong. Provide opportunities for students to control their own learning pace (self pacing). Different students' learning speeds can be served with this media. Preparation of a systematic menu by taking into account that students follow a coherent and controlled sequence because the material presented to students is interconnected according to the syllabus. Provide opportunities for students to participate in various forms of response such as: answers (in quizzes), decisions (when to study the material), and questions or opinions (in chat rooms and discussion forums). The topic is interesting and in accordance with the application of the material in everyday life in the discussion forum, so that it provides special interest for students.

Previous research conducted by Hikmi et al., (2020) regarding the Development of interactive multimedia Lectora inspires problems based on science. Where this research aims to develop Lectora Inspire Problem Based multimedia in the field of science, determine the feasibility of using multimedia, determine user responses in using this multimedia.

The weakness of the media product being developed is that the material developed is only one competency standard due to limited time and ability to complete research. The web also has limitations in terms of assessing learning outcomes, namely that it can only measure cognitive learning outcomes and cannot measure psychomotor and affective learning outcomes because psychomotor and affective assessments require direct observation from the teacher. However, psychomotor and affective values obtained from teacher observations can be integrated into value processing on the web. Media use also depends on the availability of

computers or notebooks, internet networks and electricity networks. For students or schools that do not have computer and internet equipment, this media cannot be used. It requires special skills in the field of web design to be able to create and develop media. Apart from that, it also requires persistence and sacrifice of a lot of time, energy and money to be able to produce the desired product. This media cannot be used at all levels of education because it requires prerequisite skills in the field of information and communication technology, and an attitude of independence.

This research has implications for the development of chemistry education in high schools. First of all, the proposed teaching method, which combines interactive multimedia with a problem based learning approach, can be a basis for developing more effective and interesting teaching strategies for chemistry teachers. This has the potential to increase students' intrinsic motivation towards learning chemistry and can have a positive impact on students' participation and their understanding of complex concepts. Apart from that, this research also has practical implications in supporting distance learning, which is becoming increasingly important in the era of the pandemic and developments in information technology. By using multimedia technology, learning can continue even in situations of physical restrictions. In addition, a problem based learning approach in the context of chemistry learning can also help develop important 21st century skills such as problem solving, team work, digital literacy, and critical thinking. This not only provides benefits in an academic context, but also helps prepare students to face the challenges and demands of an increasingly complex world of work. Thus, this research makes a significant contribution to advancing chemistry education and developing a curriculum that is more relevant to future needs.

Limitations of this study include the age range of the students who were the subjects of the study, which may limit the generalizability of the results to all age groups in high school. Different school contexts, including learning infrastructure and culture, can also influence the implementation and effectiveness of learning systems. Apart from that, limited research time and technological accessibility are also important factors that need to be considered. Therefore, recommendations for future research include conducting follow-up studies with larger and more diverse student samples, as well as involving multiple school contexts for more comprehensive validation. Longitudinal research and comparative analysis are also recommended to understand the long-term impact and compare the advantages and disadvantages of traditional learning methods with newly developed methods. Implementation studies and qualitative research can also provide deeper insight into the factors that influence the effectiveness of these learning systems, as well as the experiences of their use for students and teachers. Thus, it is hoped that future research can overcome existing limitations and make a greater contribution to the development of innovative and effective chemistry learning at the high school level.

CONCLUSION

This development research has succeeded in achieving the goal of producing product design and development in the form of web-based interactive multimedia to support chemistry learning on the material "Non-electrolyte and electrolyte solutions and the concept of oxidation-reduction reactions". Product design, manufacture and development are carried out using a development model which consists of several stages, namely the analysis stage, design stage, development stage and evaluation stage. Product development in the form of interactive multimedia e-learning based on the technical and pedagogical skills that developers must have. The use of multimedia by students is supported by students'

ability to use the internet which is quite good, internet network connection facilities are quite good in the school and home environment, students' ability in basic computer operations. The attractiveness of the product has been tested using expert validation processes and trials as well as ease of use which has been tested in the small group trial stage. Based on group tests, it was found that the learning media products developed were liked and received positive responses, so they could be declared good for use as chemistry learning media.

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