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Article

Development of E-Learning Chemistry Based on Project Based Learning on Buffer Solution Using Then Flipped Classroom Approach in Class XI SMA/MA

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Abstract—This development research aims to produce a development product in the form of E-learning based on Project Based Learning (PJBL) with a valid and practical Flipped Classroom approach in SMA / MA. This study uses a 4-D model development research design which includes defining, designing, developing and distributing. The product validity test was carried out by collecting data from three validators (high school chemistry teachers) using an instrument in the form of a validation questionnaire and 20 high school students using a practicality questionnaire. Based on the qualitative descriptive analysis using the formula Aiken, the results for construct validation are 0.86 and content validation is 0.86 with a high category and have a practicality value of 0.83 with a fairly practical category. Based on the results and discussion, it is concluded that E-learning based on Project Based Learning (PJBL) with the Flipped Classroom approach in SMA / MA is categorized as valid and practical.

Keywords— **E-learning, PjBL, buffer solutions**

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I. INTRODUCTION

Changes in people's lives are currently progressing rapidly, industry 4.0 is developing by creating something new, and with new changes that are so fast, education as a part of people's lives must prepare for the various changes that occur, so that they can be anticipated through efforts to improve the process. Education and learning. Many are found in the Industrial Revolution 4.0 era, developing new applications that provide more attractive learning offerings. One way to do this is to optimize the use of technology as an educational aid that can better maintain time or produce results that can change time. With Education 4.0, people and technology will be combined to create new opportunities in creative and innovative ways [1]. Here are some trends related to Education 4.0: First, learning can take place at different times and places so that students have more opportunities. Second, individual learning so that students can learn as

a learning tool in accordance with their abilities. Third, students can decide how to learn. Four project-based learning. 5, experience in this field. Sixth, interpret the data. 7 different reviews. 8 Student Involvement. 9, Advisor [2]. One of the advantages of the evaluation era of Industry 4.0 is that learning is not tied to time and space. You can do this anytime, anywhere [3].

Since the pandemic occurred due to the Coronavirus disease 2019 (Covid-19) outbreak in March 2020 in Indonesia, Covid-19 has spread to almost all regions in Indonesia. Almost all sectors of life are affected, including the education sector. The Covid-19 outbreak urged that remote education testing be carried out simultaneously for teachers, students, and parents [4]. Time, location, and distance became a big problem during the Covid-19 period, so distance learning became a solution to overcome difficulties in carrying out face-to-face learning [5]. In the education sector, the government through the Ministry of Education and Culture (Kemdikbud) does not allow face-to-face (conventional) learning and orders to implement a learning from home policy or online learning to break the chain of spreading the Covid-19 virus. Therefore, teachers are required to make a change from face-to-face (traditional) education to online education or distance education [6]. Online learning system is a learning system without face to face directly, but online using the internet network [7]. Teachers and students do learning together, at the same time, using technology-based learning media. According to Verawardina et al, online learning is effective for implementing learning even though teachers and students are in different places [8]. Online learning is able to solve the problem of students' delay in obtaining knowledge [9].

This situation pushes teachers to embrace the use of technology that can be used to support the learning process. E-learning is one of the best teaching aids for online learning. The use of e-learning in the era of industrial revolution 4.0 solved the learning problem during Covid19. The word e-learning has two parts: "e" means "electronic" and learning means "learning". Thus, e-learning means learning to use the support services of electronic devices, especially computing devices. Therefore, online learning is often referred to as “online courses” [10,11]. E-learning, which includes audio, video, animation, and navigation, is a form of independent application in electronic format of student learning resources that can improve student skills and understanding [12]. According to Prawiradilaga (2008), e-learning is part of the Integrated Learning Design Framework (ILDF). It is a learning design developed specifically for web-based learning to optimize future learning processes, e-learning or use of communication technologies [13]. There are 4 advantages to using e-Learning in your learning process. This means achieving personalized learning experiences, reducing costs, facilitating participation and increasing accountability [14]. Online learning is teacher-to-teacher because it has many features such as attendance, syllabus, books, LKPD, study videos, exercises, demo discussion forums, and allows students and teachers to provide feedback. Learn online.

Moodle is an LMS (Learning Management System) which is an application that can transform a learning medium into a web form, which is used to create and manage courses, check student attendance and performance, manage quizzes and survey assignments [15]. E-learning developed with moodle must be dynamic and comprehensive by incorporating learning material and able to accommodate a learning system that regulates the role of teachers, student roles, learning management,

utilization of learning resources, monitoring student learning development and evaluation systems. Several strong reasons, making Moodle one of the most widely used LMS. The first reason is Free and open source so that everyone can make modifications according to the needs of the institution that uses it. The model is distributed free of charge so that to use this application does not cost money. The second reason, Moodle is able to accommodate almost all conventional educational needs that are transferred in the form of online learning. The third reason, Moodle users have a large and sharing community. The fourth reason is Moodle has a small size with a maximum ability [16]

The 2013 program requires student-centered learning, with students playing a more active role. One of the learning models introduced in the 2013 curriculum is the Conservation-based Learning Model (PJBL). Project-based learning (PJBL) is learning that gives teachers the opportunity to manage classroom learning, including working on projects [17]. Project-based learning (PJBL) is an alternative learning method that can be used to evaluate student performance as well as cognitive aspects [18]. This learning model requires a student-created project. Project-based learning (PJBL) has great potential to provide students with enjoyable and meaningful learning experiences [19]. In project-based learning (PJBL), students are not completely dependent on their teachers, so students are expected to learn independently and actively [20]. Since buffer chemistry is a subject that deals with various abstract reactions and events, the learning process should be supported by the existence of a learning medium capable of displaying animal pictures.

The results of research on the application of Proect Based Learning (PJBL) can increase student activity and learning outcomes [21]. This learning is the development of an effective contextual learning because this model has the potential to make learning experiences more interesting where students are required to think creatively and collaboratively to shape student creativity and learning experiences with real projects [22].

Based on the description above, the authors are interested in developing Elearning based on Project Based Learning on Buffer Solution Material with the Flipped Classroom Approach in SMA class XI. The teaching media developed are expected to be able to make students learn independently so that they can support the learning process online.

II. METHODE

This type of research is research and development or research and development (RandD). RandD deliberately and systematically studies, envisions, improves, develops, manufactures and tests the effectiveness of its products, some of which are excellent, new, effective, efficient, productive, and of great importance. This is a goal/direction study [23]. The development model used to develop e-learning with this buffer is a 4D model (a 4D model developed by Thiagarajan et al. step). , development (development phase) and diffusion (diffusion phase) [24,25,26]. However, this study is limited to the development stage.

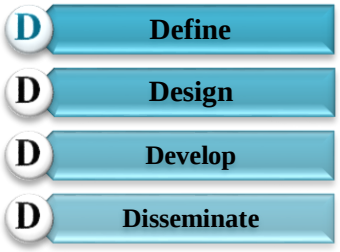

Figure 1.4D Stages of the development model

The advantages of 4D modeling are: a) suitable for use as a basis for the development of learning tools, but not for the development of

systems. learning system; Because b) more comprehensive and systematic description and c) in-depth development involving expert judgment, the learning engine is modified according to expert assessment, advice and opinion, before during field testing prior to operation. Definition Phase. In other models, this step is often referred to as a needs analysis. Thiagarajan (1974) analyzed five activities performed in the definition phase: face-to-face analysis, student analysis, task analysis, conceptual analysis, and learning goal analysis. This phase is intended to identify and define the requirements for the Core Skills-Based Learning (KD) of the revised 2013 curriculum. The design phase is aimed at designing e-learning materials according to project-based learning (PJBL) in learning materials and objectives that consist of defined phases. At this stage, an e-learning project-based learning model is designed according to a combination of modular components based on the syntax [27,28]

The development phas vfe is the stage of producing an effective product through verification tests to determine the product's effectiveness. Validation tests are performed by experts. The indicators evaluated by experts are as follows. 1) Content components include KD compliance, compliance with textbook requirements, and the benefit of adding accuracy and insights to textbook content. 2) Language components include readability, clarity of information, compliance with Indonesian rules, and effective language. 3) Presentation components provide clarity about the purpose to be achieved, sequence of presentation, motivation and appeal, stimulus and response, and integrity of information. 4) Contains graphic elements. Includes fonts, font types and sizes used, layout and arrangement, illustrations, drawings and photos, and display design. The e-learning evaluated by the validator will be modified according to the validator's suggestion to produce a valid product.

The subjects of this study were three chemistry teachers and high school students majoring in science at SMAN 1 Pendopo Barat. Validation was carried out on three chemistry teachers which included construct and content validation using a validation questionnaire instrument. The validation questionnaire aims to assess the validity of the e-learning content of the developed buffer solution material. After validation, the product developed is then revised again by the researcher until the product is declared valid. After being declared valid, the product was tried out on high school students to find out its practicality. In this study, researchers did not perform the Disseminate stage due to time and cost limitations.

Validity

The results of the validation data in the form of numbers obtained at the develop stage will be processed using the formula V 'Aiken:

$$V = \frac{\Sigma s}{n(c-l)}$$

$$S = r - lo$$

Information :

s = r – Lo

Lo = the lowest number of validity assessments (for example 1)

c = the highest number of validity assessments (eg 5)

R = number given by the assessor

The results of V ”Aiken are interpreted into the score interpretation criteria in the following table

Table 1. Aiken Score Interpretation Criteria [29]

Interval	Category
≤ 0.4	Less
0.4 <V ≤ 0.8	Moderate
0.8 <V	Valid

Practicallity

Practicality is related to the progress achieved by students used in e-learning based project based learning (PJBL) on the material throught flipped classroom approach. Analysis of student pre-quality data using Likert scale. The practicality formula used is :

$$P = \frac{f}{n} x\ 100\% \quad (2)$$

Description :

P = Pre-quality final value

f = value obtained

n = maximum value

The assessment of practicality based on Likert can be seen in table 2

Table 2. Practicality on the Likert scale

Interval	Category
80% < x ≤ 100%	Very practical
60% < x ≤ 80%	Practical
40% < x ≤ 60%	Practical enough
20% < x ≤ 40%	Less practical
0% < x ≤ 20%	Impractical

III. RESULT AND DISCUSSION

Based on the research that has been done, the results of each stage of the Thiagarajan (4D) development model have been carried out as follows.

3.1. Define Stage (Definition)

At the define stage, 5 data are obtained in the form of:

3.1.1. Front End Analysis

At this stage the researchers conducted interviews with chemistry teachers about the teaching materials and teaching media needed. Based on the results of interviews with chemistry teachers, the teaching materials and media needed are online-based media and teaching materials that can be accessed independently by students and teachers and can support online learning.

3.1.2 Student Analysis

Based on the student needs questionnaire, it can be seen that high school students still want interesting pictures and colors and animations on materials teach to make them interested in using these teaching materials. Therefore, the teaching materials developed were made in the presence of pictures, colors, animated viedo that could attract students' attention.

3.1.3. Task Analysis

Based on the 2013 revised 2018 curriculum, the material for the development of atomic theory is found in KD Knowledge: 3.12 Explaining the working principle, pH calculation, the role of buffer solutions in the body of living things. KD Skills: 4.12 Making a buffer solution with a certain pH. With the GPA as follows: 1). Explain the meaning of a buffer solution 2) Identify the pH of the buffer solution when diluted, slightly acidic, or slightly alkaline 3). Describe the types of buffer solutions 4). Describe the properties of the buffer solution 4). Calculate the pH of the buffer solution. 5). Comparing the pH of a buffer solution by adding a little acid or base or diluting it 6) Explaining the role of buffer solutions in living and industrial bodies 7). Making papers and clipping of Buffer Solutions in daily life and submitted online

3.1.4. Formulation of Learning Objectives

The learning objectives in this Buffer Solution material are described from the indicators developed in the task analysis.

3.2. Design Stage (Design)

The activities carried out in this step are designing the elearning buffer solution to be developed. The e-learning developed consists of: covers, instructions for use, lesson plans, Competency achievement indicators (IPK), modules, LKPD, evaluation sheets, and developer profiles. Teaching materials developed are based on project based learning (PJBL). The developed e-leraning is designed using Ms. software. Word, LMS Moodle, Ms. Power point, and youtube.

Figure 2. Cover display on E-learning

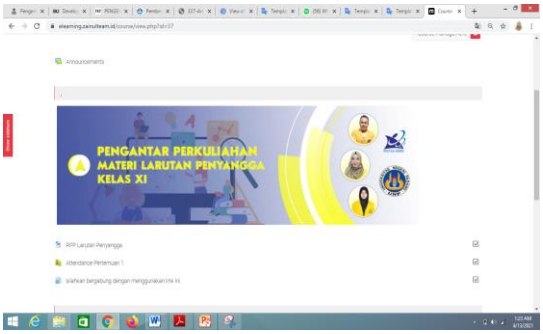

Figure 3. Home display on E-learning

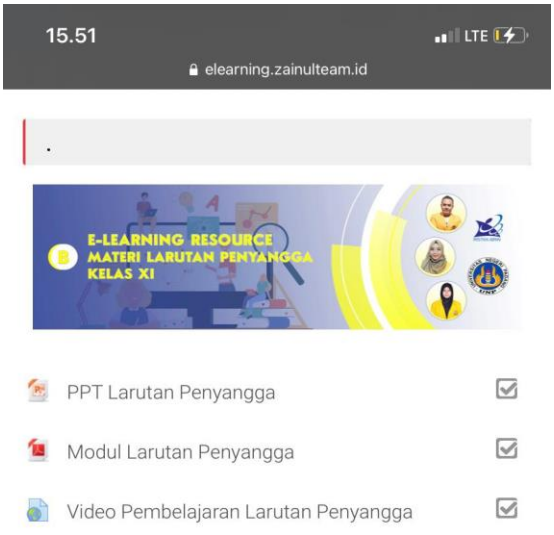

Figure 4. Display of learning resource

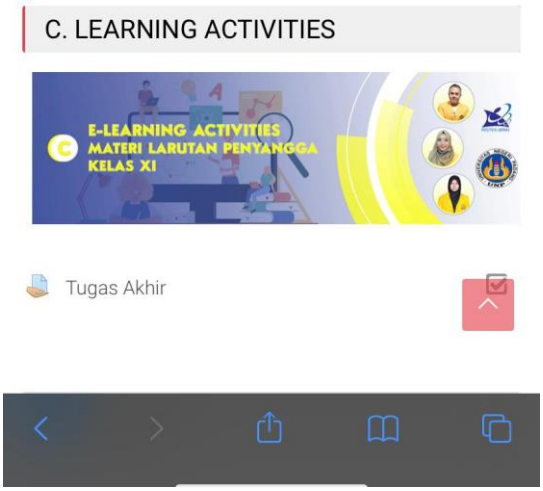

Figure 5. Display of learning activities

3.3. Development Stage

3.3.1. Validity test

The validity test on E-learning was carried out by three validators who were high school chemistry teachers. At this stage, two types of validation are carried out, namely content and construct validation using a validation sheet. The results obtained can be seen in Figure 3 and Figure 4.

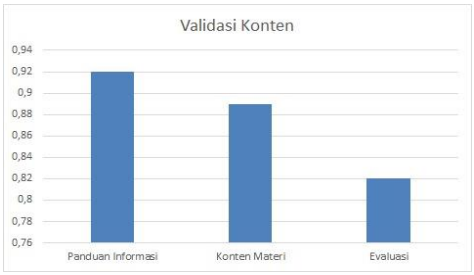

Figure 6. Graph of content validation results assessed by the validator

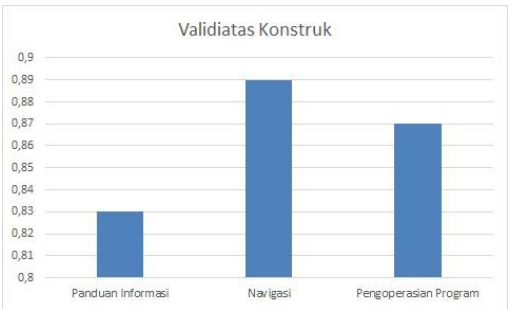

Figure 7. Graph of construct validation results assessed by the validator

The results of the content and construct validity of the E-learning learning content for the Buffer Solution material using the Moodle application developed for each component had a fairly high value of 0.86 both in the content validity and construct with very high categories. The results of the validation data showed that the learning content E-learning for buffer solution material using the Moodle application is declared valid and in accordance with the validity assessment component [26].

The content validation on the guide and information components had an average k value of 0.92, including the very high category. This proves that the guidelines and information on e-learning have met the requirements for clarity and ease of understanding e-learning.

The content / material component in elearning has an average k value of 0.88 which is in the very high category. This value proves that the content on e-learning developed is in accordance with the demands of KD according to the 2013 revision of the 2018 curriculum. The aspects of content feasibility include the suitability of the material contained in a content with KI, KD and the learning objectives provided depend on students' abilities[30] . The average k value in the evaluation component was 0.82 in the high category. In general, evaluation is a systematic process, which determines the value of something based on certain criteria through evaluation[31]. With this average value indicates that ealuation on e-learning can measure the ability of students.

The construct validation on the information alloy components has a value of 0.83 with a high category. The navigation component has a value of 0.89 with a very high category and 0.87 in the program operation component with a very high category.Based on the results obtained in construct validation, it shows that the E-learning developed has conveyed information that is easy to understand, interesting, and easy to use.

E-learning that has been validated will then be revised based on suggestions and comments from the validator.

3.3.2 Revision

At this stage, the researcher made revisions based on suggestions and comments from the validator. The revisions that the researchers did were on the GPA, usage guidelines, E-learning front cover, and adding teaching materials.

After a revision is made to the E-learning developed, it is then discussed again with the validator in order to get a valid product. The revision is complete until the product being developed is declared valid by the validator.

3.3.3Practicality test

The practicality test was carried out on students majoring in Science at SMAN 1 Pendopo Barat using a practicality questionnaire. Based on the data the researchers got, the practicality value was 0.83 which was categorized as quite practical.

IV. CONCLUSION

The Development of E-learning based on Project Based Learning on Buffer Solutions with the Flipped Classroom approach in SMA / MA is declared valid and practical with the content and construct validity of 0.86 with a very high category and a practicality value of 0.83 with a fairly practical category so that it can be used as learning media in SMA / MA

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