JHICE Journal
VOLUME 01 NO 01 2021, pp 45-57
ISSN : Print XXXX-XXXX — Online XXXX-XXXX
DOI : https://doi.org/10.24036//jhice/vol1-iss1/30

INTERNATIONAL JOURNAL OF HIGH INFORMATION, COMPUTERIZATION, ENGINEERING AND APPLIED SCIENCE

Article

Development of Project Based Learning on Reaction Rate Material Using the Flipped Classroom With Moodle for Senior High School in Indonesia

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Abstract— The development of information technology, the need for IT-based teaching, and learning concepts and mechanisms cannot be avoided. Therefore, a form of information is needed, in the form of a learning system facility called e-learning that can support the learning activities. This study aims to develop of e-learning based on project based learning on reaction rate material using the flipped classroom approach in Senior High School. This research is classified as Research and Development (R&D) using a 4-D development model. Populations in this research are students from Senior High School in West Sumatera, Indonesia. There are 20 Students of SMA N 8 Padang, in XI class level as respondents for developing this product. Research instruments used were interview sheet and validity and practicality questionnaires. Data showed that e-learning based on project based learning on reaction rate material through the flipped classroom was needed. The result of the validity sheet analysis with Aikens's V showed the average score is 0,91 (for content validity) and 0,92 (for construct validity). The result of the practicality sheet analysis the average score is 0,83 (for practicality from students). Therefore, it can be concluded that e-learning based on project based learning on reaction rate material using the flipped classroom is valid and practical.

Keywords— ***4-D Model; Flipped Class Room; Moodle; Project Based Learning; Reaction Rate***

Manuscript received 5 May 2021; revised 30 June 2021; Accepted : 04 July, Published In Press 30 December 2021.

I. INTRODUCTION

The Covid-19 pandemic has hit 215 countries in the world, including Indonesia. This is a challenge in itself for educational institutions in implementing learning. To suppress the spread of covid-19 in the Circular of the Ministry of Education and Culture of the Directorate of Higher Education No. 1 of 2020 the government has issued a policy for schools to carry out social restrictions and maintain physical distance. Learn from home, work at home, and worship at home [1]. The issuance of a policy to be able to

conduct online learning [2]. So, teachers are not only required to be good at delivering or delivering teaching materials offline (face to face in class) but also required to be experts in using the online learning system. Online learning, which is commonly known as E-learning, is following the development of digital technology in the Industry 4.0 era, which has now answered learning problems during the Covid-19 pandemic. Emphasized that digital technology is the thing that most influences the education system in the world today. This is due to the aspects of effectiveness, efficiency, and attractiveness offered by digital technology-based learning [3].

E-learning is a system that is expected not only to replace conventional learning methods and materials but to add new innovative methods and strategies in today's learning process [4]. The application of e-learning is a new medium that can overcome passive attitudes, increase learning enthusiasm, allow direct interaction, and allow students to learn independently [5, 6]. This learning is considered to have a high-efficiency value because it can be accessed anytime and anywhere and provides new experiences to increase skills in utilizing technology [7]. The use of e-learning can also make it easier for students and teachers who teach in classroom learning activities [8].

E-learning content creation uses the Project Based Learning (PjBL) model, which is a learning model that emphasizes complex learning in which students play the main role of replacing the teacher in solving problems and completing a given project [9, 10]. Project Based Learning can increase students' motivation to learn, student activity increases, student skills improve, can practice communication skills in group work, provide opportunities for students to organize projects. The use of this learning model includes the completion of a project by students whose final result is a product [11, 12]. In PjBL students are more active in learning activities, in this case, the teacher is only a facilitator and the teacher evaluates student performance results including results that can be displayed from the results of the project he is working on [13].

Flipped Classroom is a learning model that is suitable for learning using e-learning is the approach. The Flipped Classroom approach is an approach that combines online learning methods outside the classroom and doing assignments [14, 15]. This model is also known as learning that reverses traditional learning, where the material is usually given in class and students do assignments at home. It is intended that students acquire the necessary knowledge before lessons in class and during class, teachers can guide students to be more active in learning activities [16]. The implementation of a teacher-centered teaching and learning model leaves little room for students to interact with their peers and prevents students from thinking critically and learning independently. As a solution to these problems, traditional classroom activities such as listening to lectures in class should be transferred into video form so that students can learn the subject matter by watching the teaching videos not only in class [17,18]. Transferring conventional lectures into video form will make it easier for students to repeat the explanations in the video according to their needs [19, 20].

According to the New Media Consortium (NMC) report, which annually releases the latest technology in the world of education, flipped classroom learning is classified as the latest innovation medium and is highly recommended for higher education throughout the world, aiming to build students' individual learning skills, teaching and critical thinking [21, 22]. In research stated that the flipped classroom method has been applied all over the world both

in schools for various fields of study [23]. By combining the learning approach, the technology base used, and the appropriate learning model will greatly support learning in the 2013 curriculum which requires students to be more active and able to learn independently [24, 25].

Student learning outcomes can be increased by using e-learning, student learning motivation increases, and has a high level of validity and practicality [26, 27, 28]. Based on these problems, researchers are interested in researching to develop e-learning media content with the title "Development of Project Based Learning on Reaction Rate Material using the Flipped With Moodle for Senior High School in Indonesia".

II. METHODE

Research and Development (R&D) is a type of research used in this research. The 4-D model is the development model used in this study. The subjects in this development research consisted of three validators. The stages in the 4-D model can be seen in Figure 1.

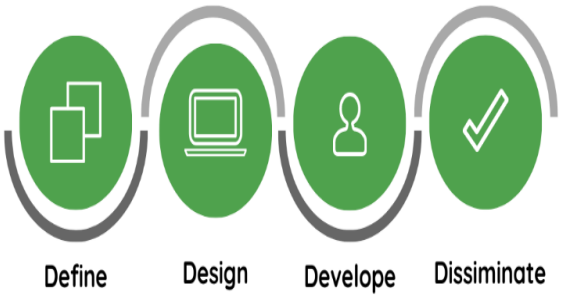

Figure 1. Stages of the 4-D development model

The creation of e-learning content begins with the define stage to define the requirements for learning activities. The requirements for learning activities begin with analyzing the basic competencies that will be achieved by referring to the 2013 curriculum syllabus. This design stage is carried out to design project-based learning e-learning on the material on reaction rates using flipped classrooms [29, 30]. In the development stage, it aims to develop e-learning based on project-based learning on the material on reaction rates using flipped classrooms. This stage consists of validity testing by three validators, revision, and practicality testing in the form of product testing by students.

Instruments used in the form of interview sheets, validation questionnaires, and practicality. Data analysis on validation using Aiken's V. Aiken's V formula as follows:

$$V = \frac{\sum s}{[n(c-1)]} \quad \text{.....(1)}$$

$$s = r - lo \quad \text{.....(2)}$$

Description:

r = Validator selection category score

n = Number of validators

lo = Lowest validity assessment number (lo=1)

c = Highest validity assessment number (c = 5)

The assessment of validity criteria based on Aiken V scale can be seen in table 1.

Table 1. Validity based on Aiken V scale [31]

Interval	Category
V ≤ 0,4	Less
0,4 < V ≤ 0,8	Medium
0,8 < V	Valid

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

$$P = \frac{f}{n} x\ 100\% \quad \text{.....(3)}$$

Description:

P = pre-quality final value

f = value obtained

n = maximum value

The assessment of praticality criteria based on Likert scale can be seen in table 2.

Table 2. Practicality based on the Likert scale

Interval	Category
80% < x ≤ 100%	Very Practical

$60\% < x \leq 80\%$	Practical
$40\% < x \leq 60\%$	Practical Enough
$20\% < x \leq 40\%$	Less Practical
$0\% < x \leq 20\%$	Impractical

III. RESULT AND DISCUSSION

This research produces e E-Learning Based on Project Based Learning on Reaction Rate Material using the Flipped Classroom. The value of the results of the validity of content and constructs using Aiken's V is 0.91 and 0.92 so that this media is said to be valid and the result of the student response obtained a score of 0.83 which means that e-learning developed is practical.

A. Define Stage

1) **Front End Analysis:** The use of information technology in learning is still inadequate. This is evidenced by data from the Central Bureau of Statistics in 2017, Indonesian internet users reached 143.26 million users, but their use is still dominated by the exchange of messages (89%) and social media (87%). This means that information technology has not been utilized optimally to improve abilities, especially in the learning process. This research is also related to conditions in Indonesia and the world hit by Covid-19 with the issuance of policies, namely learning from home, working from home, and worshiping from home, so it is necessary to develop e-learning based on project-based learning on the material on reaction rates through the flipped classroom approach.
2) **Student Analysis:** Based on previous research, it was found that the learning process using e-learning could improve student learning outcomes [32]. In addition, it can increase student motivation [27]. E-learning media is categorized as a valid and practical learning tool with a high level of validity and practicality [28].
3) **Task Analysis:** In the analysis of tasks carried out an analysis of Basic Competencies on chemicals, namely the reaction rate described in Indicators of Competency Achievement (IPK). Basic Competencies (KD) in this material are KD 3.6 which is described as IPK 3.6.1. Explain the meaning of the reaction rate, 3.6.2. Describe the collision theory in terms of reaction rates and 3.6.3. Describe the factors that affect the rate of the reaction.
4) **Concept Analysis:** to determine the fundamentals needed in the reaction rate material by determining the basic concepts contained in the reaction rate material and compiled into a hiraerki concept map based on the sourcebook that uses textbooks.
5) **Analysis of Learning objectives:** The analysis of learning objectives is obtained based on the Competency Achievement Indicators that have been made in the task analysis, so the learning objectives of this material can be explained, namely by compiling e-learning content with computer-based independent learning strategies and students' devices are expected to be able to explain reaction rates, explain the theory collision and Explain the factors that can affect the rate of reaction by developing an attitude of religiosity (having faith and piety, carrying out all orders), independence (creative and innovative), integrity (honest and responsible).

B. Design Stage

Activities carried out in this step, namely designing the e-learning preparation rate of reaction to be developed. This e-learning arrangement was made using the Adobe Illustrator application, Wondershare Filmora, Microsoft PowerPoint, and Kvisoft Flipbook Maker [18]. The results obtained are:

1) **E-learning Introductory Page:** On this page, there is a description of the reaction rate material, lesson plan, syllabus, and a link to start an online class. Each material icon is made to be connected directly to the target page or document. In the first stage, interactive activities occur between educators and students. In the orientation stage, students are given an introduction and direction towards the learning activities that will be passed. Because one measure of the success of learning activities is strongly influenced by the clarity of instructions given at the beginning of the activity. The cover page design can be seen in Figure 2.

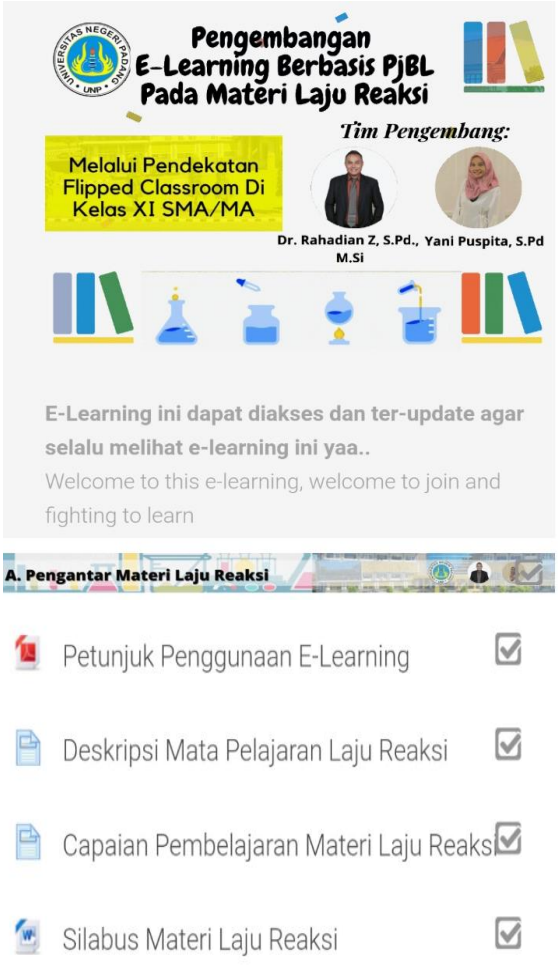

Figure 2. Home Display on E-Learning

2) **Learning Resources Page:** The material presented on the e-learning tool uses PDF, Word, SWF formats, and presentations (PPT) made at each meeting. The learning resources used are books, student worksheets, i-Spring media, videos, practical guides, etc. On this page, there is also a youtube link showing the application video. Videos show the relationship between material and applications in everyday life. The design of the learning resources page can be seen in the image below.

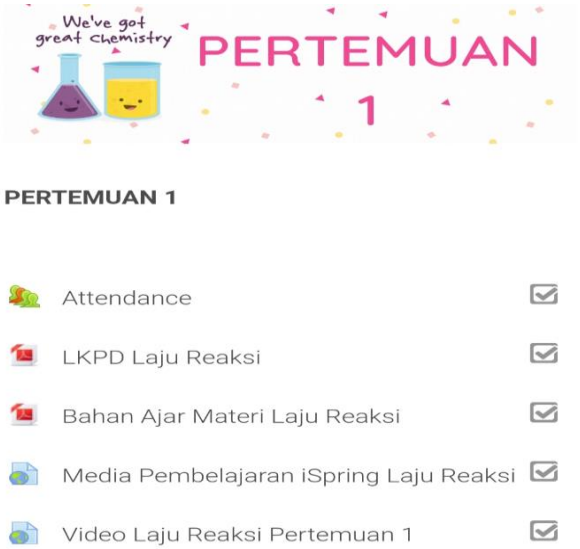

Figure 3. Display of learning resource for meeting materials 1

The first meeting discussed the concept of reaction rate. The teaching materials contained in the first meeting were student worksheets, books, i-Spring learning media, and learning videos. The following is one form of the display if students want to open student worksheets (LKPD), in Figure 4.

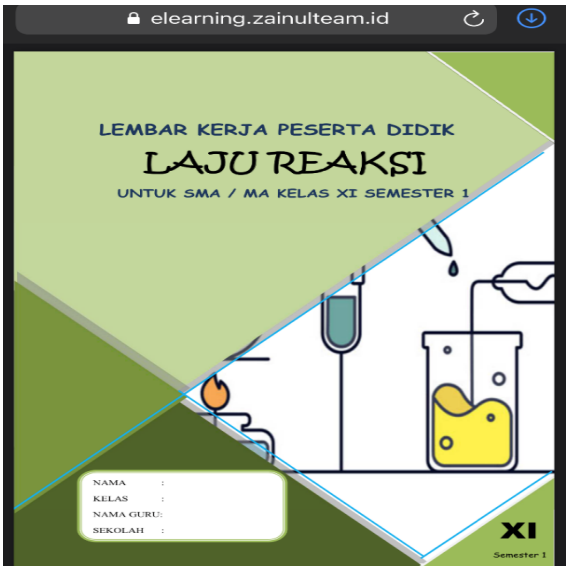

Figure 4. Display of reaction rate teaching materials

The second meeting discussed the collision theory. The teaching materials contained in this meeting were the collision theory PowerPoint, the first collision theory video, and the second collision theory video. The display of the second meeting which can be seen in Figure 5.

Figure 5. Display Learning resource for meeting materials 2

The third meeting discussed the factors that affect the rate of reaction. The teaching materials contained at this meeting were practical guides regarding student projects at home. The following is the display form of the third meeting, namely in Figure 6.

Figure 6. Display Learning resource for meeting materials 3

3) Learning Activities Page: All student activities can be found on this page. Student activities such as, there is a forum for discussion, chatting, submitting project assignments, and evaluations that must be completed by the user within a certain time. The design of the learning activities page can be seen in the image below.

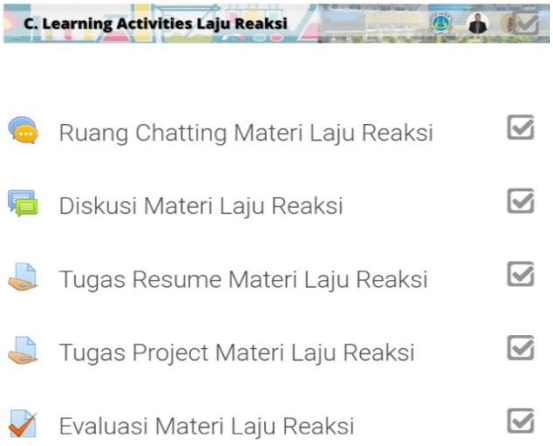

Figure 7. Display of Learning activities

On this page, there is a form for submitting project assignments that will be made by

students at home based on the instructions given by the teacher, as for the appearance for collecting this assignment can be seen in Figure 8.

Figure 8. The project assignment submission view

In the display of learning activities, there are evaluation questions, evaluation questions are made to see the extent of students' understanding after using e-learning that has been developed and see the responses of the students themselves. The evaluation questions made consisted of various types of questions, namely multiple-choice, true-false, multiple-choice text, etc. The display of the evaluation questions can be seen in Figure 9.

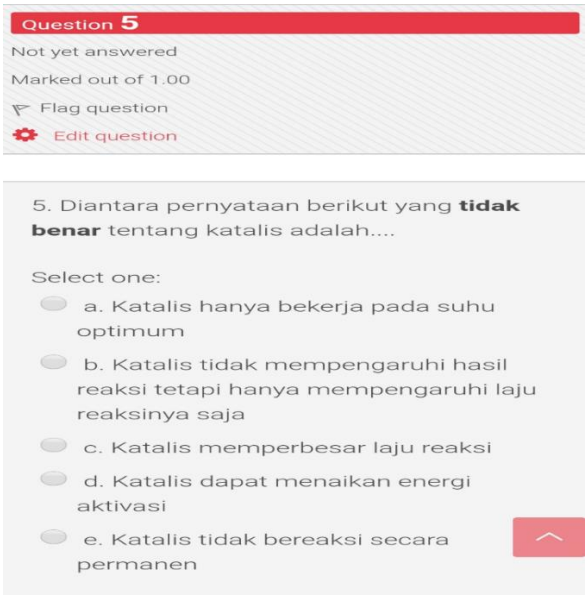

Figure 9. Evaluation of material reaction rate

C. Develope stage

1) Validity test

Validity testing is intended to be able to assess a product that has been designed. The validity of this e-learning is determined using an assessment questionnaire sheet that has been validated by three validators. This is based on the statement that to test the validation, three experts can use judgment [33]. The validation test in this study is divided into two, namely the content validity test and the construct validity. The content validity consists of a guide and information component, the material on e-learning and evaluation. Construct validity consists of three components, namely guide and information, aesthetics, program performance and systematics, and design principles. Overall, the validity of project-based learning e-learning on the material reaction rate through the flipped classroom approach developed for each component of content validity and construct validity has very high categories, namely 0.91 and 0.92. The validation results show that e-learning based on project-based learning on the material reaction rate through the flipped

classroom approach is declared valid and follows the validity assessment component [34, 35].

Validity testing is intended to be able to assess a product that has been designed. The validity of this e-learning is determined using an assessment questionnaire sheet that has been validated by three validators. This is based on the statement that to test the validation, three experts can use judgment [33]. The validation test in this study is divided into two, namely the content validity test and the construct validity. The content validity consists of a guide and The results of the validation of the guide components and information on content validation have an average value of 0.94, very high category. Based on the scores, it can be concluded that the guidelines and information on e-learning have met the requirements for clarity and ease of understanding e-learning. This is following the principles of learning using e-learning, which can provide assistance and convenience for learners to understand learning material and provide assistance in carrying out assignments according to clear directions [36, 37].

Furthermore, the content component in e-learning with a value of 0.89 is included in the very high category. This value proves that the content in the e-learning developed is following the demands of the KD 2013 revision of the 2018 curriculum. The aspect of content feasibility includes the suitability of the material contained in a content with KI, KD and the learning objectives provided depend on students' abilities [38]. This is following the provisions of the facilities that e-learning must-have, which must be able to build new insights and techniques related to learning objectives and also following the principles of making e-learning, namely subject matter that is delivered systematically and according to applicable standards general [36, 39].

The average score of the evaluation section is 0.88 in the high category. In general, evaluation is a systematic process, which determines the value of something based on certain criteria through evaluation [40, 41]. With this average value, it shows that evaluation on e-learning can measure the abilities of students. This follows the principles of making e-learning where there must be a means used to determine learning achievement, namely by evaluating feedback from students [36].

Next is construct validation. The first component in construct validation is guidance and information. The average value is 0.97, including the very high category. This value proves that e-learning has conveyed information that is clear and easy to understand. This is following the features that e-learning must-have, one of which can provide information about the teaching and learning process, such as objectives, syllabus, and others [42].

The average score for the program performance component is 0.90, which is in the very high category. This section covers program installation, user-friendliness, and consistency in e-learning. To produce e-learning that attracts students' attention, e-learning must be simple. Simple means that it makes it easier for students to use technology and the menu system, the convenience of the provided panel makes the student's study time more efficient. E-learning that is made must also have a service system, fast responsiveness, and high learning flexibility (can be used repeatedly) to handle the needs of students [43, 44].

The last component is systematicity, aesthetics, and design principles, with an average score of 0.88, which includes very high validity categories. Interesting e-learning can motivate students to read learning materials [45]. The number of functions included in online learning can be optimized to increase students'

interest in learning and learning outcomes when learning in the classroom [26]. The results of content and structure validity analysis are shown in Figure 10 and Figure 11.

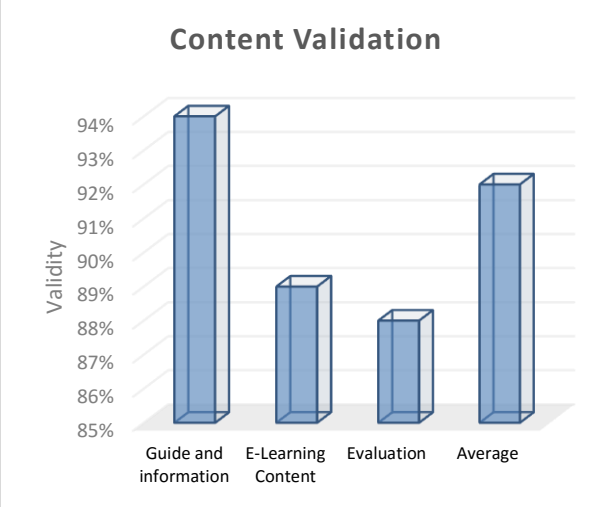

Figure 10. Content validation

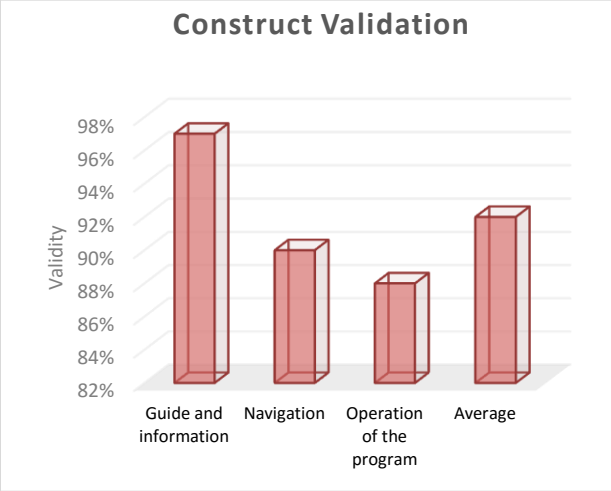

Figure 11. Construct validation

Based at the description above, it is able to be concluded that E-learning knowledge of made on Reaction Rate Material primarily based on project-primarily based gaining knowledge of the usage of the Flipped Classroom Approach which is demonstrated primarily based totally on assemble validation questionnaires and legitimate content material can be used withinside the gaining knowledge of process, mainly response price materials.

2) Practicality

Practicality testing was carried out on 20 students at public high schools in the city of Padang. The practicality data of students with a value of 0.83. The evaluation of the practicality of all students shows that the e-learning delivered has language that is easy to understand, the storyline presented is also easy to understand, this e-learning can be reused, so that learning time is more effective, can increase memory, increase the desire to learn, and makes it easy for students to follow the reaction rate material. In terms of benefits, e-learning is categorized as very practical. This shows that the e-learning developed is in accordance with the function of e-learning as an independent teaching material, so that students can take advantage of the module for self-study without depending on the presence of the teacher. Pictures and experiments can assist college students recognize the idea via the questions withinside the evaluation questions.

E-learning knowledge of that is made have to additionally have excessive gaining knowledge of flexibility (may be used repeatedly) [43]. According to preceding research, the gaining knowledge of method the usage of e-learning knowledge of can enhance pupil gaining knowledge of outcomes, gaining knowledge of motivation, and feature a excessive level of validity and practicality [26]. The benefits of using E-learning can also be seen from students' activities in learning. Learning using E-learning makes students actively conduct learning activities through classroom activities, such as discussing on discussion forums and chat discussion rooms. The learning outcomes, activities, and motivation of students in learning using E-learning prove that E-learning content is suitable for use in chemical learning in high school.The consequences of the pupil practicality evaluation may be visible in Figure 12.

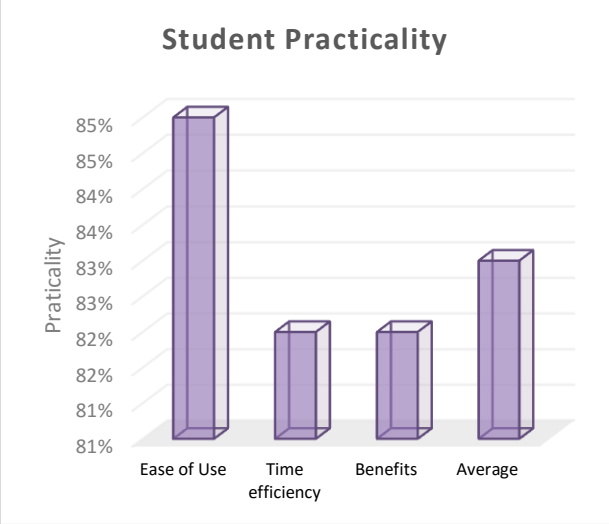

Figure 12. Student praticality

The results of practicality prove that E-learning is based on Project Based Learning on Reaction Rate Material using the Flipped Classroom Approach in Senior High School is practically used in the learning process.

IV. CONCLUSION

Development of Project Based Learning on Reaction Rate Material using the Flipped With Moodle for Senior High School in Indonesia produced in this development research has content and construct validity levels of 0.91 and 0.92, respectively, with very high scores. The practicality for students got a result of 0.83 with a very high score category. So, Project Based Learning on Reaction Rate Material using the Flipped With Moodle for Senior High School in Indonesia produced is valid and practical for use in the learning process.

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