JHICE Journal
VOLUME 02 NO 01 2022, pp 36-45
ISSN: Online 2809-6916
DOI : https://doi.org/10.24036/jhice/vol2-iss01/56

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

Article

Development of E-Learning Content on Corrosion Based on Flex Discovery Learning Approach for Senior High School

Rahmi Eka Witri[1*], Citra Girsang[2], Anna Mariana Situngkir[3] Dian Fitriyani[4]
[1] Magister Programme of Educational Chemistry , Postgraduate, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Barat, Padang Utara, West Sumatera, Indonesia. 25171 Indonesia
[2,3]UNESCO IHE Delft, Belanda
[4]Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Indonesia, Kampus Universitas Indonesia Depok, Jl. Lingkar Kampus Raya, Pondok Cina, Kecamatan Beji, Kota Depok, West Java 16424, Indonesia
[*]rahmiswee3@gmail.com

***Abstract*—** The COVID-19 pandemic has affected the education system in Indonesia, one of which is the implementation of learning from home policies. To assist the learning process, corrosion e-learning based on flex discovery learning has been developed for senior high school. This research is a research and development with 4D model. E-learning has been validated by three validators and tested for practicality by 10 students of SMA Negeri 2 Pasaman, West Sumatra, Indonesia. Data were analyzed by Aiken V and the percentage of students' understanding, using instruments in the form of validity and practicality questionnaires. The average value of V content and construct validity test results was 0.86 and 0.88 and for practicality the average value was 0.83. These data prove that the developed e-learning is valid and practical so that it can be used in the learning process.

Keywords— **E-Learning, Discovery Learning, Flex, Corrosion**

Manuscript received 5 May 2022; revised 15 June 2022; Accepted: 20 June, Published 30 June 2022.

I. INTRODUCTION

All human life is experiencing a very wide impact due to the Covid-19 Pandemic, including the world of education. The most felt impact is the change in the learning process to distance learning process. According to the circular letter of the Minister of Education No. 4 of 2020, during the Covid-19 emergency period, distance learning (PJJ) is carried out, either online, offline or a combination of both [1].

Distance Learning process makes students less enthusiastic in learning and does not understand the learning material due to the lack of interaction between educators and students. In this condition, educators are required to continue to carry out learning in class (face to face) and balanced by applying learning from home (learn from home) using a blended learning model. For this reason, learning interactions are needed through face-to-face learning activities with e-learning that involve technology for the implementation of education during this pandemic[2].

The COVID-19 pandemic has forced teachers to get out of their comfort zone, like it or not, teachers must be internet literate, one of which is that teachers must be able to use e-learning. E-learning is utilization of internet technology as a solution to improve learning[3].

E-learning possible become a new thing for some teachers, but maybe some already consider it a familiar thing. For teachers who live in the area (not in the city) of course this is a new thing. Even though E-Learning is a new thing for the local teachers' world of work, but like it or not they have to use it in the midst of conditions that do not allow someone to meet face to face. Or for teachers who have thought that cellphones are

just a communication tool, now they have to volunteer to make them a partner in teaching. This condition finally forced the teachers to voluntarily want to be friends with the internet. Not a few of them were initially anti, now they are familiar with the internet[4]. One of the learnings that is always related to the internet is e-learning. By using learning support facilities, e-learning can be created by combining content digitally [5]. Learning with e-learning can be done anytime and anywhere, students are free to undergo the process as they wish. Besides that, e-learning is also equipped with learning resources such as teaching materials and multi-media, so that learning with e-learning is more effective and flexible [6] [7].

Ideally, the learning carried out should be student-centered, this is in line with what is stated in the 2013 Curriculum. For that we need a learning model that can involve the active role of students, one of which is the discovery learning model. In the Discovery Learning model, students are trained to seek and investigate knowledge critically, analytically and systematically so that by itself they can formulate their findings. One of the advantages of the discovery learning model is that the knowledge acquired will last longer and be easier to remember because children are directly involved in the process of discovering the knowledge, besides being able to improve their reasoning and critical thinking skills [8]

Each learning model always uses syntax/steps. Stimulus, Problem statement; Data collection; Verification and generalization are steps that must be followed in the discovery learning learning model [9]. The learning process using e learning with discovery learning models is carried out using a blended learning flex model approach or what is often called online or network-based learning. The Blended Learning Flex Model focuses on independent learning based on online learning where the teacher has prepared the focus of the material and assignments through the internet network[2].

The learning model cannot run optimally without the use of optimal media. One of the media used is LMS (Learning Management System). LMS is an application designed to create, distribute, and manage the delivery of learning materials.Its features provide learning materials and multimedia resources online. LMS can be used in face-to-face learning directly or online. LMS is a combination of traditional learning techniques and the use of digital learning resources[10].

One of the LMS that is widely used is Moodle. Moodle is one of the most famous learning management systems in the world. MOODLE was designed by Martin Douglas at Curtin University, Australia. Moodle is a free software known as a modular object-oriented dynamic learning environment that aims to help students and lecturers achieve quality teaching[11]. The software application that is often used by educational institutions is Moodle that aims to help accelerate learning, improve learning, improve learning outcomes enhance the high quality of learning process and manage learning. Moodle is very flexible and has complete features so that almost all user needs are available in this e-learning. Including managing the learning process[12] [13].

The learning process becomes easier by using Moodle [14]. To increase student interest and learning outcomes, the features contained in the Moodle application must be used optimally[12]. One alternative to improve the quality of learning and train higher order thinking skills is to develop e-learning using the Moodle application [15].

In the learning process, teachers and students are greatly helped by this Moodle application-based E-learning. Flex model is a blended model that utilizes the internet network as a medium for distributing materials and learning activities [16]. Students in the group (modality) participates in online learning according to the lesson schedule that has been designed by themselves, the teacher, or the school [17]. Learning in schools is carried out online and face-to-face learning if students need individual tutoring assistance, discussions, and group projects[2].

Some of the problems above encourage researchers to conduct research on e-learning development using the Moodle application with the title "Practice Study of Corrosion E-

Learning Development Based on the Flex Discovery Learning Approach for SMA".

II. METHODE

Research and development (R&D) is a type of research conducted. Research aims to develop new products or improve existing products which can be held for accounted [18]. In this case, the resulting product will be tested for effectiveness [19]. This study uses a 4D model. The 4-D model (four D model) includes 4 stages: define, design, develop and disseminate[20][21] . In this study, only validity and practicality will be tested, which are in the development stage.

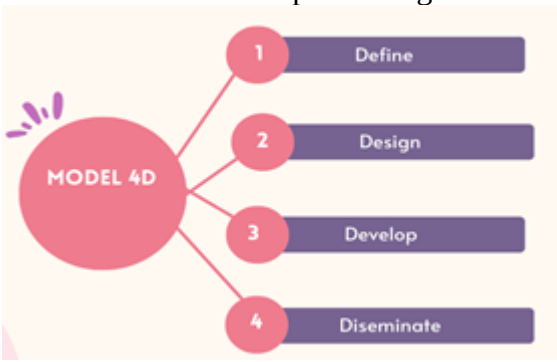

Figure 1. Stages of the 4D Model

1. Define stage

At this stage we determine and define the things needed in developing learning media. At this stage the researcher collects information about the importance of e-learning with a flex approach based on discovery learning on on corrosion material by considering students' creativity, problems faced in the learning process and the availability of infrastructure, especially ICT-based equipment [22]

2. Design stage

At this stage the researchers have started to design a prototype learning device. Several stages need to be carried out such as choosing suitable media for learning, preparing E-learning content according to the needs in learning such as: preparing clear instructions for use, preparing a syllabus, learning implementation design, source books, Student Worksheets, videos learning, powerpoint, and evaluation questions/quizzes that are packaged as attractive as possible

3. The develop stage

Revision of learning media carried out at this stage was carried out according to input from the validator and the results of student responses to the use of e-learning on corrosion material. The research instrument used was a content and construct validity questionnaire given to three media experts and a chemist. The media expert validator is a postgraduate student of UNP chemistry education and the chemist validator is a chemistry teacher at SMAN 2 Pasaman.

The research instrument used was a content and construct validity questionnaire given to three expert validators, namely postgraduate students of UNP chemistry education. The research instrument that has been filled in is then analyzed to determine the validity and practicality of the e-learning that has been developed. Aiken V is used to analyze the validity with the formula [23]

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

$$S = r - l_o \quad \text{.....(2)}$$

l_o = lowest category of given scale
c = number of categories to choose from
r = the value provided by the validator
n = number of validators

Based on the V aiken scale, the validity assessment criteria can be seen in Table 1 below

Table 1. Validity based on V aiken scale

Aiken Scale	Validity category
V≤ 0.4	Less
0.4 ≤V ≤0.8	Are
0.8 < V	Valid

The number V ranges from zero to one. The greater the value of V (close to 1 or equal to 1), the better the value of the validity of a product, and conversely the smaller the value of V (close to zero or equal to zero) then the value of the validity of a product also decreases[24]

To assess the product in terms of use, benefit and efficiency of learning time, practitioners use an instrument in the form of a practicality questionnaire. The practitioners in this study were 10 students of class XII at SMAN 2 Pasaman. Data from the practicality of the questionnaire were processed using the percentage approach as proposed by Kunandar[25] and the practicality category can be seen in table 2 with the following formula:

$$P = \frac{F}{N} \; x \; 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

P = percentage of student understanding
F = score gained
N = maximum value

Table 2. Practicality Category

Practical criteria	Practicality level
0.85 - 1.00	Very practical
0.70 - 0.85	Practical
0.50 - 0.70	Less practical
0.01 - 0.50	Not practical

4. Disseminate Stage

At this stage, the effectiveness of e-learning was tested, but in this study the fourth stage (dissemination) was not carried out because the purpose of this study was limited to obtaining valid and practical products.

III. RESULT AND DISCUSSION

The result of this research is the learning media in the form of corrosion e learning for class XII high school students. By using aiken's V, the content and construct validity values obtained are 0.86 and 0.88, meaning that this learning media is valid. Meanwhile, from student responses, a score of 0.83 was obtained, meaning that the e-learning developed could be used practically. Here are the steps that have been taken :

3.1 Define stage

3.1.1 Front end analysis

The define stage starts from the front end analysis which aims to determine the fundamental problems in chemistry learning. The Covid-19 pandemic has affected all aspects of life. Various policies have been issued to contain the spread of COVID-19 virus, starting from educating the public about the 3M slogan, namely: wearing masks, washing hands with soap and keeping a distance[26] to other policies, one of which is by implementing a work from home policy called "Work from Home" (WFH)[27].

This policy applies to the community aiming to complete all the work at home. This policy applies to communities that aim to reduce interaction by completing all work from home. Likewise, the world of education in Indonesia is also feeling the impact of the Covid-19 pandemic. Due to interaction restrictions, the Ministry of Education and Culture has also published a school closure policy and replaced it with a learning from home process[28]. To support distance learning during the pandemic, it is necessary to develop e-learning based on flex discovery learning on corrosion materials for class XII SMA/ MA.

3.1.2 Student analysis

Analysis of student was carried out by giving questionnaires to students of SMAN 2 Pasaman whose learning process only used the google class room application, not using the e-learning that had been designed regularly. From the results of the questionnaire analysis, It is concluded that flex discovery-based corrosion e learning for SMA needs to be developed.

3.1.3 Concept Analysis

Analysis of concept aims to identify the main concepts/materials that will be taught to students, in this case referring to the Minister of Education and Culture 37 of 2018 concerning changes in core competencies (KI) and basic competencies (KD)[29]. Referring to this Minister of Education and Culture, the syllabus of knowledge about corrosion is in:

KD 3.5 Analyze the factors that influence the occurrence of corrosion and how to overcome them.

From KD 3.5, Indicators of Competence Achievement (IPK) can be derived:

3.5.1 Analyzing the process of metal corrosion through experiments

3.5.2 Analyzing ways to prevent or inhibit the corrosion process through experiments

3.1.4 Task Analysis

Analysis of task aims to identify the skills that students must possess,, in this case referring to Permendikbud 37 of 2018 concerning changes in core competencies (KI) and basic competencies (KD)[29]. Referring to this Permendikbud, in the syllabus, skills about corrosion are in KD 4.5 Propose ideas to prevent and overcome corrosion. From KD 4.5, Indicators of Competence Achievement (IPK) can be derived presenting the experimental results of the corrosion process and the corrosion prevention process.

3.1.5 Setting Instructional Goals

The learning objectives are derived from the analysis of competency achievement indicators based on the basic competencies contained in the 2013 revised 2018 curriculum. The learning objectives on corrosion material are formulated as: Through Discovery Learning activities based on a flex approach by digging up information from various source,s conduct simple investigations and process information, so that students participate actively, have an attitude of curiosity, be careful in expressing opinions, answer questions and provide criticism and suggestions, and can analyze the factors that influence the occurrence of corrosion and propose ideas to prevent and overcome the occurrence of corrosion

3.2. Design Stage

The learning media included in e-learning was created using the Canva application to design covers, labels and powerpoints in the form of videos and learning videos, . Making e-learning is also supported by other applications, such as MS Word and pdf in the manufacture of teaching materials and student worksheets (LKPD).

In developing e-learning, Moodle software is used by logging in via the https://elearning.zainulteam.id/ link. The initial stage, we first create an account, as shown in Figure 2

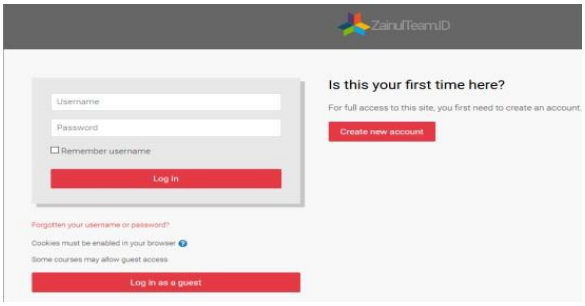

Figure 2. Login to Zainul Team E-learning

After creating an account, we will log in and start compiling e learning, so that later it will look like picture 3

Figure 3. Home on E-LearningFlex-based Discovery Learning (DL)

There are three parts to this e-learning, namely the introduction of corrosion materials, corrosion learning resources and corrosion learning activities. Introduction of corrosion material such as attendance, syllabus, design of learning implementation, introduction of corrosion material, and web meeting to conduct meetings. As a guide in the implementation of learning, researchers also develop lesson plans and syllabus.

This stage is the orientation stage, where students are given instructions about the learning activities to be undertaken. The clarity of instructions given at this early stage is one measure of the success of learning activities[30]

Figure 4. Introduction to Corrosion Material

The second part is Corrosion Learning resources. In this section, students can find concepts from learning materials through the resources provided by the teacher, be it books, videos, powerpoint, and even student worksheets. To attract students' interest in learning, the learning resources provided are made as attractive as possible such as videos, powerpoint and worksheet. The worksheets developed are designed to be as attractive as possible and serve as a guide in following every step of learning[31].

Figure 5. Learning Resources

The third part is learning activities. In this section there are activities that must be followed by students in the learning process. This activity aims to measure student achievement in understanding a learning material. In learning activities on this corrosion material there are discussion forums, chat discussion rooms, video assignments and practicum reports, results of LKPD discussions and evaluation questions in the form of quizzes that require students to actively play their roles. Students are given the freedom to access which parts of the web site they are fascinated in, which motivates them to discover out due to the fact this activities is driven via their curiosity [32].

Figure 6. Learning Activities

3.3 Design Stage

3.3.1 Validation

To assess a product, a validity test is carried out. An instrument is stated to be valid if it is able to measure what it is supposed to measure [33]. To determine the quality of the product, validation is carried out by experts. From the validation results, it can be seen the weakness of the product and improvements are made according to the suggestions from the validator so that a higher quality product is produced[34] [35].

The instrument used in this study was a content validity and construct validity questionnaire filled out by 3 experts. Content validity consists of 3 components, namely (a) guidance and information, (b) content/materials in e-learning and (c) evaluation. And construct validity also has three components, namely (a) guidelines and

information, (b) program performance and (c) aesthetic systematics and design principles. In the following pictures 7 and 8.

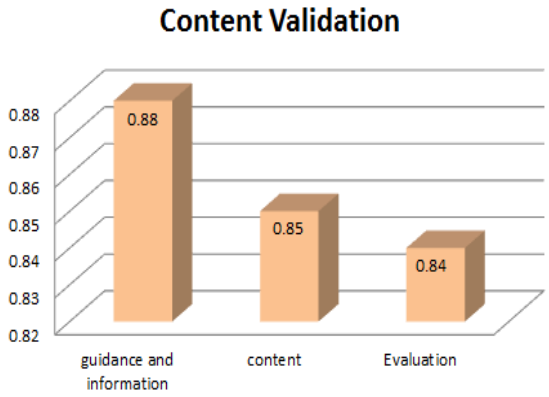

Figure 7. Graph of Content Validation Results

In Figure 7 it can be seen, the guidance and information components have an average score of 0.88, the category is valid. This proves that the e-learning guidelines and information are clear and easy to understand. The content/material component of e-learning has an average Aiken score of 0.85, a valid category, meaning that the content/material developed in e-learning is in accordance with the learning objectives and basic competencies [36] And for the evaluation component, the average value of Aiken's V is 0.84 with a valid category. Evaluation in general can be interpreted as a systematic process for determining the value of something from exclusive criteria.

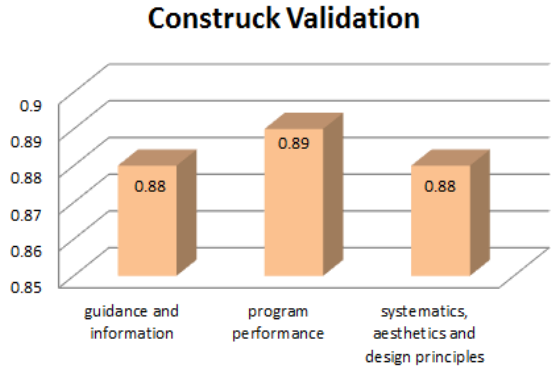

Figure 8. Graph of Construct Validation Results

Furthermore, the results of construct validation can be seen in Figure 8. Similar to content validation, the first component of construct validation is also guidance and information with an average of V Aiken of 0.88 is included in the valid category. This also proves that the guidelines and information contained in e-learning are easy to understand and clear. Aiken's average score on the program performance component is 0.89 with a valid category. This means that the program is working properly. And in the last component, the average value of Aiken is 0.88 in the valid category for systematic, aesthetic and design principles, this proves that the e-learning developed attracts children's learning interest, so that learning outcomes increase [37]

3.3.2 Practicality

Practicality analysis obtained from the student response instrument to E-learning corrosion with an average of 0.83 is in the very practical category, it is considered that students have enthusiasm and concern for the use of E-learning. From a practical point of view, it can be concluded that the developed e-learning can be used as an independent learning medium, where students learn independently without being dependent on the presence of the teacher[38].

Learning using E-learning involves students actively through classroom activities, such as discussions in discussion forums and chat room discussions, and other activities whose features have been provided in e-learning. The ability of students to think critically in collecting information, observing objects, recording observations, providing explanations, and drawing conclusions can also be developed through the discovery learning stage in e-learning.

Table 3. Practicality Test Results

No	Question	Practical Value
1	Instructions for using DL flex based e-learning on corrosion topics are clear	0.86
2	The language used in DL flex-based E-learning on corrosion topics is easy to understand	0.85
3	can repeatedly use DL flex-based E-learning on corrosion topics	0.88
4	learning time with DL flex-based E-learning on the topic of corrosion becomes effective	0.83
5	learning time with DL flex-based E-learning on the topic of corrosion becomes efficient	0.77
6	thinking skills improve with the use of DL flex-based E-learning on the topic of corrosion	0.83
7	The use of DL flex-based E-learning on the topic of corrosion can improve memory	0.82
8	interest in learning through the use of E-learning based on DL flex on the topic of corrosion is increasing	0.83
9	DL flex-based E-learning on corrosion topics can make self-study easier	0.81
10	DL flex-based e-learning on the topic of corrosion can increase students' learning motivation	0.82

IV. CONCLUSION

Based on the data analysis of the research that has been done, the learning media that has been developed in the form of corrosion e-learning based on flex discovery learning approach for senior high school has a content validity level of 0.86, a construct validity level of 0.88, and a practicality level of 0.83. So it can be said that corrosion e-learning based on flex discovery learning approach for senior high school is valid and practical, so the resulting product can be used in teaching and learning activities

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