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Article

Development Content Learning System (CLS) Material Inter-Molecular Force Based on Project Base Learning (PjBL) with Flipped Classrooms in Senior High School

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Abstract— E-learning is based on project-based learning with the approach of flipping the class on intermolecular forces as a variant of the learning media. This study aims to produce intermolecular learning material based on project-based learning models and is supported by the zainulteam.id LMS model and to reveal the validity and practicality of E-learning. This type of research is R&D with a 4-D model which includes stages, design, development, and dissemination. This research is in the development stage in the development section of the validity and practicality test. The instruments used were a valid questionnaire given to three experts and a practical questionnaire given to 20 students of SMAN 8 Padang. The data analysis technique used the Aiken V formula and the Kunandar formula. Data analysis shows the content and structure validity of 0.83 and 0.89 and a practical value of 0.83, so that it can prove that the content of e-learning developed is valid and practical

Keywords— ***E-learning, PjBL, Flipped Classroom, Inter Molecular Force***

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I. INTRODUCTION

Facing the era of the industrial revolution 4.0, you must be familiar with the rapid development of technology. This also has an impact on technological developments in the field of education. The rapid development of technology, encourages educators to update the teaching materials used. In addition, educators are also required to be able to master and utilize existing technological advances in order to

create students who are prestatif and can learn independently and creatively[1].

During the learning process, the existence of media becomes very important. Material that is abstract, can be helped by the presence of media. in other words, learning media serves as a way that can provide visual experience, motivate learning, clarify the content of the material, and simplify concepts that are unique, specific, and easy to understand[2].

To encourage students to use educational and positive media technology, teachers play a very significant role in facilitating their learning activities to use media technology as a learning resource. Media technology, if properly utilized, will be a very valuable tool, especially if it is integrated into a curriculum relevant to the 21st century[3].

One of the chemicals that includes concepts involving the representation of phenomena at the macroscopic, symbolic, and microscopic level is intermolecular forces. A thorough understanding of the topic of intermolecular force depends on the learner's ability to understand and integrate the three levels of representation in a phenomenon that occurs in a substance[4].

The ideal learning is student centered learning, students will try to construct their own knowledge and be actively involved in seeking information. As described in project-based learning (PjBL), the learning model is innovative learning that emphasizes contextual learning through complex activities so that students can investigate to understand it, and support activities to emphasize learning and assignments in multidisciplinary student work and products oriented (artifact). The application of PjBL in this learning is an effort to foster awareness of the benefits of knowledge. Through PjBL learning strategy students transfer knowledge independently so that from the activity students feel concerned about the environment that can ultimately lead to positive attitudes and behaviors towards lingkungan[5,6,7].

The Flipped Classroom learning model is one effort that can be applied in the face of this 21 eternal education. In fact, the concept of the "flipped classroom" learning model is that students who do what they do in class at home, that is, learn to understand the materials taught by the teacher, while in class, students do what students usually do at home, that is, do problems[8,9,10].

In higher education in Indonesia, most students are educated in a learning environment that tends to focus on textbooks, which ultimately makes teaching and learning activities unattractive and students tend to be passive in learning activities. Teaching participants usually have little time to interact with their peers and with teachers both inside and outside the classroom[11,12].

E-Learning is one of the learning that can be used to facilitate teacher performance in teaching. E-Learning is the most efficient and close learning with students. If this media is packaged well, uniquely and seriously then E-Learning is not only a medium of learning, but also as a medium of information, entertainment and education[13,14].

Moodle stands for Modular Object-Oriented Dynamic Learning Environment, which is a dynamic learning place using an object-oriented model. The Moodle application was first developed by Martin Dougiamas in August 2002 with version 1.0 of Moodle. One of the most well known open source learning management systems in the world. LMS is a software package used to provide online learning materials and online multimedia resources. Moodle is an online learning application that is widely used in educational institutions, both with the aim of helping accelerate learning, improving learning

outcomes, improving the quality of the learning process and managing learning. Moodle-based online learning has complete functions and is very flexible, so that almost everything and needs of users can be done in this e-learning. Including arranging it as a way of managing learning [15,16,17,18].

E-learning based on the Moodle application provides convenience for students and teachers who teach in the classroom learning process[19]. The many features contained in moodle application-based E-learning can be optimized to increase students' learning interest and learning outcomes during classroom learning[15,16].

Based on these problems, researchers are interested in conducting research to develop e-learning media content using moodle application with the title "Content Learning System (CLS) Material Inter-Molecular Force Based on Project Base Learning (PjBL) with Flipped Classrooms in Senior High School".

II. METHODE

This research uses the "Research and Development" method or simply "R&D", which is a method of producing certain products. The 4-D model (four D models) includes 4 stages, namely definition, design development and dissemination, which is one of the development models used in this research[20]. However, this research is limited to the validity and practicality test that is part of the developstage.

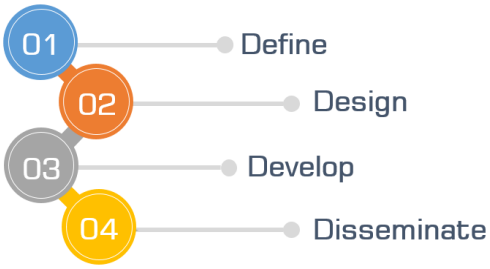

Figure 1. Stages 4D Models

Define stage is done to establish and define the need in developing a learning medium. There are 5 stages that are done namely "front-end analysis, learner analysis, task analysis, concept analysis,then specifying instructional objectives"[20].

The design stage was done to prepare a prototype of the learning device[20]. The stages are carried out such as, designing E-learning content, starting from preparing instructions for use, design of learning implementation, student worksheets, learning videos, powerpoints, and evaluation questions. The develop stage was carried out to create a revised learning medium based on input from validators and the results of students' responses to e-learning on inter-molecular force materials[20].

The research instrument used in the form of a questionnaire of the validity of content and constructs given to three media and chemistry experts. The validity of E-learning is determined by analyzing the questionnaires that have been filled by validators and the results of student responses. The result of data analysis used is descriptive data analysis. Descriptive data analysis aims to determine how the validity and practicality of e-learning content has been developed. Validity level analyzed using Aiken's V formula[21].

$$V = \frac{\Sigma s}{n(c-1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$S = r - lo \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

lo = 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 Aiken's V scale the validity assessment criteria can be seen in Table 1.

Table 1. Validity Based on Aiken's V Scale

Aiken's V Scale	Validity Category
$V \leq 0{,}4$	Less
$0{,}4 \leq V \leq 0{,}8$	Are
$0{,}8 < V$	Valid

Practicality questionnaires are aimed at practitioners to assess products in terms of use, learning time efficiency, and benefits. Practitioners in this study were 20 students of class XI at SMAN 8 Padang. Data from

questionnaires practicality is processed using the persentage approach as suggetsted by Kunandar[22] and the practicality category is seen in Table 2.

$$P = \frac{F}{N} \times 100\% \text{ …….....(3)}$$

P = percentage of student's 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	Faily practical
0,50-0,70	Less practical
0,01-0,50	No practical

III. RESULT AND DISCUSSION

This research produces e-learning content on inter-molecular force material as a learning medium of senior high school X class. The value of the results of the validity of content and constructs using Aiken's V is 0.83 and 0.89 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.

3.1 Define Stage

3.1.1. Front-end Analysis

The existence of the Covid-19 pandemic has led to various policies carried out by the government to reduce the spread of the Covid-19 virus in Indonesia. Efforts that have been made by the government include physical distancing or appeal to maintain distance between communities, avoid activities that eat up a lot of people, and avoid many people. This effort was made to stop the spread of the Covid-19 pandemic.

The government implemented a policy called "Work from Home" (WFH). This policy is work that applies to the community, and its goal is to complete all work in the home. Education in Indonesia is also one of the areas affected by the Covid-19 pandemic. Due to interaction restrictions, the Indonesian Ministry of Education also issued a policy to dissolve schools and replace the teaching and learning process with an online system [23].

Based on this analysis, teaching materials in the form of e-learning based on project-based learning are developed and become suitable and alternative teaching materials for the learning process, especially intermolecular forces.

3.1.2. Learner Analysis

Based on the results of a questionnaire given to several students at SMAN 8 Padang that learning at school was not yet available in the form of e-learning, therefore teaching materials were developed in the form of e-learning. Project-based learning is relevant and becomes an alternative in the learning process, especially in intermolecular compression material.

3.1.3. Task Analysis

The resulting learning media is created with the help of canva application to design covers and labels, powerpoint as a material processor, ms.word as teaching materials learning materials, video as a support for learning and Moodle as a means of E-Learning to be used in learning activities.

Analysis task aims to determine the outlines of the material to be taught[21]. In accordance with the syllabus Permendikbud 37 Year 2018 for the knowledge section of inter-molecular force materials is on the basic competency (KD) 3.7. The basic competency that must be fulfilled by students is determining the inter-molecular force (atoms, ions, and molecules) and its relation to the physical properties of substances and KD 4.7 namely reasoning the properties of substances around us by using the principle of interaction between particles.

3.1.4. Concept Analysis

This analysis aims to determine the concept of alkaline acid matter and compile it inthe concept[21]. The concepts contained in inter-molecular force materials are London style, ddipol-dipole style, and hydrogen bonding.

3.1.5. Specifying Instructional Objectives

Learning objectives are determined from competency achievement indicators based on basic competencies listed in curriculum 2013 revision 2018. The purpose of learning on inter-molecular force materials is formulated into Through the learning activities of flipped classroom approach and project base learning model by digging information from various learning sources, Simple investigation and processing of information, it is expected that learners are actively involved during the teaching and learning process, have a curious attitude, are thorough in making observations and are responsible in expressing opinions, answering questions, giving advice and criticism and can determine the interaction between particles (atoms, ions, and molecules) and their relation to the physical properties of substances and reasoning the properties of substances around us by using the principle of interaction between particles.

3.2 Design Stage

The application used in development is Moodel E-learning by going to the https://elearning.zainulteam.id/link. Before we design an E-learning for a learning material, first to create an account, as shown in figure 1.

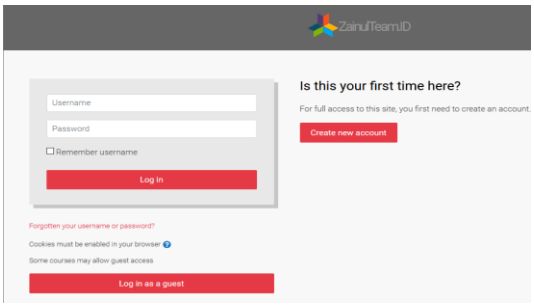

Figure 2. Login To E-learrnig ZainulTeam.id

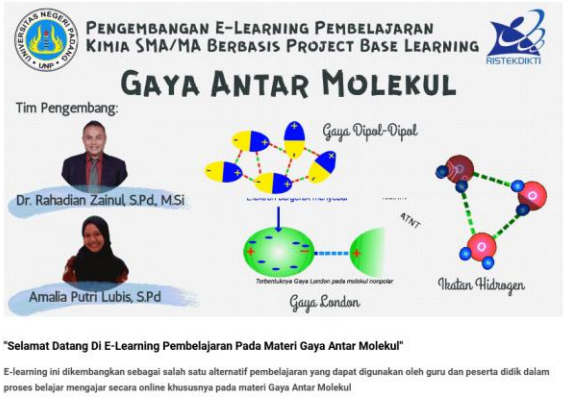

Figure 3. Home on E-Learning

Project Based Learning (PjBL) approach consists of three steps, namely the introduction of materials, learning resources, and learning activities. Introduction to materials on inter-molecular forces such as absence, syllabus, learning implementation design, introduction of inter-molecular force materials, and web meetings to conduct meetings. Lesson plan and syllabus developed by researchers which aim to become teachers as guidelines in carrying out learning.

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[24].

Figure 4. Material Introductory

Learning resources are steps taken by students to find or find concepts from learning material and the teacher provides resources that can help students find concepts in the material. Learning resources on intermolecular forces, such as ppt slides, supporting videos, source books, and student worksheet. The worksheet was developed with the aim of being one of the guides for students in carrying out learning. The worksheet that was developed was also designed as well as possible, so that students were interested in taking part in learning. There were students who thought that the use of worksheet was very interesting[25].

Figure 5. Learning Resources

Learning aktivities is the activity of learners in the learning process that is used to see the extent to which students can understand a learning material. In this exploration activity, students are given the freedom to explore which parts of the site they are interested in and motivated to know because this exploration activity is driven by their curiosity[26]. Learning aktivities on inter-molecular style materials, such as discussion forums, chat discussion rooms, resume tasks, discussion results, and evaluation questions.

Figure 6. Learning Activities

3.3 Develop Stage

3.3.1 Validation

Validity is an assessment of the design of a product. An instrument is said to be valid when it can measure what should be measured[27]. The purpose of the validation test by experts is to get an assessment so that the level of product validity can be known and to know the weaknesses of the product by asking for suggestions for improvement from the validator to improve the product being developed. Furthermore, suggestions from the validator will be used as a reference in revising the product to make it better[3,11,12]. The instruments used in this study are a questionnaire of the validity of the construct and the validity of the content.

Validation is done by 3 experts. The validity of the content consists of guiding and information components, content/materials in E-learning and evaluation. The validity of the construct also consists of three components, namely guidance and information, program performance and systematics, aesthetics and design principles. The results of content validation and construct validity can be seen in Figure 7 and Figure 8.

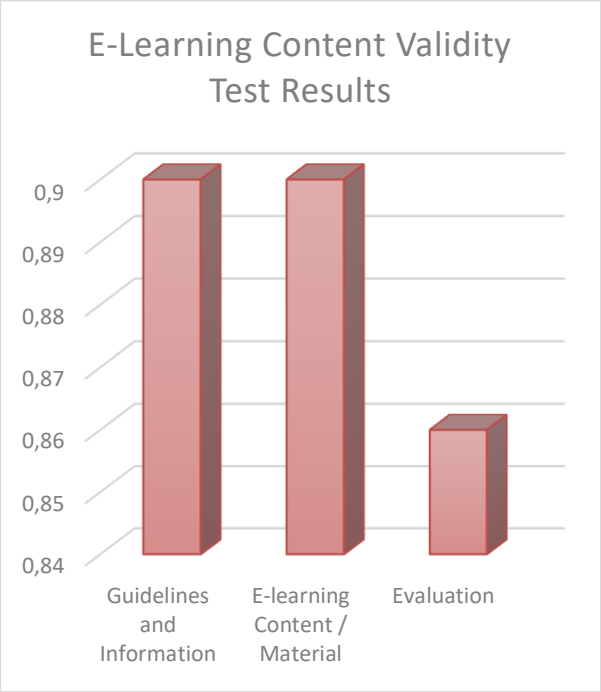

Figure 7. Content Validation Test Result Graph

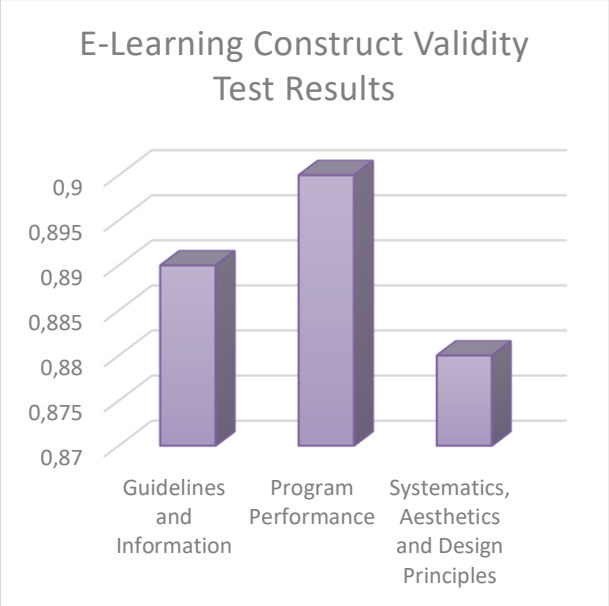

Figure 8. Construct Validation Test Result Graph

Because the values obtained are 0.83 and 0.89 in accordance with the content validity and analysis of the e-learning constructs developed on molecular style learning materials, the e-learning developed is valid.

The content verification wizard and the information component have an average Aiken score of 0.90 in the valid category. This proves that e-learning guides and information have met the requirements for clarity and ease of understanding about e-learning.

The content/material section of e-learning has an average Aiken score of 0.90 in the valid category. E-learning developed is in line with basic competencies and learning objectives. In addition, to create a learning medium must meet the capabilities to be achieved and contain the content of learning materials[28,29]. The average Aiken's V value in the evaluation component is 0.86 with a valid category. In general, evaluation is a systematic process, which determines the value of something based on certain criteria through evaluation[30].

Next is construct validation where the first component is guidance and information. Aiken's V average is 0.89 with a valid category. This value proves that E-learning has conveyed clear information and easy to understand. In the performance section of the program obtained an average Aiken value of 0.82 with a valid category. This section covers program installation, ease of use and consistency in E-learning.

The last part, namely the principles of systematics, aesthetics and design in e-learning, has an average Aiken value of 0.88 in the valid category. In accordance with the affective function, namely how attractive learning media can make students interested in learning, so that student learning outcomes are good [31].

3.3.2 Practicality

Based on the student response questionnaire to E-learning on the material of intermolecular forces, an average value of 0.83 was obtained with the very practical category, it appears that students have an interest and concern in learning using E-learning. 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[32].

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 project base learning stage in E-learning can also lead critical thinking students to gather information, observe objects, record observations, provide explanations, and draw conclusions.

Table 3. Practicality Test Results

No	Questions	Practicality Value
1.	PjBL-based e-learning using moodle app has clear instructions for use	0,85
2.	Languages used in PjBL-based E-learning that use moodle applications are easy to understand	0,86
3.	PjBL-based e-learning using moodle apps can be used over and over again	0,89
4.	Learning with PjBL-based E-learning using moodle apps makes learning time effective	0.82
5.	Learning with PjBL-based E-learning using moodle apps makes learning time efficient	0,76
6.	PjBL-based e-learning using moodle app helps improve thinking skills	0,82
7.	PjBL-based e-learning using moodle apps helps improve memory	0,83
8.	With PjBL-based E-learning that uses this chemical moodle application can increase learning interest	0,84
9.	With PjBL-based E-learning that uses moodle application, it can make it easier to learn independently	0,80
10.	With PjBL-based E-learning that uses moodle application can increase students' learning motivation	0,83

IV. CONCLUSION

Content Learning System (CLS) In the intermolecular force material based on Project Base Learning (PjBL) with the Flipped Classroom approach in Senior High School can be developed and has a content and construct validity level of 0.83 and 0.89 respectively with valid categories. Practicality for students obtaining a score of 0.83 in the category of quite practical. So, e-learning learning is content based Project-Based Learning on Intermolecular Force Material using the Flipped Classroom Approach in Class X Senior High School is produced valid and practical for use in the learning process.

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