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# *Validity and Practicality of Flipped Classroom Based on Structured Inquiry Using LMS Moodle on Basic Laws of Chemistry for Phase E High School*

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**Abstract—The basic laws of chemistry are abstract and require mathematical skills. This material is considered difficult by students. This study aims to determine the validity and level of practicality of a structured inquiry-based flipped classroom learning system using LMS Moodle on the basic laws of chemistry for phase E SMA. This type of research is educational design research (EDR) with the Plomp model. The learning system was validated by 5 validators, namely 3 chemistry lecturers of FMIPA UNP and 2 chemistry teachers of SMAN 1 Merangin. The results showed Aiken's V 0.92 average validity test with a valid category. The practicality of 2 chemistry teachers of SMAN 1 Merangin was 94% with a convenient category. The practicality of 9 students of SMAN 1 Merangin is 95%, with a very practical category. The results of the research of the flipped classroom learning system based on structured inquiry using LMS Moodle on basic laws of chemistry for phase E SMA have been valid and practical.**

**Keywords— Flipped Classroom Learning System; Structured Inquiry; Moodle LMS; Basic Laws Of Chemistry**

## I. INTRODUCTION

The basic laws of chemistry are classified as difficult chemical materials due to the characteristics of abstract material and require mathematical skills [1]. One of the student's difficulties in understanding this material is that the topics are tough for students to understand. of the basic laws of chemistry so the students make their interpretations of the concepts learned. This makes students often experience misconceptions [2], and students are less interested in learning this material, causing students to be inactive [3]. The basic laws of chemistry are the basic material for gaining knowledge chemical calculations [4]. The basic laws of chemistry have a relationship with one another. If there is one law that is not understood, it will make it difficult to understand other laws. It needs to improve the understanding of students on the basic laws of chemistry [5]. In the learning process, teachers should choose the proper learning methods and models and use the appropriate learning strategies to address students' difficulties in understanding the material [6].

An effective learning model to make students become active and think critically and analytically is inquiry learning[7], [8]. This is because students actively conduct investigations to find answers to problems and discover facts[9]. The inquiry learning models are broken down into confirmatory inquiry, structured inquiry, guided inquiry, and open inquiry based on how involved teachers are in the learning process [10]. The structured inquiry learning model emphasizes students' ability to solve problems based on procedures given [11].Structured inquiry learning consists of observation, hypothesis, collection, and organization of data and conclusions[12], [13]. This model is suitable for the science learning process and paired with material

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that is classified as difficult so that it can help students understand concepts [14], [15]. In addition, learning with this model is proven to increase students' knowledge in the long term [16] and can improve student's scientific reasoning skills [17].

Observations and interviews were conducted in three schools in Merangin. The results found that the learning methods were used lectures and discussions. It made learning still teacher-centered. This will result in the learning process being controlled by only a few parties, causing students to be inactive[11]. So, it is necessary to apply a flipped classroom learning system. This system adheres to learning activities in reverse. Learners will learn the material before class learning begins so that the learning process in class only serves to continue and reinforce the material learned [18], [19], [20]. This will make the learning process student-centered[21]. Learning in a flipped classroom is carried out in 2 stages, synchronously and asynchronously[22]. Asynchronous activities are carried out when students learn freely and not bound by time (online) by accessing material that has been presented by the teacher, while synchronous activities are carried out when learning is carried out simultaneously (offline)[23], [24]. It has been demonstrated that flipped classroom instruction can enhance students' learning results in chemistry courses [25] and can maximize the learning process [26].

The utilize of flipped classroom learning system will run optimally if it is equipped with the use of suitable media and learning models. Learning Management System Modular Object Oriented Dynamic Learning Environment (LMS Moodle) is a cloud-based media that can be accessed using a mobile phone or laptop using an internet connection[27]. Using Moodle as an LMS to facilitate learning does not use big storage space capacity, network, and security systems that you can set up. It has many features that can make learning interactive and make learning flexible[28], [29].

In the era of Merdeka curriculum implementation, the flipped classroom learning system will be implemented utilizing the LMS Moodle in conjunction with the structured inquiry learning model to meet the demands of learning innovation. Innovation in education needs to be held to raise the standard of instruction [30]. Based on the findings from observations and conversations with teachers and students at three distinct Merangin Regency schools, it is found that there still needs to be more innovation in learning, and teachers and students want technology-based learning that can be done flexibly. Therefore, it is necessary to develop a structured inquiry-based flipped classroom learning system using the Moodle LMS on basic laws of chemistry phase E SMA to know its validity and level of practicality.

## II. METHODS

Using Plomp's development model, this research was classified as educational development research (EDR)[31]. The purpose of this study was to determine the viability and practicality of a structured inquiry-based flipped classroom learning method on basic laws of chemistry, phase E SMA, using the LMS Moodle. A questionnaire with practicality and validation sheets was the instrument utilized in this study. Three UNP chemistry lecturers and two SMAN 1 Merangin chemistry teachers participated in the validation process, while nine SMAN 1 Merangin students took the small-group practicality test. Aiken's V formula was utilized for the analysis of the given validity data[32].

$$V = \frac{\sum s}{n\,(c-1)}$$

$$s = r - Io$$

Description:

V = Validator agreement index

R = Validator's preferred category score n = Number of validators

Io = The lowest validity assessment number (Io = 1)

c = The highest validity assessment number (c = 5)

Table 1 displays the validity assessment categories based on Aiken's V formula.

**Tabel 1**. Validity Data Based on Aiken's V

| *Aiken's V* interval | Category |
|---|---|
| V < 0,8 | Invalid |
| V ≥ 0,8 | Valid |

The practicality data obtained was examined using Purwanto's modified formula[33].

$$NP = \frac{R}{SM} \times 100\%$$

Description:

NP = Percent value sought (Practicality of the product)

R = Total value obtained from the questionnaire

SM = Maximum score in the questionnaire

Practicality assessment categories based on the modified formula by Purwanto can be seen in Table 2.

**Tabel 2**. Criteria for assessing prettiness

| Score | Criteria |
|---|---|
| 86%-100% | Very Practical |
| 76%-85% | Practical |
| 60%-75% | Practical enough |
| 55%-59% | Less practical |
| ≤ 54% | Not Practical |

## III. Results And Discussion

The development model proposed by Plomp was used in this study [31]. The stages of Plomp's development were preliminary research (initial investigation), prototyping phase, and assessment phase. This research was limited to the formation of prototype IV at the prototyping phase stage to produce a valid and practical product. The results of product development were described as follows

### *3.1. Preliminary Research*

This phase included developing a conceptual framework, reviewing the literature, and analyzing needs and context.

3.1.1. Requirement analysis

At this stage, observation questionnaires and interviews were conducted with the chemistry teachers and students of SMAN 1 Merangin, SMAN 6 Merangin, and SMAN 12. Based on these activities, the problems interested by the teachers and students were obtained, among others:

1) The basic laws of chemistry are classified as difficult chemical materials due to the characteristics of abstract material and require mathematical skills.
2) Lecture and discussion methods still dominate learning.

3) Insufficient learning time and lack of innovation in learning.

4) Teachers and students want technology-based and flexible learning.

3.1.2. Context analysis

The curriculum used is the independent curriculum. This analysis aimed to determine learning outcomes, objectives, and the flow of learning objectives. The learning outcome was applied the basic laws of chemistry[34]. Learning objectives apply the basic laws of chemistry.

3.1.3. Literature study

The literature study in this research is as follows :

1) The structured inquiry learning model has learning stages consisting of observation, hypothesis, data collection and organization and conclusion[12]. In the observation and hypothesis section, the teacher presents learning material through leading questions accompanied by pictures, tables, or videos. In the data collection and organization section, the teacher provides alternative problem solving through problem exercises or practicum activities and in the conclusion section, the teacher guides students to be find conclusion[10], [13]. The application of structured inquiry in learning can increase students' knowledge in the long term[16], [14].

2) This learning system is based on the principle that theoretical learning activities will be presented with the help of internet-based electronic media while practical learning activities and discussion of assignments will be carried out in the classroom[18]. Through the application of flipped classroom learning, it can enhance students' learning outcomes on buffer solution material [25]. The flipped classroom learning system is very appropriate to maximize the learning process since students participate in it actively [26].

3) Learning Management System (LMS) is software used for technology-based online or electronic learning[35]. Moodle LMS is equipped with many features that can be tailored to user needs such as chat features, discussion forums, quizzes, workshops, grade storage, uploading learning materials or materials, collecting and reviewing assignments or surveys. Moodle LMS is an interactive learning media because it can accept various formats of learning materials in the form of images, videos, PPT, animations to audio so as to make the learning process more interesting[27]. The advantages of using Moodle LMS are that it does not use a large storage space capacity, network and security systems can be set up by yourself, and has many features that can make learning interactive and is available in 120 language options[28].

4) The basic laws of chemistry materials were developed based on the textbook.

3.1.4. ²

All of the viewpoints that inform the creation of new products are referred to as the conceptual framework.:

1) Teachers and students experience problems such as students finding it difficult to understand on the basic laws of chemistry, learning methods still using lecture and discussion methods, insufficient learning time, and a lack of innovation in learning.

2) The solution to overcome the above problems is the development of a structured inquiry-based *flipped classroom* learning system using the *Moodle LMS* on the basic laws of chemistry phase E SMA.

3) The development model used was the Plomp development approach, which is restricted to evaluating the product's viability and usability.

### *3.2. Prototyping Phase*

3.2.1. Prototype I

Prototype 1 was produced by determining the design of the components in the designed product[31]. The result of prototype 1 was flipped classroom learning system using LMS Moodle which is arranged based on structured inquiry learning stages on basic laws of chemistry.

3.2.2. Prototype II

Prototype II was generated from *self evaluation* using *self evaluation* questionnaire[31]. The self evaluation findings indicated that the learning system was finished and in compliance with the tool.

3.2.3. Prototype III

Prototype III was produced through expert review and one to one evaluation. Expert review was known as validation test. Validation was done by giving validation questionnaires to five validators, they were three UNP chemistry lecturers and 2 E phase chemistry teachers of SMAN 1 Merangin. After that, revisions will be made which aim to improve the product which was considered still inappropriate by the validator before the product was tested[36]. The validation results were contained in Table 3.

**Tabel 3**. Validity Data Analysis Results

| No | Aspects assessed | Vaalidity | Category |
|---|---|---|---|
| 1. | Content component | 0,89 | Valid |
| 2. | Presentation component (construct) | 0,88 | Valid |
| 3 | Language component | 0,91 | Valid |
| 4 | Graphics component | 0,91 | Valid |
| | Average Validity | 0,92 | Valid |

Considering the outcomes of the data analysis, the average validation result was 0.92 with a valid category. Valid was interpreted the product can measure what should be measured[37]. In the validity of the content component, a value of 0.89 was obtained in the valid category. This showed that the product developed by the curriculum used, namely the independent curriculum, both in terms of phase E-learning outcomes and learning objectives as well as leading questions, videos, tables, and images presented by the material based on the curriculum that can guide students[38], [39]. The presentation/construct component has a validity value of 0.88 and a valid category. This demonstrated the internal consistency of the model's constituent parts [39]. The learning system was developed and has also been equipped with exercises to help students find concepts. Learning using structured inquiry facilitated students in concept discovery with direct investigation activities[40].

With the valid category, the language component received a validity value of 0.91. Language-related indicators evaluated by validators include readability, information clarity, appropriateness of writing according to Indonesian language regulations, and effective and efficient language use[41]. With the valid category, the graphic component validity value was 0.91. The developed learning design was connected to the graphic component. Fun learning was made possible by effective learning design [42], [43].

The next test was a one-to-one evaluation. Nine students with medium, low, and high ability levels were assessed[31]. The evaluation found that the appearance, presentation of material, and learning steps in the structured inquiry-based flipped classroom learning system using LMS Moodle for basic chemical laws material were clear and equipped with relatively

easy-to-understand instructions, which could help students find concepts. One form of improvement was suggested by the validator can shown in Figures 1 and 2. The validator gave a comment to include the reference of the referenced image.

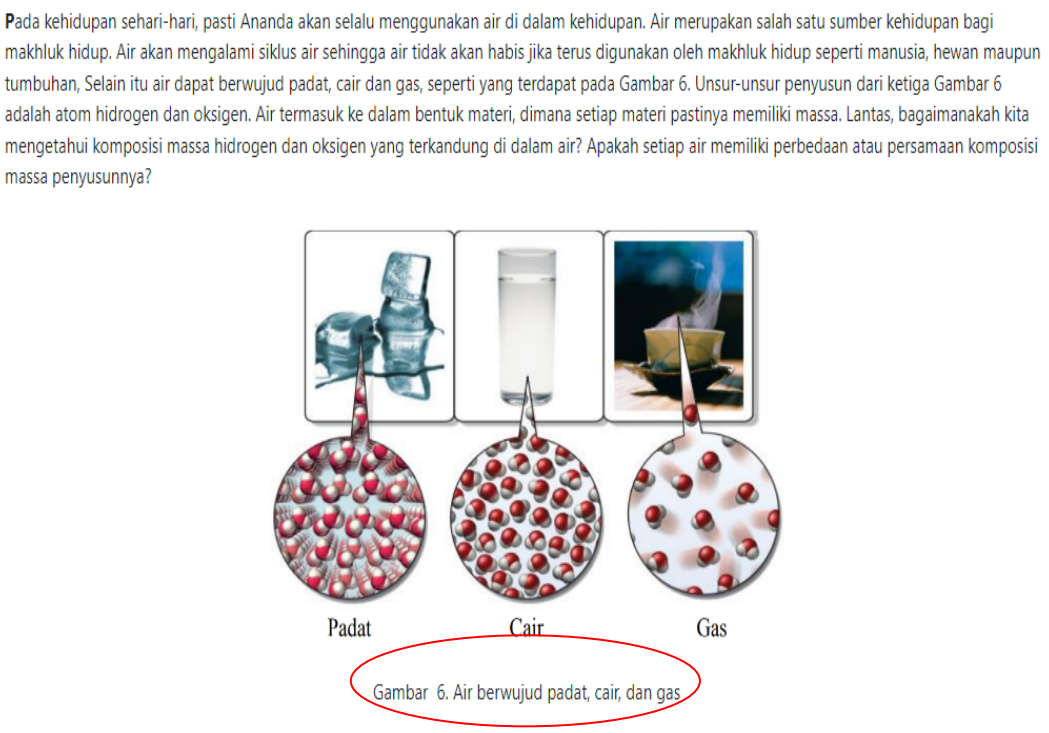


Figure 1. Before it is revised

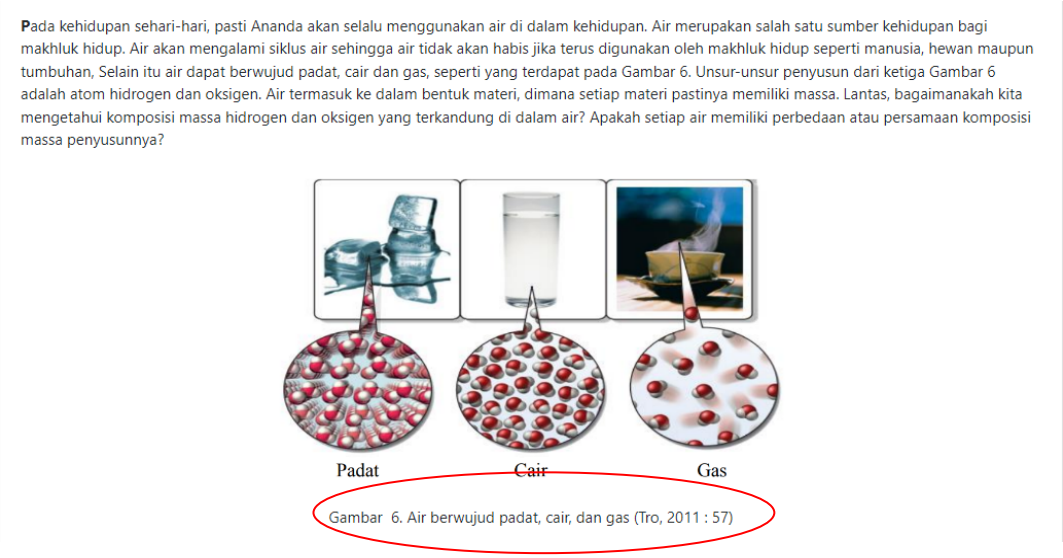


Figure 2. After revision

3.2.4. Prototype IV

Prototype IV resulted from *small group* testing. Two chemistry professors from phase E of SMAN 1 Merangin and nine students from phase F (XI) took the practicality small group test. The teacher and students used the tool, which was a practicality questionnaire[31]. The results of teacher and student practicality contained in Tables 4 and 5.

**Tabel 4**. Teacher Response Practicality Results

| No | Aspects | Practicality value (NP) | Category |
|---|---|---|---|
| 1. | Ease of use | 94% | Very practical |
| 2. | Time efficiency | 95% | Very practical |
| 3. | Benefits | 94% | Very practical |
| | Average practicality | 94% | Very practical |

Tabel 5.Hasil Praktikalitas Respon Siswa

| No | Aspects | Aspects | Aspects |
|---|---|---|---|
| 1. | Ease of use | 93% | Very practical |
| 2. | Time efficiency | 98% | Very practical |
| 3. | Benefits | 94% | Very practical |
| | Average practicality | 95% | Very practical |

The aspects were assessed on practicality can be seen in Tables 4 and 5. How easy it is to use and whether instructors and students can utilize it in everyday scenarios are two ways to assess a product's practicality[44]. The small group test for teachers, the average value of product practicality was 94%, which is a very practical category. In the small group test for students obtained an average value of practicality of 95%, a very practical category. This showed that all aspects of the product assessment are practical and could be used in the learning process. This also proves that flipped classroom learning and LMS Moodle can improve the effectiveness of class time and allow students to learn at their own speed[45]. The use of LMS Moodle was also proven to be effective and efficient which is equipped with various features as well as existing tools so it made learning effective and efficient[46].

## IV. CONCLUSION

This research was produced the *flipped classroom* learning system based on structured inquiry using *LMS Moodle* on basic laws of chemistry for phase E SMA. The validity results showed that the system was valid with Aiken's V value of 0.92. The practicality results of small group showed that the system was very practical with a percentage of teacher and student questionnaires of 94% and 95%, respectively.

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