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Validity and Practicality of Flipped Classroom Learning System Based on Structure Inquiry using LMS Moodle on Chemical Bonding for Phase F High School

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Abstract **– The subject of chemical bonding is abstract and considered difficult by students. This study aims to determine the level of validity and practicality of flipped classroom learning system based on structured inquiry using LMS Moodle on chemical bonding for phase F in high school. This type of research is development research or education design research (EDR) using Plomp's development model. The flipped classroom learning system using LMS Moodle was validated by three chemistry lecturers of FMIPA UNP and two chemistry teachers from SMA Laboratorium Pembangunan UNP. The result of the validity test using Aiken's V showed an average value of 0.9 with a valid category, the results of the teacher's practicality test showed an average value of 94% with a very practical category and the results of the practicality test to nine students showed an average value of 90% with a very practical category. The research results of the flipped classroom learning system based on structured inquiry using LMS Moodle on chemical bonding subject in phase F high school have been valid and practical.**

Keywords—Flipped Classroom Learning System, Structured Inquiry, LMS Moodle, Chemical Bonding.

I. INTRODUCTION

Chemical bonding is one of the subject in chemistry learning that is classified as abstract and difficult to apply contextually [1] [10] [11] [14]. Chemical bonding is a basic subject that must be understand correctly so that they do not experience difficulties in learning more advanced chemistry [12]. The difficulties experienced by students can come from several factors, one of them is the low understanding of concepts and interest in learning [13]. This difficulty results in students who would rather memorise chemistry concepts which will be a barrier to meaningful learning [2]. Chemical bonding subject requires visualisation of three levels representation in learning [1], which are macroscopic level, submicroscopic level, and symbolic level [14]. These three levels representation can be visualised using the help of computer technology [15]. One of the learning systems that use computer technology is Flipped Classroom [3].

Flipped classroom is a condition that reverses traditional learning which usually consists of classroom learning and at-home learning [4]. This kind of learning system utilises computer technology that supports students online so as to provide flexible time for students to access learning subjects [5], such as the use of LMS Moodle learning media [6].

LMS Moodle is an application programme that can convert learning media into web form [16]. Students are given the freedom to access learning subject and interact with teachers and friends using the LMS Moodle [17]. The results of the study showed that learning chemistry using three levels representation with the help of learning media and combined with a learning model can

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improve students knowledge, besides that it can also improve students cognitive learning outcomes [7]. One of learning models that can be combined with the flipped classroom learning system is structured inquiry.

Structured inquiry requires students to make observations, hypothesis, collect and process data, and make conclusions [8]. Structured inquiry has several steps where students investigate and find out for themselves the questions or problems given by the teacher through systematic procedures [9]. Students concept understanding obtained through learning with a structured inquiry model is better than students who use conventional learning models [18].

The results of interviews with chemistry teachers at SMA Pembangunan Laboratorium UNP, SMA Negeri 3 Padang, and SMA Pertiwi 1 Padang revealed that there are misconceptions that occur, such as students not being able to differentiate between ionic bonds and covalent bonds, ineffective learning time, and the inability of students to work on exercises that have the same meaning but different sentences. Therefore, it is necessary to implement a flipped classroom learning system to effectively utilise learning time in the classroom as much as possible. [18]

The results of the students questionnaire at SMA Laboratorium Pembangunan UNP, SMA Negeri 3 Padang, and SMA Pertiwi 1 Padang obtained 81.7% indicated that chemical bonding subject is difficult. This is because this subject is abstract, and they have never used teaching subject provided on electronic learning media. The learning that is expected by students is learning that is easy to understand and integrated with technology and learning that is flexible and can be accessed anywhere. Therefore, research on the development of a structured inquiry-based flipped classroom learning system using LMS Moodle in high school phase F chemical bonding subject aims to determine the level of validity and level of practicality.

II. METHOD

The type of research is Education Design Research (EDR) or Education development research using the Plomp development model. This research was held to produce a flipped classroom learning system based structured inquiry on chemical bonding subject for phase F high school. This research was held at SMA Laboratorium Pembangunan UNP. This research was restricted to the practical test.

The research instruments that used validation questionnaire and practicality questionnaire. Validation was carried out by five validators and the practicality test subjects were nine students and two chemistry teachers from SMA Laboratorium Pembangunan UNP. The results of the study were analysed using descriptive statistics to obtain the average number and percentage. The validator's assessment of each statement was analysed using Aiken's V formula, where Aiken's V formula is as follows [20]:

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

$$s = r - I_0$$

Description :

V = Validator approval index

s = The score assigned by the validator minus the lowest score in the category used

r = Validator's choice of category score

I_0 = Lowest score

n = Numbers of validator

c = Number of categories chosen by the validator

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Based on Aiken's V scale, the criteria for the level of validity of the flipped classroom learning system based on structured inquiry using LMS Moodle on chemical bonding on high school phase F will be seen after being converted into the categories contained in Table 1.

Table 1. Aiken's V Validity Categories

Scale of Aiken's V	Validity
V ≥ 0,8	Valid
V < 0,8	Not Valid

Practicality data analysis technique using the following formula [21]

$$NP = \frac{R}{SM} \; x \; 100$$

Description :

NP = The percent value sought or expected

R = The raw score obtained by the learner

SM = Maximum score

The data obtained was then processed using the formula and converted into categories as in Table 2 to determine the level of practicality of the flipped classroom learning system structured inquiry-based using LMS Moodle on high school phase F chemical bonding subject.

Table 2. Practicality Categories

Value	Practicality
86% - 100%	Very practicality
76% - 85%	Practical enough
60% - 75%	Practical
55% - 59%	Less practical
≤ 54%	Not practical

III. RESULTS AND DISCUSSION

This development research was carried out using Plomp's development model which has three stages: preliminary research, development or prototyping phase, and assessment phase.

3.1 Preliminary research

At this stage, needs analysis and context analysis, literature study, and conceptual framework development are carried out.

3.1.1 Need Analysis

Need analysis aims to find out the problems experienced by teachers and students in the learning process. At this stage, interviews were held with chemistry teachers and distributing questionnaires to students at SMA Laboratorium Pembangunan UNP, SMA Negeri 3 Padang, and SMA Pertiwi 1 Padang. The results of interviews and questionnaires were obtained as follows

- The lack of learning hours leads to ineffective learning.
- The existence of students' misconceptions in distinguishing ionic bonds and covalent bonds as well as determining valence electrons and bond types
- Learners find it difficult to repeat lessons at home where if given questions with different wording, learners will experience confusion
- Teachers still use lecture and discussion methods in teaching and learning.
- Students have never used teaching subject presented in electronic media.
- Students like learning that is integrated with technology so that it is flexible and can be accessed anywhere

Students learning activities can be improved using the LMS Moodle, thus every students learning activity can be carried out properly without the constraints of limited learning time in the classroom [16].

3.1.2 Context Analysis

Context analysis aims to develop curriculum-based materials that are applied at school, namely the independent curriculum. The stages of curriculum analysis include learning outcomes, learning objectives, and the flow of learning objectives

3.1.3 Literature Study

The literature review aims to find sources and references related to the research in order to support the understanding of information about the structured inquiry-based flipped classroom learning system using moodle LMS. The results of the literature review are as follows

- Chemical bonding is one of the basic materials in chemistry learning that has abstract concepts that are difficult for students to understand. [12]
- Flipped classroom is an active, student-centred approach that is shaped to maximise effective classroom learning time [22]. Flipped Classroom has advantages, such as students can repeat watching learning videos repeatedly so that the flipped classroom learning model is in accordance with the capacity of different students' abilities. [23]
- Moodle LMS is an application that can convert learning media into web form [16]. Learners are given the freedom to access learning materials and interact with teachers and friends using the Moodle LMS [17].
- Structured inquiry is a learning model that prioritises active learner involvement in discovering concepts and solving problems. [24].

3.1.4 Analysis of concept

The development of a conceptual framework aims to identify problems and find solutions to problems found in the research, which are

- It was found that there were problems in learning chemical bonds in the form of learning methods that still use lecture or discussion methods, insufficient learning time, and not using or utilising technology-integrated media in learning.
- Analyse the curriculum and learning outcomes used at the school to obtain the objectives of learning chemical bonding materials.
- Followed by a literature review on the use of structured inquiry-based Moodle LMS and developed using the Plomp development model on chemical bonding materials.

3.2 Prototype Phase

3.2.1 Prototype I

The result of prototype I is a flipped classroom learning system based on structured inquiry using LMS Moodle on chemical bonding. Formative evaluation is conducted in the form of self-evaluation using checklist. The evaluation results show that the components of the LMS Moodle are complete.

3.2.2 Prototype II

At this stage, formative evaluation was carried out in the form of expert review and one-to-one evaluation. Validation was carried out by three chemistry lecturers from FMIPA UNP and two chemistry teachers from SMA Pembangunan Laboratory UNP. Validity is carried out using an instrument in the form of a validation questionnaire that assesses aspects of the content component, construct component, language component, and graphic component.

The results of the validation assessment on each aspect can be seen in Table 3

Table 3. Validation Result

No	Validated Aspects	Score	Category
1	Construct Component	0.94	Valid
2	Content Component	0,92	Valid
3	Linguistic Component	0,9	Valid
4	Graphic Component	0,83	Valid
Average score		0,9	Valid

Overall, the validation of the flipped classroom learning system based on structured inquiry using LMS Moodle on chemical bonding material phase F SMA has an average Aiken's V value of 0.9 with a valid category. The results of this validation can be detailed based on the assessment aspects as follows :

- The construct component has an Aiken's V value of 0.94 with a valid category. The product is said to be valid in terms of construct if all components are consistently interrelated [25]. This construct validation shows that there is a systematic conformity in the preparation of the flipped classroom learning system with the steps of the structured inquiry learning model. The materials are presented sequentially according to the flow of learning objectives, intertwined with each other, and have a consistent relationship [26].
- The content component has an Aiken's V value of 0.92 with a valid category. The product is said to be valid in terms of content if it meets the needs and its components are based on the latest scientific knowledge [25]. The content validation shows that the developed product is in accordance with the curriculum and based on a strong theoretical rationale [26].

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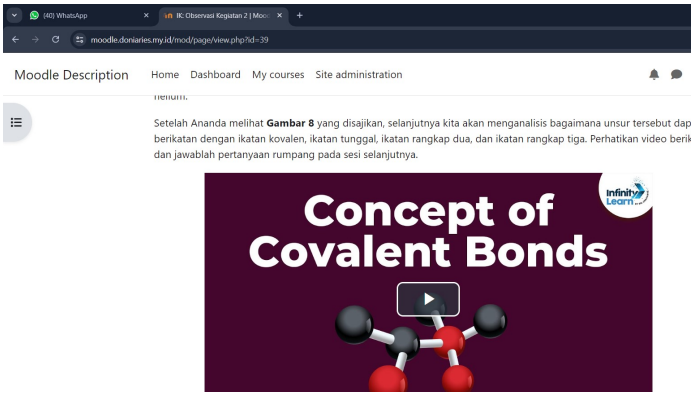
- The language component has an Aiken's V value of 0.9 with a valid category. The product is said to be valid in terms of language based on readability, clarity of information, suitability of writing correct Indonesian language rules, and effective and efficient use of language [27].
- The graphic component has an Aiken's V value of 0.83 with a valid category. The product is said to be valid in terms of graphics seen from the use of type and size of letters, illustrations, images, videos, and colours from the product developed can be attractive overall. [27].

  Individual evaluation was conducted to three students of SMA Laboratorium Pembangunan UNP. There are four aspects of assessment, namely clarity of content, language, understanding of concepts, and writing. The results of the assessment stated that the video and sound display contained in the LMS Moodle was clear, the presentation of material and exercises on the LMS Moodle used language that was easy to understand, and there were still writing and punctuation errors in the LMS Moodle.

Suggestions obtained from validators and individual evaluations were then revised to produce a valid prototype III. The revisions made can be seen in Figure 1 :



(a)

(b)

Figure 1. Product revision: (a) product before revision using English video and (b) product after revision using Indonesian video.

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3.2.3 Prototype III

The product was tested for practicality to nine students and two chemistry teachers from the UNP Development Laboratory High School with the help of a practicality instrument in the form of a questionnaire. The practicality results obtained from filling out the teacher's practicality questionnaire have an average score of 94% with a very practical category and an average student practicality score of 90%. The results of teacher and learner practicality can be seen in Table 4 and Table 5.

Table 4. Teacher Practicality Results

No	Aspects Assessed	Percentage	Category
1	Ease of Use	90%	Very practical
2	Time Efficiency	100%	Very practical
3	Benefits	93%	Very practical
Average Score		94%	Very practical

Table 5. Students Practicality Result

No	Aspects Assessed	Percentage	Category
1	Ease of Use	89%	Very pactical
2	Time Efficiency	91%	Very practical
3	Benefits	89%	Very practical
Average Score		90%	Very practical

The assessment of the ease of use aspect of the product for teachers obtained a score of 90% with a very practical category and for students obtained a score of 89% with a fairly practical category. This explains that the structured inquiry-based flipped classroom learning system using LMS Moodle on chemical bonding material is easy to use because the material presented is clear and easy to understand. In addition, the use of LMS Moodle can facilitate students in learning. The level of product practicality can be seen by considering whether the product is easy to understand and can be used by teachers and students under normal conditions [25].

The assessment of the time efficiency aspect for teachers obtained a score of 100% with a very practical category and for students obtained a score of 91% with a very practical category. This shows that the time used in learning is efficient and students can adjust to their own pace of understanding the material [28].

The assessment of the benefits aspect for teachers obtained a score of 93% with a very practical category and for students obtained a score of 89% with a fairly practical category. This shows that learning with a structured inquiry-based flipped classroom learning system using LMS Moodle can help students in finding concepts and exercises and evaluation questions can be useful for concept consolidation

3.2.4 Prototype IV

The research was limited until a valid and practical prototype IV was obtained..

IV. CONCLUSION

This research produces a product in the form of a flipped classroom learning system based structured inquiry using LMS Moodle on chemical bonding for high school phase F. The validation results showed that this system is valid with a validity value of 0.9 with the valid category. Practicality results showed that this system is practical with a teacher practicality percentage of 94% with a very practical category and a student practicality percentage of 90% with a very practical category

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