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FLIPPED CLASSROOM LEARNING SYSTEM BASED ON GUIDED INQUIRY USING MOODLE ON COLLOID

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Abstract

This study aims to develop a digital-based learning system so that it can be used to meet the demands of the industrial revolution 4.0 by determining its validity and practicality. The type of research used in this study is Education Design Research (EDR) using the Plomp development model. This research was conducted in one of the public high schools (SMA Negeri 8 Padang) in the 2022/2023 academic year. Data was collected using a validated questionnaire and a practicality questionnaire. The study's results obtained an average validity of 0.87 with a valid category. The results of the practicality test for students have average practicality of 87% in the very practical category and average practicality for teachers of 92% in the very practical category. Overall, from the research results, it can be concluded that the guided inquiry-based flipped classroom learning system using Moodle on colloidal material is valid and practical.

Keywords : *Flipped Classroom ; Guided Inquiry ; Moodle ; Colloid*

INTRODUCTION

The era of industrial revolution 4.0 in education is required to run and develop following increasingly sophisticated technological developments. In the current era of the industrial revolution 4.0, global education globally responds to the challenges of the 21st Century by making 21st Century skills a global goal of education (Dotti & Mawardi, 2020). Education is necessary to take advantage of the sophistication of information and communication technology, so it is also hoped that there will be a change from teacher-centered learning to student-centered (Pranaja & Astuti, 2019). So those teachers are required to create innovative learning. Learning can be done using technology and must also be adapted to the learning model (Fathullah, 2020).

One of the learning methods that can take advantage of technological sophistication is blended learning (Guswita & Mawardi, 2021). Blended learning combines several methods and learning strategies virtually or physically to achieve learning objectives (Hasbullah & Siti, 2015). Blended learning appropriately combines synchronous and asynchronous learning to achieve learning objectives (widianto¸2018). The learning system that follows the blended learning method is the flipped classroom learning system (Guswita & Mawardi, 2021).

The flipped classroom concept is learning that is done in class, such as understanding the material but is done at home, and activities that are usually done at home, such as doing assignments or exercises, will be carried out at school so that students are more independent (Arif Eko, 2018). The flipped classroom can make students active in the learning process that can be done anytime and anywhere (Herpika & Mawardi, 2021). To help implement the learning system, a learning model that supports the learning is also needed. One learning model that promotes active learning using a scientific approach is the guided inquiry learning model (Guswita & Mawardi, 2021).

The guided inquiry leads students to understand the material with a learning cycle of exploration, concept formation, and application, discussing and interacting with others (Hanson, 2005). In guided inquiry learning, students are advised to build an understanding to solve a problem; with this method, learning will be centered on students (Asra & Mawardi, 2013). Guided inquiry learning is suitable for learning because students must observe, ask, conclude, associate, communicate, guide students in concept discovery, and answer critical questions (Fani & Mawardi, 2022). With the guided inquiry learning model, students will develop necessary thinking skills in problem-solving (Aumi & Mawardi, 2021).

LMS (Learning Management System) is essential in implementing the guided inquiry-based flipped classroom learning system (Ismail & Mawardi, 2021). One Learning Management System that can be used is Moodle. Moodle is open-source software that supports the implementation of e-learning with an integrated paradigm in which various learning support features are easily accommodated on an e-learning portal (Surjono, 2010). In this moodle, interactions between fellow students, teachers, and students can occur (Seprida, 2015). This learning system will be applied to colloid material, one of the materials in class XI even semester. Colloidal material is very abstract and difficult to understand. Although colloid is very close to everyday life, students still feel unfamiliar with the material because of the limited learning media (Asmara, 2015).

Based on the background described, the researchers conducted a study titled "Flipped Classroom Learning System Based on Guided Inquiry Using Moodle on Colloidal Material."

METHODS

The type of research conducted is Educational Design Research (EDR) using the Plomp development model developed by Tjeerd Plomp. The plomp development model consists of 3 stages, namely (1) the Preliminary Research Phase, (2) the Development or Prototyping Phase, and (3) the Test and Assessment Phase (Plomp & Nieveen, 2007).

At the preliminary research stage, needs and context analysis, literature study, and conceptual framework development were carried out. In the prototyping phase, formative evaluation consists of self-evaluation, one-on-one evaluation, expert review, and small groups. The assessment stage is the final stage of the research.The research subjects in this study were three chemistry lecturers, FMIPA UNP, three chemistry teachers, and 15 students of class XII IPA SMAN 8 Padang.

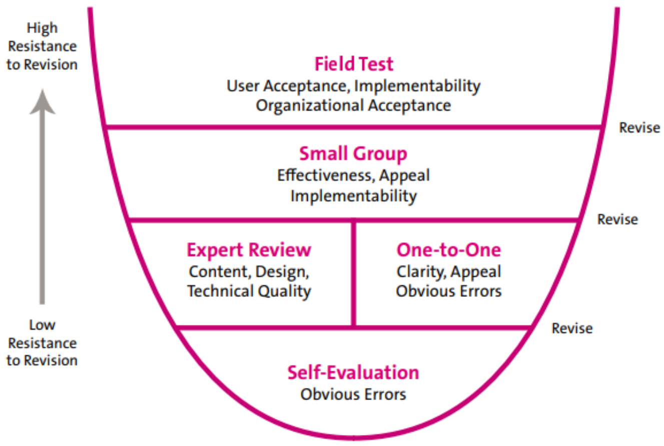


Figure 1. Stages of a formative evaluation of educational research (Plomp & Nieveen,2013)

The data collection instruments of this study were validation instruments and practical instruments. The validation instrument was in the form of a validation questionnaire given to 3 chemistry lecturers and two chemistry teachers. The assessments in the validation questionnaire are the components of the feasibility of content, presentation, language, and graphics. The practicum instrument used was a response questionnaire given to students and teachers. Student response questionnaires were obtained from a small group evaluation conducted on 12 students of SMAN 8 Padang. The level of practicality can be assessed from the ease of use, time efficiency, and benefits.

The validity analysis technique uses Aiken's V scale, where the Aiken's V formula is as follows.

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

$$s = r - Io$$

Information:

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

r = Validator choice category score

Io = Lowest score in the scoring category

n = Number of validators

c = The number of categories selected by the validator

The validity of the guided inquiry-based flipped classroom learning system with five validators will be seen after being converted to the categories listed in table 1 below (Aiken, 1985).

Table 1. Validity level conversion

Interval	**Validity**
$V < 0{,}8$	Invalid
$V \geq 0{,}8$	Valid

The practicality analysis technique uses the following modified formula from Purwanto (2010).

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

Information :

NP = percent value sought or expected

R = raw score obtained by students

SM = the ideal maximum score of the test in question

100 = fixed number

The level of practicality of the guided inquiry-based flipped classroom learning system will be seen after being converted to categories such as table 2 below (Yunus & Sardiwan, 2019).

Table 2. Practicality level conversion

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

RESULTS AND DISCUSSION

In this study, the plomp development model was used, which consisted of 3 stages, namely (1) the preliminary stage, (2) the development stage or prototyping, and (3) the assessment stage (Plomp & Nieveen, 2007).In the preliminary stage, needs and context analysis, literature study, and conceptual framework development were carried out. The needs analysis was conducted by interviewing three chemistry teachers in several schools: SMA N 7 Padang, SMA N 8 Padang, and SMA N 10 Padang. From the interviews, it was concluded that teachers still have difficulty implementing a student-centered learning process following the demands of the industrial revolution 4.0 and the needs of the 2013 curriculum.

The context analysis is done by analyzing the curriculum and syllabus. Curriculum analysis is carried out to systematically identify and develop objectives, materials, and learning strategies to develop learning tools. Syllabus analysis is done by analyzing basic competencies. The essential competencies will be reduced to several indicators of competency achievement and learning objectives on colloidal material.The literature study was conducted by analyzing journals to find solutions based on problems obtained on colloidal material. Based on several literature reviews conducted by researchers, the above issues can be overcome by implementing a guided inquiry-based flipped classroom learning system through LMS Moodle.

Flipped Classroom is often interpreted as a class that is reversed. In learning with the Flipped Classroom method, the concept of what is usually done in class will be done at home, and what is done at home will be done in class (Bergmann & Sams, 2012). Guided inquiry is a learning model where the teacher acts as a facilitator who helps students develop conceptual understanding to solve a problem (Asra & Mawardi, 2013). Moodle stands for Modular Object-Oriented Dynamic Learning Environment). In this moodle, interactions between fellow students, teachers, and students can occur (Seprida, 2015).

Researchers identify problems at the conceptual framework stage and find solutions to the issues obtained. So at this preliminary stage, the prototype I was produced in the form of a guided inquiry-based flipped classroom learning system on colloidal material in the Moodle LMS.

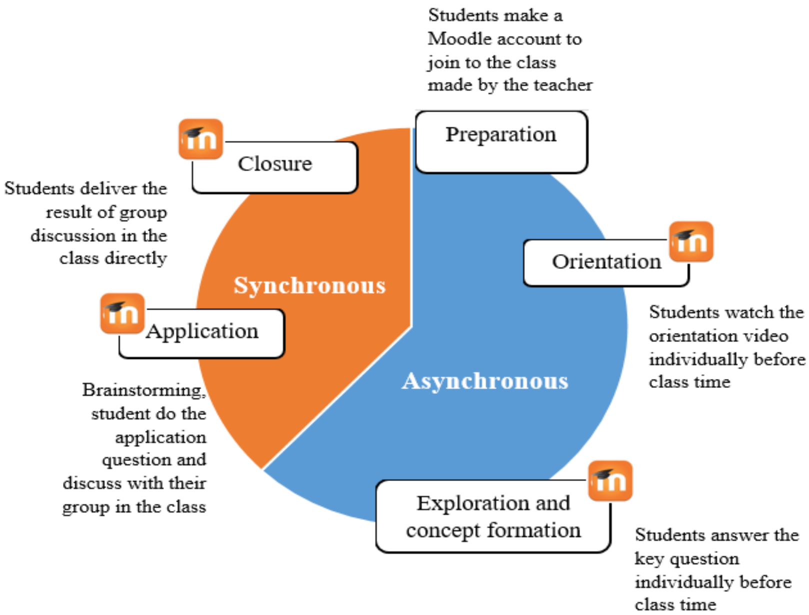


Figure 2. The cycle of guided inquiry learning model- flipped classroom (Source: Ismail & Mawardi, 2021)

Before entering the learning stage, students are introduced to the procedures for using Moodle. Then enter the learning stage, the first is the orientation stage. At the orientation stage, students are directed to watch videos provided on Moodle. Furthermore, in the concept exploration stage, students explore the model supplied in Moodle, which is used to answer critical questions, making it easier for students to find the concepts and learning objectives that have been set. At the application stage, students are formed in small groups to work on practice questions in the comments column of the Quiz Assignment feature. The closing stage is carried out using the jitsi (virtual synchronous) or the face-to-face step in class (live synchronous).

After obtaining prototype I, self-evaluation was carried out using a checklist sheet to produce prototype II. In prototype II, an expert review was developed and conducted by three chemistry lecturers at FMIPA UNP using a validated questionnaire. The validation results obtained an average validity value of 0.87 with a valid category. The results of the validity analysis can be seen in Figure 2.

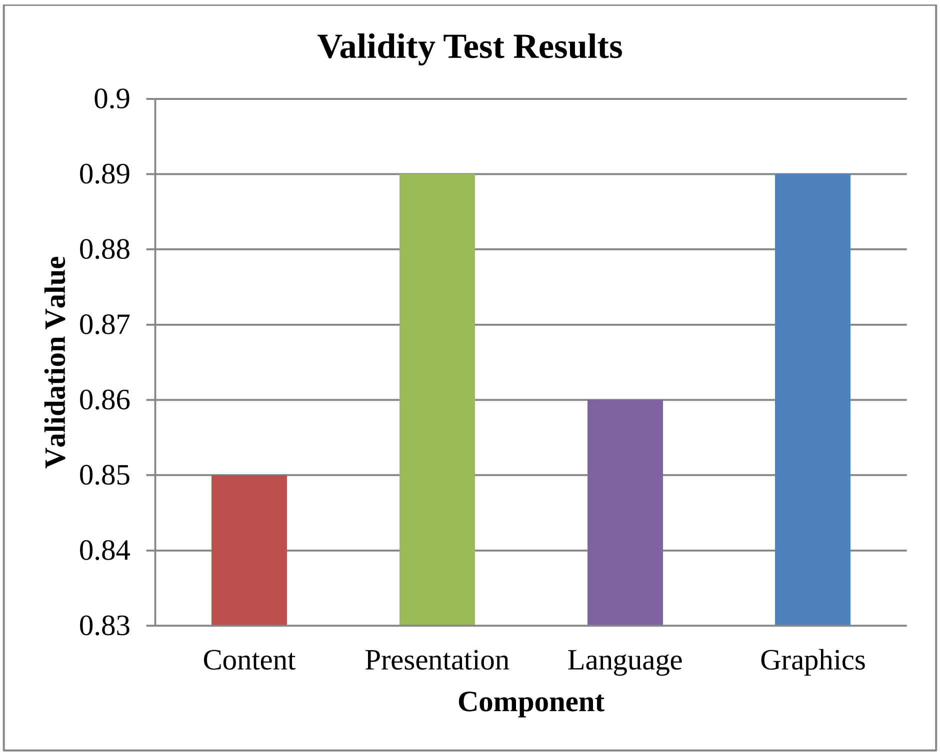


Figure 3. Validation Results

After revisions were made based on suggestions from experts, the valid prototype II was tested in a one-to-one evaluation. The one-to-one evaluation stage was conducted by interviewing three students with different abilities, namely high, medium and low abilities. The instrument used is an interview sheet. Based on the results of the interviews, it was concluded that the video display and sound video were clear, the model and critical questions were also easy to understand, and the language and instructions provided were easy to understand. After an expert review and one-to-one evaluation were carried out, prototype III was produced.

Furthermore, the final stage of the development and manufacture of prototypes is the evaluation of a small group that will produce prototype IV. The purpose of doing a small group is to determine the level of practicality of prototype III that has been created. Practical tests were conducted on three high school chemistry teachers and 12 SMA/MA class XII students with different levels of ability, namely high, medium, and low. From the results of the practicality test, it can be concluded that the model provided can assist students in answering key questions, making it easier for students to understand and find concepts independently on colloidal material. At the exploration and concept formation stage, models and critical questions can be given, as shown in Figure 3.

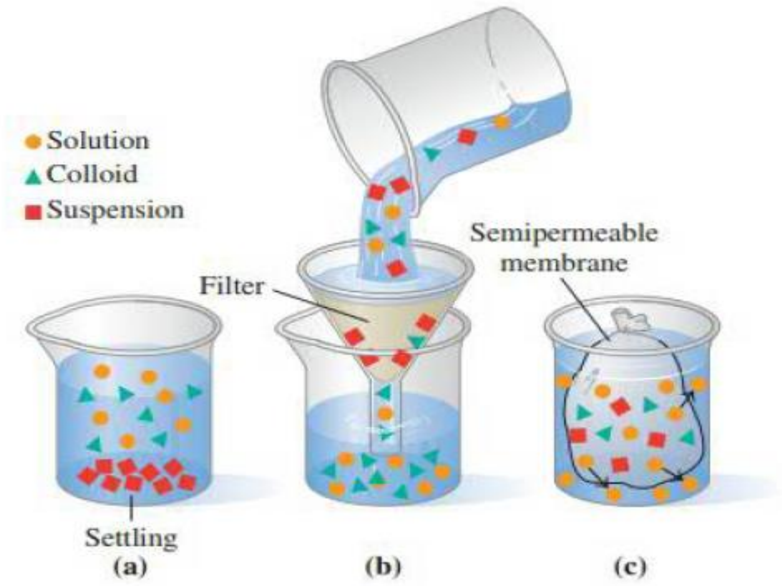


Figure 4. Example of the model used in the exploration and concept formation stage of model 1 (Source: Karen Timberlake, 2019)

The picture of students' understanding of the colloid concept can be seen in table 3.

Table 3. Description of students' answers at the exploration and concept formation stage

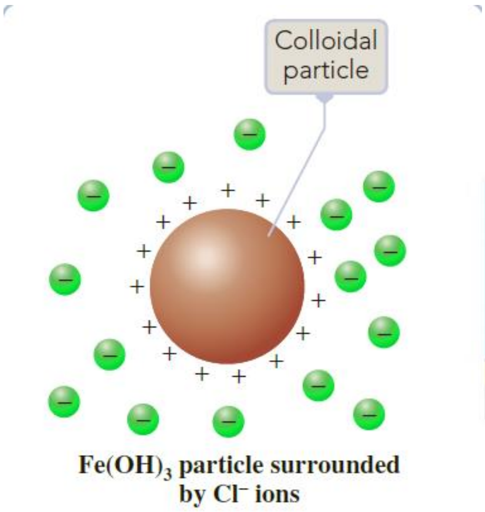
Student 1	In solutions, colloids, and suspensions, suspensions can be purified by filtering; colloids are distilled with a semipermeable membrane, while solutions, even if using a semipermeable membrane, cannot be filtered.
Student 2	Solutions cannot be purified, and suspensions are purified if filtered, while colloids will separate using a semipermeable membrane.
Student 3	When the filtered suspension is filtered, the solution will come out of the semipermeable membrane when using semipermeable membrane.

To see students' explanations, they can be adjusted to the principles or theories in the literature (general text books).

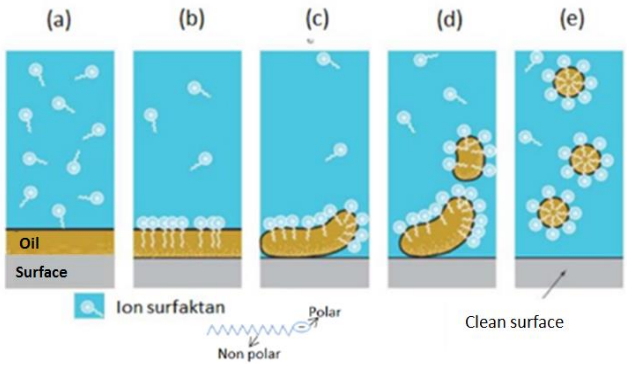
Table 4. Description of textbook answers at the exploration and concept formation stage

Textbooks	Filtering can separate suspended particles from solution, but a semipermeable membrane is needed to separate colloidal particles, whereas real solutions cannot be separated (Timberlake, 2019).

Based on Figure 4, a multi-presentation chemical picture is given related to the different concepts of suspension, colloid, and solution. Student 1, who has high analytical skills, answers with an understanding that is not much different from a textbook. Student 2 also has good analytical skills, so understanding the material presented in the answers is also close to the description of the explanation from the textbook. Then students 1 and 2 can form concepts and have an understanding obtained from the analysis based on the model that has been given. In student 3's answer, there was a misconception where in the answer, it was said that a semipermeable membrane was used to remove the solution. According to Timberlake(2019), semipermeable membranes are used to purify colloids by separating colloids from other particles.



(a) Sol $Fe(OH)_3$



(b) Cleansing Oil by Soap

Figure 5. Example of the model used in the exploration and concept formation stage of model 2 (Source: Chang, 2010)

The description of students' understanding of the hydrophobic and hydrophilic properties of colloids can be seen in table 5.

Table 5. Description of students' answers at the exploration and concept formation stage

Student 1	Figure (a) The colloidal particles adsorb positive ions, and there is no attraction between them so they are categorized as hydrophobic colloids; in Figure (b), there is an attraction between the non-polar hydrophobic ends of the detergent attracting non-polar oil particles. While the polar hydrophilic end will interact with polar water, so it is categorized as a hydrophilic colloid.
Student 2	Figure (a) there is no attraction between colloidal particles, positive ions are adsorbed by the particles, Figure (a) includes hydrophobic colloids, Figure (b) the polar end interacts with water, while the non-polar end of the detergent will attract oil impurities which also non-polar, this example is a hydrophilic colloid.
Student 3	Figure (a) draws ions around the colloid, including hydrophilic colloids, Figure (b) removes oil from the colloid surface due to detergent being pulled, and Figure b includes hydrophilic colloids.

To see students' explanations, they can be adjusted to the principles or theories in the literature (general textbooks).

Table 6. Description of textbook answers at the exploration and concept formation stage.

Textbooks	Figure (a) Sol Fe(OH)3 is a hydrophobic colloid; positive ions are adsorbed to the surface, and repulsion between like charges prevents particle agglomeration. Figure (b) Cleaning dirt using soap is a hydrophilic colloid; the hydrophobic tail will dissolve in oil which is also non-polar. Finally, the fat is removed as an emulsion, and the hydrophilic tail will interact with water (Chang, 2010).

Based on Figure 5, a chemical multi-presentation model related to the nature of hydrophobic and hydrophilic colloids. Student 1, who has high analytical skills, understanding in answering critical questions is not much different from the explanation in the textbook. Student 2, who has good analytical skills, also has an experience that is not much different from the description in the book. Meanwhile, student 3 has a slight misconception when distinguishing hydrophilic and hydrophobic colloids. According to Chang (2010), Fe(OH)3 sol because it has no interaction with the dispersion medium, Fe(OH)3 sol only adsorbs ions on the colloidal surface to avoid particle aggregation. Meanwhile, in soap cleaning, applying hydrophilic properties to colloids, where the hydrophobic tail will dissolve in oil which is also non-polar, finally, the fat is removed in the form of an emulsion. The hydrophilic tail will interact with water.

Based on the analysis of answers from 3 students as a sample in the small group test, they can understand the concept of hydrophobic and hydrophilic properties in colloids based on the provided model. Critical questions are formed as simple as possible so that they are easy to understand but still achieve the goal of developing the concept of understanding the material for students.

The aspects assessed in the practicality test are ease of use, time efficiency, and benefits. Based on the results of the practicality test, data processing students obtained an average score of 87%, categorized as very practical, and the practicality test by the teacher brought an average value of 92% with a very practical category. Thus, the learning system developed is declared practical. The results of the practicality analysis are shown in Figure 5.

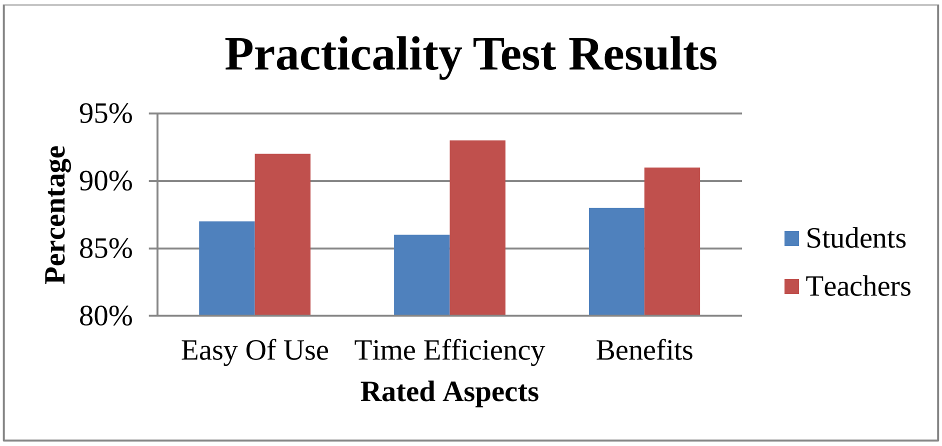


Figure 6. Practicality Test Results

CONCLUSION

Based on the results of the study, it was concluded that the guided inquiry-based flipped classroom learning system using Moodle on colloidal material could be developed with a validity value of 0.87. The student's level of practicality obtained a percentage of

87% with a very practical category, and the practicality level of the teacher got a rate of 92%, categorized as very practical.

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