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The POGIL Model Integrated Flipped Classroom Assisted Learning Management System (LMS) for Learning Solution in ERI 4.0

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Abstract: The use of technology in learning is highly demanded during the covid-19 pandemic and the development period of the Industrial Revolution Era 4.0. The right learning model is a challenge that must be solved by educators. The LMS-assisted FGIL model was introduced as an appropriate model used for current and future learning. This development is a type of EDR (Educational Design Research) research with a plomp research model. Lecturers as expert review, and 12 students became the subject of research in this development research. The data obtained in the form of content validity data and media validity was processed using Aiken's V formula, while practicality data was processed with practical percent. Based on the results of the study obtained a value of V for content validity and media validity of 0.88; and 0.91; which is in the valid category. Then the practical results showed a value of 89.00% with a very practical category. So, it can be concluded that the model developed has been valid and practical so that it is worth using in learning.

Keywords: POGIL; Flipped classroom; LMS; ERI 4.0

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Introduction

Learning in the time of the covid-19 pandemic urgently requires the presence of information and communication technology. This is also in line with the rise of discussions related to the Era of the Industrial Revolution 4.0 today. Where, during the ERI 4.0 period, the trend of digitization, automation, and the use of information and communication technology, emphasizes technological interconnection activities (Jankowska et al., 2021; Alaloul et al., 2020). Therefore, it is highly demanded creativity and pedagogy of an educator to utilize technology in learning, to equip Generation 4.0 graduates with skills, competencies, and experience improvements (Mourtzis et al., 2020).

Law No. 14 of 2005 on Teachers and Lecturers explains that lecturers are obliged to plan, carry out the learning process, and assess and evaluate learning outcomes. The selection of methods, learning models, and technologies that are able to support the learning process becomes an important point (Law No. 14, 2005).

Flipped classroom (FC) is a set of pedagogical approaches that move classroom learning out of the classroom, and vice versa (Cormier & Voisard, 2017). The FC approach is a key component of blended learning, which guides active and social learning in the classroom with learning outside the classroom. Learners with FC are able to create a collaborative learning environment, students centered, and able to generate student interest (Evseeva & Solozhenko, 2015; Kang & Kim, 2021; Westermann, 2014). Learning with FC consists of two stages. First, is the stage of introduction and understanding of material online before the class takes place (asynchronous). Second, is

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the stage of application and evaluation of concepts, which can be done virtually or offline (synchronous) (Jensen et al., 2015; Stöhr et al., 2020).

Guided Inquiry Learning (GIL) is a learning model that is able to engage the active role of students, and motivate students in building meaning and developing a deep understanding in each student (Kuhlthau & Maniotes, 2010; Wen et al., 2020). Learning with GIL, heard over 5 stages: (1) orientation, (2) exploration, (3) concept formation, (4) application, and (5) closure (Hanson, 2005).

The combination of the application of the Guided Inquiry Learning model with Flipped Classroom in organic chemistry has been shown to have a significant effect on student performance, as well as being able to maximize interaction between lecturers and students (DeMatteo, 2019). Development is carried out in the form of application in learning assisted by LMS Edmodo, and different implementation procedures adapted to online learning conditions. In addition, it also assists the zoom meeting application as a video record tool, and a virtual face-to-face communication tool.

LMS serves as an important catalog, registration, and approval, running and monitoring learning, evaluation, communication, reports, training plans, and as an integrase in learning (Effendi & Zhuang, 2005). LMS Edmodo provides academic requirements such as quiz features, assignments, polling, for evaluation, and supports learning and communication for distances from campus (Balasubramanian et al., 2014). This development was introduced as an FGIL (Flipped Classroom-based guided inquiry learning) learning model with LMS Edmodo.

Method

Research is conducted based on the type of research EDR (Educational Design Research), which designs, develops, and evaluates an intervention such as programs, strategies, teaching materials, products, and learning systems are a problem in the education cycle (Plomp & Nieveen, 2013).

The Plomp model becomes a guideline for implementation in this study with stages: (1) preliminary research, and (2) assessment phase. In the preliminary stage of research, needs analysis, context analysis, literature studies, and the development of a frame of mind are carried out. Furthermore, in the assessment phase stage, limited research to the small group stage, which consists of self-evaluation, expert review, one-to-one evaluation, and small group

The second stage is context analysis that is carried out by selecting materials, analyzing the Semester Learning Plan (RPS) of general chemistry courses, Expected Learning Outcomes (ELO), learning achievements, and sub-materials taught to be developed into a series of appropriate and appropriate learning objectives. The third stage of literature studies is done by analyzing several articles. Articles are analyzed to reinforce the reasons for the research being conducted, as well as research supporting articles that support the research.

The preliminary research phase ends with the creation of a conceptual framework. This is done after the implementation of needs analysis, context analysis, and literature studies are conducted. The framework will briefly describe the problems that occur in the world of Education today in the environment of the university's chemistry study program, and the solutions offered to solve them. Then continued in the first assessment stage, namely product development. At this stage will be given an overview of the learning implementation cycle with Flipped Classroom Integrated POGIL with LMS Edmodo to be produced prototype 1.

The second stage of self-evaluation is the stage of assessment of researchers related to products that have been designed. This analysis is carried out based on a valid self-evaluation questionnaire, then revised the product based on assessment, to produce prototype 2.

The third stage of expert review, and one-to-one evaluation. Expert review was conducted by 5 chemistry lecturers as content experts and 5 chemistry lecturers and media lecturers as media experts. The assessment is based on the content validation and validation of valid media. Then a revision of the product is carried out based on the suggestions of the validator. Furthermore, the One-to-one evaluation stage was conducted on 3 FMIPA UNP chemistry students in the class of 2020, with high, medium, and low categories as population representatives. Each student will observe and test the product in general, then provide responses and suggestions based on the interview questionnaire that has been provided. The product is revised based on all suggestions given until prototype 3 is obtained.

The fourth and final stages of the study are small groups. The small group was held on 9 students of chemistry FMIPA UNP Force 2018 as representatives with a category of 3 people with high, medium, and low ability levels, which are seen based on general chemistry grades semester 1. At this stage, field trials will be conducted for one cycle of learning activities with FGIL. At this stage, student responses, suggestions, and assessments will be obtained regarding the products tested. Then the product was revised based on the suggestion, to produce a prototype 4.

Data from observation and interview activities are processed in the form of conclusions. Then the data obtained from expert validators is processed using

Aiken's V formula, to see the validity of a resulting product can be used equation (1).
Aiken's V Formula:

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

Information:
s : r - Io
r : the value given by the validator
I_o : lowest validity value
n : number of expert validators
c : highest validity score

While the data was obtained through the small group stage in the form of a response from students, to determine the practicality of the resulting product, using equations (2).
Practicality formula:

$$p = \frac{f}{N} \times 100 \quad \text{(2)}$$

Information:
p : final value
f : score
N : maximum score

Result and Discussion

The research that has been carried out, produces several parts based on the implementation of the plomp stage. The first results of the study in the form of needs analysis were conducted through unstructured observations of the online learning processes and conditions of FMIPA UNP chemistry students from 2018 to 2021. These observations are carried out without observation guidelines, then the observer develops observations based on events that occur in the field (Bungin, 2007).

The results of the analysis illustrate that the online learning process during the pandemic was largely carried out by lecture methods. Learning with this method causes students to be passive in learning, lacklustre, saturated, and cause lazy effects (Suryanto, 2018). This is evident from the analysis of several learning processes and recognition from some students where they only hear well, do not ask questions, there are even some cases of students who close the camera during zoom meetings, and fall asleep during the lecture process. Lecture methods also result in students being less creative, easy to forget lessons, difficulty transferring learning outcomes to new situations, causing low learning outcomes and most likely students misunderstanding the intentions of the teacher (misconception) (Tambak, 2014; Rem, 2009). In addition, the lecture method is not suitable for improving students' critical thinking skills (Grove & Bretzb, 2010).

LMS becomes an important means of online learning, but LMS is only used as a container of attendance, delivery of lecture materials, delivery of assignment files, and student answer files. Then at the evaluation stage such as midterms or end-of-semester exams, LMS is not utilized properly. Evaluation activities are only done by sending questions in the form of files in LMS, then answers written on paper, scanned, and then sent back in the form of files in LMS. While LMS in learning serves to provide learning experiences to students, improve the quality of content, manage learning in the digital era (Thepwongsa et al., 2021; Nguyen, 2021), manage quizzes, provide assessment reports, and feedback on users (Widiyawati & Anistyasari, 2020).

The second stage is a context analysis. At this stage, the Chemical Bond is selected as the material to be presented with the Flipped Classroom integrated POGIL model. Chemical bonds are a very complex matter, and to understand them requires an understanding of matter in atomic structure, and the periodic properties of elements (Nurbaity et al., 2012; Bergqvist, 2017). In studying chemical bonds many exception concepts must be understood such as beryllium which was the first member of alkaline earth metals but formed covalent compounds, in contrast to its group elements. Then exceptions to octet rules such as expanded octets, coordination, and octets are incomplete (Chang & Overby, 2010). Chemical bonding materials are appropriately applied with the POGIL model too (Moog & Spencer, 2009).

Chemical bonding on the curriculum of FMIPA UNP chemistry study program studied on general chemistry courses for first-year chemistry students. This course has 3 Expected Learning Outcomes (ELO), 13 study materials (teaching materials) that must be studied, and 4 expected final abilities, to be spelled out in the form of more complex learning objectives, as follows: (1) Explaining the process of forming ion bonds based on Lewis structure, (2) Explaining the process of forming ion bonds in terms of the energy involved based on the Born-Haber cycle, (3) Explaining the properties of ionic compounds, (4) Describes the process of covalent bond formation, (5) Distinguishes single covalent bonds, and double covalent bonds, (6) Describes the process of forming covalent bonds, (7) Describes deviations of octet rules, (8) Distinguishes the polarity of a compound, (9) Determines the molecular shape of a compound, (10) Determines the type of bond in a covalent compound based on molecular orbital theory, (11) Determines the naming of an ion compound, (12) Determine the naming of a covalent compound, (13) Analyze the process of forming metal bonds.

The third stage is to carry out literature studies by finding and understanding sources and references related to the purpose of development research. DeMatteo, (2019) on research on "Combining POGIL and a Flipped Classroom Methodology in Organic Chemistry", Learn by applying the three stages of POGIL, exploration, concept formation, and application to organic chemicals. The learning stage is done by providing assignment notes and understanding concepts outside the classroom, and discussion activities in the classroom. However, this learning is not planned for online learning. Hrastinski (2008), "A Study of Asynchronous and Synchronous E-Learning Methods Discovered that Each Supports Different Purposes" Discuss learning related to e-learning that is carried out asynchronously and synchronously. Asynchronous is a learning activity where teachers and students are not online at the same time, flexible, and done at any time. Synchronous is a real-time learning activity, where teachers and students are online at the same time, and usually also assisted by video conferencing and chat. Alliyah et al (2021), "Development of Edmodo Platform Assisted Teaching Materials on Comparative Materials", states that Edmodo is a free platform with features that can support online learning. Balasubramanian et al (2014), Details that Edmodo has quiz features, ratings, quizzes, assignments, polls, messages, small groups, file posts, file submissions, and more that support online learning.

The fourth stage is carried out the development of a frame of mind, after conducting a need analysis, concept analysis, and literature study, a frame of mind is produced. The fifth stage and the first stage of the prototyping stage are product development, which results in prototype 1. The resulting product is an integrated POGIL model flipped classroom with LMS, designed for online learning, or blended learning, with the learning cycle illustrated as illustrated in the following image.

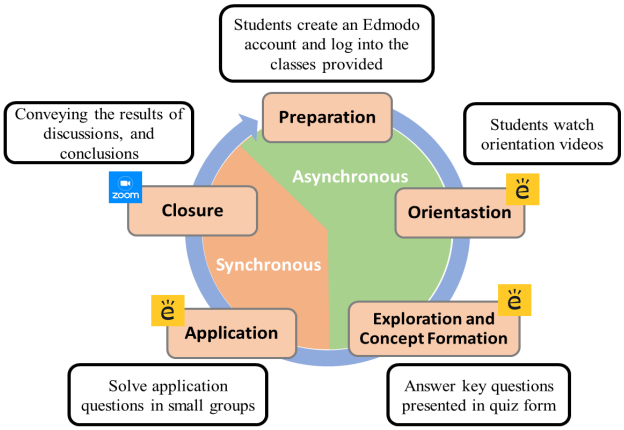

Figure 1. POGIL Integrated Learning Cycle Flipped Classroom assisted LMS

The learning process is carried out asynchronously and synchronously. Asynchronous consists of the orientation, exploration, and formation stages of concepts through LMS Edmodo. Learning begins with the preparation stage in the form of student Edmodo accounts and is included in filling out the absence of asynchronous activities on LMS Edmodo. At the orientation stage, students are presented with videos containing learning instructions, learning objectives, perceptions, motivations, and introductory materials. Example of an orientation video post display on Edmodo, in figure 2.

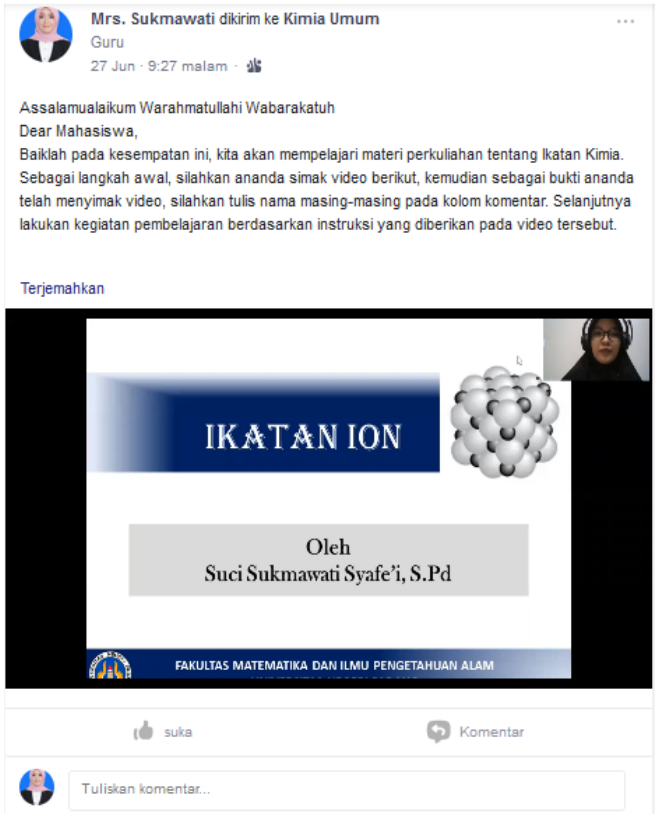

Figure 2. Orientation Video on Edmodo

At the time of exploration and concept formation, students will analyze the model (picture, or table) presented. Then answer some key questions related to the model. The student's image analysis allows us to investigate his or her understanding of chemical concepts (Meijer et al., 2009), and is believed to be able to reveal the mental model of students (Harle & Towns, 2013; Cooper et al., 2017). An example of a display on Edmodo can be seen in figure 3.

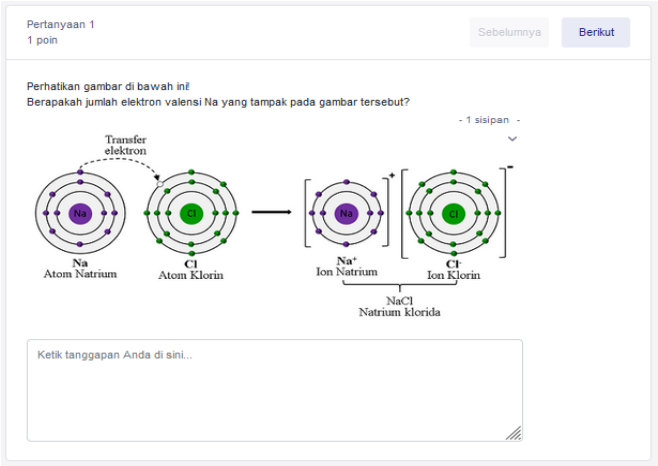

Figure 3. Exploration and Formation of Concepts

Then synchronous activities continued with the application stage and closing right at lecture hours, for 2 hours of learning. In 1 hour of initial learning, the application stage is carried out, by conducting group discussions on the Edmodo small group feature. Each student will discuss the answers to the questions given in their respective groups. Examples of displays on Edmodo such as Figure 4.

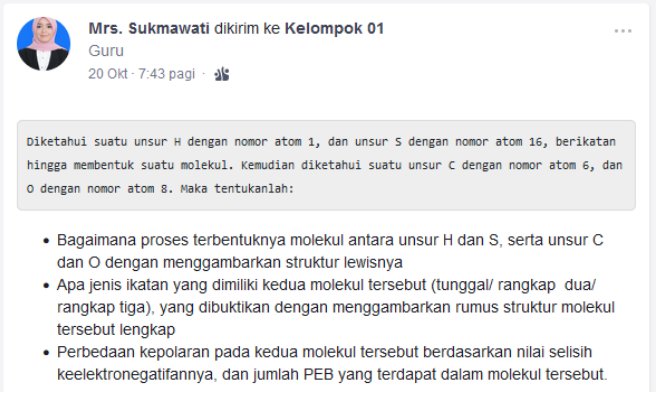

Figure 4. Questions on Small Group Features

Then the closing stage is carried out in real-time through the zoom meeting application by including a zoom link on the Edmodo LMS, which can be viewed like the following 5 images.

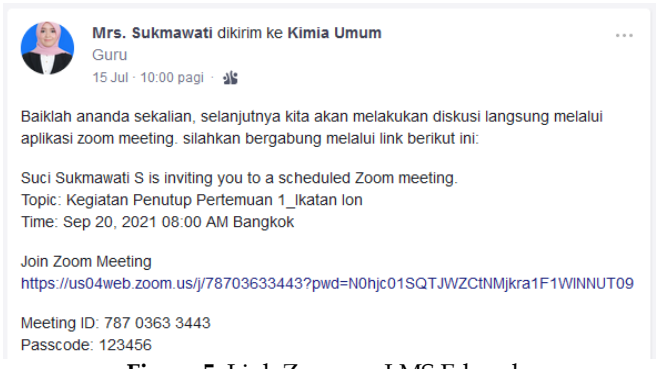

Figure 5. Link Zoom on LMS Edmodo

After the development of the product, then this stage produces prototype 1.

The fifth stage of self-evaluation. At this stage, personal assessments are generated from researchers based on aspects of assessment: (1) guided inquiry learning steps based on the flipped classroom, (2) asynchronous absence links, (3) orientation videos uploaded to Edmodo, (4) models and key questions on Edmodo, (5) synchronous absentee links, (6) small group sharing on small-group features in Edmodo, (7) application stages on small-group features in Edmodo, (8) zoom meeting links on Edmodo for the pup stage, (9) learning scenarios. The assessment is conducted using a valid self-evaluation instrument. All aspects that are considered to have been fulfilled properly, and revised to some parts that are not good such as language improvements in questions, until prototype 2 is produced.

The sixth stage is expert review. Expert review is conducted by content experts and media experts, by assessing and reviewing products performed either with or without the presence of researchers. Content validation is done by 5 chemistry lecturers as content experts, while media validation is done by 5 media lecturers and chemistry as media experts. Validation is done based on valid validation sheet guidelines. In this process, some suggestions are obtained from validators, which are then revised to the input (in the appendix). After the revision is implemented, an assessment is obtained from each validator. Validity aspects of validators are measured using Aiken's V formula, with valid categories worth ≥ 0.8 for 5 validators (Aiken, 1985).

The results of the content validation analysis presented in table 1, and media analysis results, are presented in Table 2.

Table 1. Analysis of Content Validation Results

Aspects Assessed	Value "V"	Category
Content components	0.90	Valid
Serving components	0.85	Valid
Language component	0.81	Valid
Graphics component	0.80	Valid
Average	0.84	Valid

Table 2. Analysis of Media Validation Results

Aspects Assessed	Value "V"	Category
View Aspects	0.88	Valid
Ease Aspect	0.91	Valid
Average	0.89	Valid

Based on the results of validation of each generally assessed aspect, it has been stated that the product developed is valid and worthy to be tested in the learning process. However, there is one category of invalid assessment in the language component, namely

the use of symbols/chemical symbols that have not been consistent at all stages of learning with a valid value of 0.78. However, it does not affect the overall aspect of the valuation. The product remains valid.

The next stage is one-to-one evaluation, to see the student's response to the product developed. Three students as respondents observed, and work on some activities on products that have been developed. After that, an interview of the product is conducted to find out their response to this product.

Based on the results of the interview it can be concluded that the orientation video display on Edmodo contains clear information, prerequisite materials, and introductory materials, as well as for instructions that are easy to understand. The model (picture/table) presented is clear and able to help students in answering key questions. Then in the use of Edmodo, students do not experience difficulties. This is because the Edmodo platform has a look that resembles Facebook (Reski & Palittin, 2021), with features that are easily recognized. However, there are some questions that students do not understand, so revisions are made to some of these questions. Then the revision was completed based on the advice of the expert review, and the advice of respondents at the one-to-one evaluation stage, until prototype 3 was produced.

The seventh stage is small group evaluation. This stage was conducted a small-scale trial, with 9 chemistry students representing the population. The selected students consist of 3 students with high, medium, and low ability. Activities are carried out for 3 days. The material tested was only a sub-material of ion binding.

First asynchronous activities, where students are given 2 days to complete each stage. Then, continue the synchronous activity, which is the application stage by conducting a group discussion at an hour of initial learning, on the small group feature in Edmodo. The closing stage is done by conveying the results of discussions through zoom meetings and conducting Q&A with peers and teachers related to concepts that have not been understood.

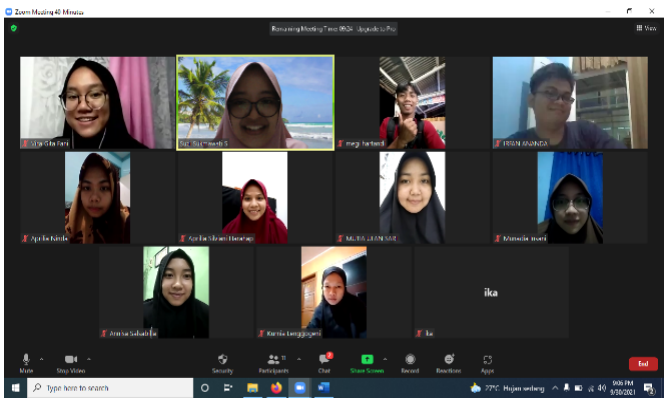

Figure 6. Closing Activities at Zoom Meeting

After learning activities at the small group stage, it was disseminated practicality questionnaire to students to see the student's response to learning with the LMS Edmodo-assisted FGIL Model.

Table 3. Analysis of Small Group Practical Results

Aspects Assessed	Value "P"	Category
Ease of use	88.90	Very practical
Time efficiency	90.00	Very practical
Benefit	89.00	Very practical
Average	89.00%	Very practical

The student response states the result that each component of the assessment is declared practical, which can be seen in Table 3. Then the assessment and suggestion of improvements obtained at this stage became the guidelines for further product revisions which then resulted in prototype 4.

Conclusion

The FGIL (Flipped Classroom-based Guided Inquiry Learning) learning model developed for chemical bond learning is analyzed based on validity and practicality. Validation is done on content and media, with validity results of 0.84 and 0.89 with valid categories. Then the practicality shows a value of 89% with a very practical category. This shows that the LMS-assisted FGIL learning model developed has been valid and practical, so it can be used in learning.

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