11(1), 2022, 109-120 DOI: 10.23960/jppk.v11.i1.2022.11
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595 | p-ISSN: 2302-1772
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Development of Guided Inquiry-Based Flipped Classroom Learning System Using Moodle on Buffer Solution Material For the Industrial Revolution 4.0

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Received: March 18th, 2022 *Accepted:* April 18th, 2022 *Online Published:* April 29th, 2022

Abstract: Development of Guided Inquiry-Based Flipped Classroom Learning System Using Moodle on Buffer Solution Material for the Industrial Revolution 4.0. This research aimed to develop a guided inquiry-based flipped classroom learning system using moodle on buffer solution material and to test the validity and practicality of the learning system results. This conducted research isclassified by Educational Design Research with the Plomp development model. The subjects of this research were 3 teacher of the chemistry, and 20 students in class XII MIPA 3 at SMAN 8 Padang. The instrument used is a questionnaire of the validity and practicality of the developed learning system. The validity data were analyzed by Aiken's V formula while the practicality used the percentage method. The results of construct validation are 0.91 and the content validation are 0.86 in the valid category, while the practical results obtained from student responses and teacher's response are 94% in the very practical category. Based on the results of these studies indicate that the learning system developed is valid and practical. so, this learning system can be used as an alternative learning that support the industrial revolution 4.0 era.

Keywords: Buffer Solution, Flipped Classroom, Guided Inquiry, Industrial Revolution 4.0.

Abstrak: Pengembangan Sistem Pembelajaran *Flipped Classroom* Berbasis Inkuiri Terbimbing Menggunakan *Moodle* Pada Materi Larutan Penyangga Untuk Era Revolusi Industri 4.0. Penelitian ini bertujuan untuk mengembangkan sistem pembelajaran flipped classroom Berbasis inkuiri terbimbing menggunakan moodle pada materi larutan penyangga dan menguji kevalidan serta kepraktisan sistem pembelajaran yang dihasilkan. Jenis penelitian yang dilakukan adalah Educational Design Research dengan model pengembangan Plomp. Subjek penelitian ini adalah 3 orang guru kimia, dan 20 siswa kelas XII MIPA 3 SMAN 8 Padang. Instrumen yang digunakan adalah angket validitas dan praktikalitas sistem pembelajaran yang dikembangkan. Data Validitas dianalisis menggunakan rumus Aiken's V sedangkan praktikalitas menggunakan metode persentase. Hasil validasi konstruk sebesar 0,91 dan validasi isi sebesar 0,86 dalam kategori valid. Sedangkan hasil praktikalitas yang diperoleh dari respon peserta didik dan respon guru sebesar 94% dalam kategori sangat praktis. Berdasarkan hasil penelitian tersebut menunjukkan bahwa sistem pembelajaran yang dikembangkan sudah valid dan praktis. Sehingga sistem pembelajaran ini dapat dijadikan sebagai alternatif pembelajaran yang mendukung era revolusi industri 4.0.

Kata kunci: Larutan Penyangga, Flipped Classroom, Inkuiri Terbimbing, Revolusi Industri 4.0.

▪ INTRODUCTION

Introduction The Covid-19 virus pandemic was announced by the government since the first case of Coronavirus Disease 2019 (Covid-19) in March 2020. This Covid-19 has spread so quickly in almost all countries, including Indonesia. Therefore, the World Health Organization (WHO) has enacted this outbreak as a global pandemic on March 11, 2020 (Asmuni, 2020) Almost all sectors of life have affected by this pandemic, and the education sector is no exception. Education is a continuous and never-ending process, so the learning process must continue even though the country and even the world are affected by the COVID-19 outbreak. To address this, the implementation of face-to-face learning has shifted to distance learning.

Distance learning is also known as online learning. Online learning is a learning process without a direct face-to-face meetings between teachers and students. With online learning, most of the implementation of the teaching and learning process must make more use of internet-based technology. Thus, the Covid-19 pandemic is one of the factors that driving the acceleration in implementing the education system of the Industrial Revolution Era 4.0. In the Industrial Revolution 4.0 Era, the internet is used as the main key in every process carried out. The era of revolution 4.0 is marked by the increasing interaction and development of digital and virtual systems (Lase, 2016).

Educational challenges are becoming increasingly complex. On one side, learning is required to adapt to the industrial revolution 4.0 era. On the other side, learning is beingdone in the COVID-19 pandemic situation (Sugianto, 2021). This is certainly a demand for educators to be able to adjust or develop new strategies in implementing their learning so that learning objectives can be accomplished. Learning that can be used in online learning which optimizes the use of technology is blended learning. The learning method that is used in blended learning combines online learning with face-to-face learning (Hikmah & Chudzaifah, 2020). As for this blended learning, it consists of two learning conditions, synchronous and asynchronous learning. Asynchronous learning is a learning process that occurs at different times and places. Meanwhile, synchronous learning is a learning process that occurs in the same time even though theirposition is in a different places (Murphy et al., 2011). Blended learning hasfour models. One of the model categoryis the rotation model. The rotation model has four kind of submodels, including station rotation, lab rotation, individual rotation and flipped classroom (Watson et al., 2020).

Flipped classroom is also known as a reverse classroom learning. The learning that carriedout in a flipped classroom is by reversing the learning process that occurs during the class and outside the class schedule. By using a flipped classroom, students learn the subject matter’s concept earlier outside the classroom by watching videos and accessing learning resources provided byeducators. After having prepared learning materials from home, the class schedule is used to solve problems encountered with the teacher (Nja et al., 2022). A flipped classroom supports scientific learning. Under the scientific approach, there are four learning models that can be used. One of them is inquiry learning. Inquiry learning consists of four types, one of them is Guided Inquiry Learning. A guided inquiry model can motivate students to actively explore their own knowledge so that they can make students active and independent in learning (Fitriani et al., 2016).

Based on the research that has been done by Syakdiyah et al., (2020), it can be concluded that the flipped classroom with all its types can follow the industrial era 4.0.

The flipped classroom will give students the freedom to independently explore their abilities and be responsible during the learning process.

Then, Kardena & Mawardi (2020) has conducted a study entitled "The Influence of Inquiry Based Learning Model With a Flipped Classroom Approach on Self Efficacy and Ion Equilibrium Learning Outcomes in Salt Solutions". In their research, theyhave stated that learning activities by applying a flipped class approach to the inquiry based learning model are more effective in improving knowledge learning outcomes. This happens because the flipped classroom learning through the inquiry based learning model emphasizes the active role of students in finding their own concepts in each of the core stages of inquiry based learning. Therefore, to support a flipped classroom learning based on a guided inquiry, an LMS is used in its application. The Learning Management System that is used here is Moodle. Moodle is a free open source, Moodle can be used to enlarge an e-learning system easily. Moodle can be modified in accordance with the wishes and needs (Lebeaux et al., 2021).

Based on the problems that have been described, the writers are motivated to develop a learning system that can be used in this Covid-19 pandemic situation that supported the industrial revolution 4.0 era, yet still continue to apply student-centered learning. For that reason, it is necessary to conduct a research on a development of guided inquiry-based flipped classroom learning system using moodle on buffer solution material for the second year of senior highschool student.

▪ METHOD

The type used in this research is Educational Design Research (EDR) with the Plomp development model. The Plomp model is a development model that developed by Tjeerd Plomp, this model consists of three stages, which are Preliminary Research, the prototyping phase and the assessment phase (Hedberg, 2008).

The first stage is preliminary research. At this stage, analysis of needs & context are carried out, which is useful for seeing problems in the field related to learning. Furthermore, a literature study is carried out to find solutions to the problems found. After finding a solution from the literature review, then it is proceed with making a conceptual framework in the form of an overview of the research.

The second stage is the prototyping phase. At the prototyping phase, formative evaluation is carried out to get the perfect product. The product resulting from the initial design is called prototype I. In prototype I, a formative evaluation is carried out in the form of self-evaluation to produce prototype II. This evaluation is carried out to see the components that must exist in prototype I, if all components are available, then prototype II is produced. In prototype II, a formative evaluation is carried out in the form of an expert review and one to one evaluation. The expert assessment is carried out with a validity questionnaire on the content and media of the developed product, while the individual evaluation is carried out on 3 students with high, medium and low ability levels. After making improvements from the evaluation, prototype III is produced. In prototype III, a formative evaluation is carried out in the form of a small group test to produce prototype IV. Small group test is conducted on 20 students.

Data Analysis

The validator's assessment of each statement was analyzed using the Aiken's formula:

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

Information:
s : the score determined by the validator minus the lowest score in used category
n : number of validators
c : the number of categories selected by the validator.

With the category level of validity can be seen in Table 1 below:

Table 1. Validity Category

No	Aiken V Score	Validity
1	V < 0,79	Invalid
2	V ≥ 0,79	Valid

(Lewis. R. Aiken, 1985)

Furthermore, the practicality data were analyzed using the following formula:

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

Information :
NP : Percentage value sought
R : Scores obtained by students
SM : The ideal maximum score of the test in question
100 : Fixed number

With the category level of practicality can be seen in Table 2 below:

Table 2. Practicality Category

No	Score	Practicality
1	86% - 100%	Very Practical
2	76% - 85%	Practical
3	60% - 75%	Medium
4	55% - 59%	Low
5	≤ 54%	Impractical

(Yunus & Sardiwan, 2018)

▪ RESULT AND DISCUSSION

Based on the research that is carried out with the type of Educational Design Research (EDR) using the Plomp model stages, the resulting product in the form of a flipped classroom learning system based on the guided inquiry using Moodle on the buffer solution material for class XI SMA/MA. Educational Design Research (EDR) is an educational development research that includes a systematic study of designing, developing, and evaluating educational interventions, such as programs, learning processes, teaching and learning materials, and learning products and systems that can be used as solutions to problems that arise (Hedberg, 2008). It is said to be a learning

system, because in this study it contains learning components contained in the system. This is supported by Pane & Darwis Dasopang (2017) and Gaja & Mawardi (2021) who has stated that the learning system is a unity of several interrelated learning components to establish the learning objectives that have been set. The components of the learning system are students, educators, learning objectives, subject matter, learning methods, learning media used, and learning evaluation.

Preliminary Research

The first stage of Plomp's development is a Preliminary Research. This stage of the preliminary research isdone to obtain information about educational problems. There are three stages in this preliminary research, which areneeds and context analysis, literature review, and development of aconceptual framework.

The needs analysis stage is carried out to see the situation in the field related to problems that occur during the learning process. Based on the obtained results, it is known that teachers experience difficulties on the online learning process during the pandemic. Teachers have not been able to carry out student-centered learning while online, due to limited time and reach which is resulted in the learning process being more teacher-centered with the lecture method.

The second stage of the initial research is the literature review. The literature review is carried out by seeking and understanding information from various sources, either from articles, journals, books, and others in order to obtain solutions to the problems encountered in the needs analysis. The results of the literature review stage have shown that online learning can fulfil the blended learning manner by integrating offline learning processes and online learning processes. Blended learning is a learning process that occurs in two conditions, synchronous and asynchronous. Synchronous is a learning event that occurs at the same time and places or the same time, but in the different place. Meanwhile the Asynchronous is a learning event that occurs at different times and in the different places (Chaeruman et al., 2020). In addition, in online learning, students are also expected to remain active in the learning process. The learning process that can make students active is learning with a guided inquiry, guided inquiry can make the students think critically, and being responsible for achieving their understanding independently, so as to make students active during the learning process. This is supported by Aini et al., (2019) who has stated that the guided inquiry model can be one of the effective models applied to chemistry learning.

The learning process must also adapt to the times, in the era of the industrial revolution 4.0, it is required to maximize the use of technology as a learning aid. The use of technology in learning is also needed as a supporter of the 4.0 revolution era (Cholily et al., 2019). Technology has the power to connect and communicate with students at the same time (Herpika & Mawardi, 2021). Mobile and internet technology are very important to be used as learning media in the 4.0 era because they can make students more flexible in learning, because learning can be done anytime and anywhere.

Therefore, the solution to the problems found is the development of guided inquiry-based flipped classroom learning system using moodle, which the learning is carried out on a buffer solution material.

Prototyping Phase

After preliminary research, it is continued with the Prototyping Phase. At the prototyping stage, IV prototypes are produced, which are evaluated by formative

evaluation. The first design of the product to be developed is called prototype I, which is a flipped classroom learning system based on guided inquiry using the Moodle. the display on Moodle can be seen in the Figure 1 below.

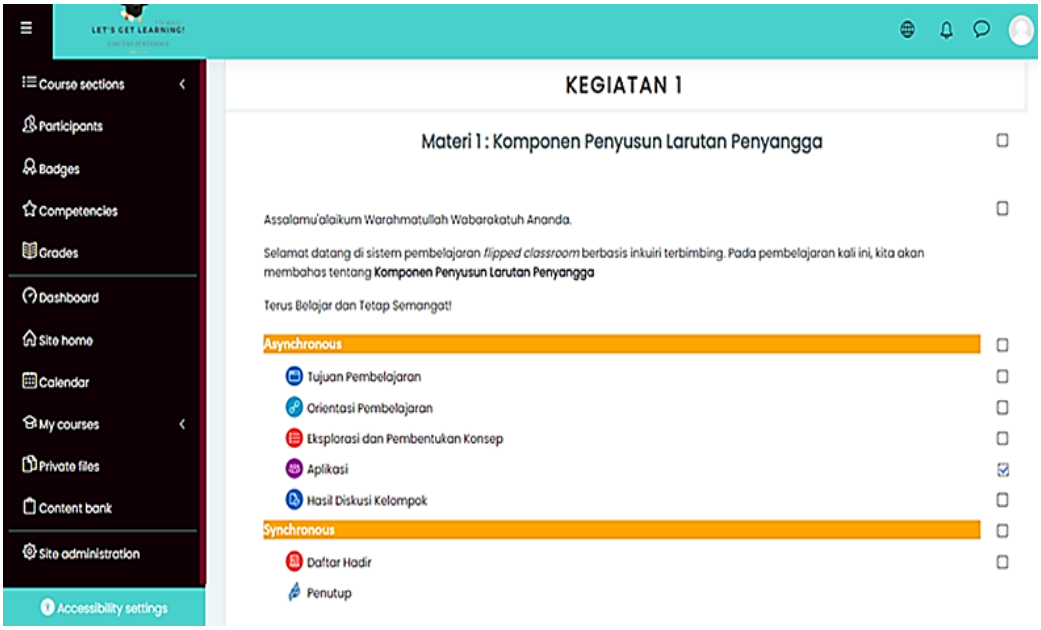

Figure 1. Learning View on Moodle

In this learning system, the guided inquiry stage is carried out in a flipped classroom, namely the orientation, exploration and concept formation stages, and the application stage is carried out online outside of study hours. Meanwhile the closing stage that occurs directly during learning hours using the jitsi feature in the form of a video conference in Moodle. This is supported by (Pratiwi & Silalahi, 2021) who have stated that in the flipped classroom the teacher makes a video and is watched by the students before entering the learning schedule (asynchronous). And on the learning schedule, several group discussions are held to solve problems and apply applications to see what students have found (synchronous). The steps for learning the flipped classroom based on guided inquiry can be seen in Figure 2 below.

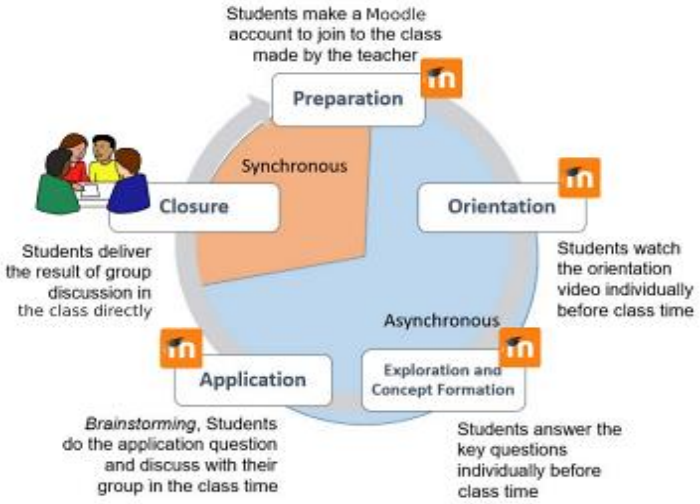

Figure 2. Flipped-guided inquiry learning model cycle (Ismail & Mawardi, 2021).

The stages of learning the guided inquiry with the presentation of the flipped classroom starting from the asynchronous orientation. At this orientation stage, students are prepared to learn. The orientation stage is presented in the form of a video uploaded to Moodle. The second stage is exploration and concept formation which is also carried out asynchronously. At this stage, students are asked to explore the model to answer key questions that is requiredto findthe concepts, so that learning objectives can be achieved. This is supported by Aumi & Mawardi (2021) who have stated that students will easily understand the concept if the learning model is presented clearly and does not raise doubts. An example of the model contained in Moodle can be seen in *Figure 3* below.

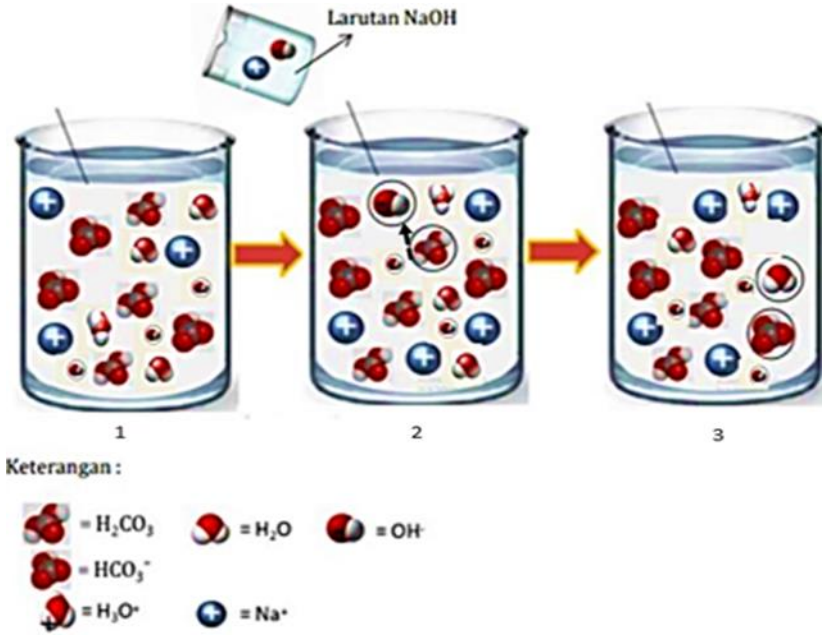

Figure 3. Buffer Solution Model (Tro, 2016).

The picture above is an acid buffer that is given the addition of a base. Based on the results of research and students' answers in Moodle, it can be seen that the model can help students to find the concept of the working principle of a buffer solution. Students analyze the model by counting the amount of each component contained in the first beaker, then in the second beaker there is the addition of NaOH which causes a reaction between H_2CO_3 and OH^-. The result of this reaction is seen in the third beaker which produces HCO_3^- with H_2O. After that, students recalculate the number of components contained in the third beaker (end of reaction) and compare that amount with the components in the first beaker before adding the base. Thus, students can find out which direction the equilibrium will shift if a little base is added to an acid buffer solution.

The third stage is the application which is still carried out asynchronously. The application is the stage where students apply the concepts that have been obtained by answering practice questions. The last stage is closing. At the closing stage, this is done directly with the teacher (synchronous). The closing is the final stage of inquiry learning. Students will present the results they have obtained and the teacher will provide reinforcement to the concepts that students get (Pedaste et al., 2015). This

application stage aims to provide reinforcement of the concepts possessed by students as well as to see whether students have understood the concept or not (Aulia & Mawardi, 2021).

After the prototype I is produced, it is continued with self-evaluation activities. Self-evaluation is carried out to see the completeness of the components in prototype I, from the results of self-evaluation it is seen that the components that must exist in prototype I are already available, so that from this activity a prototype II is produced.

Furthermore, to produce prototype III, the stages carried out are evaluation of expert reviews (expert review) and individual evaluations (one to one evaluation). Evaluation of expert judgment is in the form of validation activities on prototype II to get the level of validity of the prototype that has been produced. This validation stage is carried out by asking a team of experts in their field to assess the product that has been designed, so that a scientifically valid prototype is obtained. The evaluation of the expert assessment was carried out by 6 validators of content and 6 validators of media.

The result of validity value on the education system can be seen in Table 3 and Table *4* below.

Table 3. The Result of Content Validity

No	Aspects Assessed	V	Validity Category
1	Content Feasibility	0.89	Valid
2	Construction Feasibility	0.86	Valid
3	Linguistic	0.86	Valid
4	Graphics	0.85	Valid
Average		**0,86**	**Valid**

Table 4. The Result of Construct Validity

No	Aspect Assessed	V	Validity Category
1	Visual aspect	0.91	Valid
2	Easy to use	0.92	Valid
	Average	**0.91**	**Valid**

Then, one to one evaluation is carried out, this activity is carried out by interviewing 3 students of SMAN 8 Padang, the first student with the highest achievement, the second student with moderate achievement, and the third student with the lowest achievement. From the interview, it is found that the orientation video displayed is clear and easy to understand, and the use of the language is also clear. According to (Qurrotaini et al., 2020) the use of media in the form of clear videos in learning can make it easier for students to learn learning materials. And from the results it is also seen that the language used is clear. This is in accordance with the opinion of (Ningrum, 2020) who has stated that students will not experience misunderstandings and confusion if the language conveyed is clear and easy to understand. Thus, the results of expert assessment and individual evaluation are called prototype III.

Furthermore, to produce prototype IV, a small group trial activity is carried out to ensure the practicality of the resulting product. This small group trial is conducted on 20

students and 3 educators. From the practical results, the average practicality value of students and teachers is the same, that is 94% in the very practical category. Validity test and practicality test are part of formative evaluation, which aims to improve the resulting product (Anjelina & Mawardi, 2021). The graph of practicality results can be seen in Figure 4 and Figure 5 below.

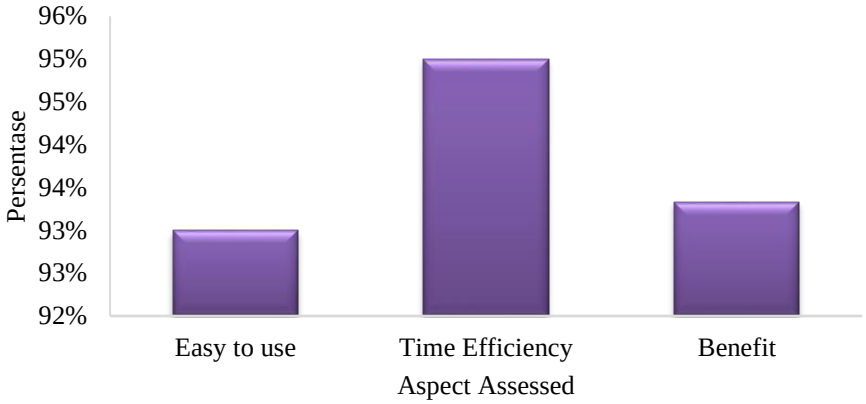

Figure 4. Student Practicality Result

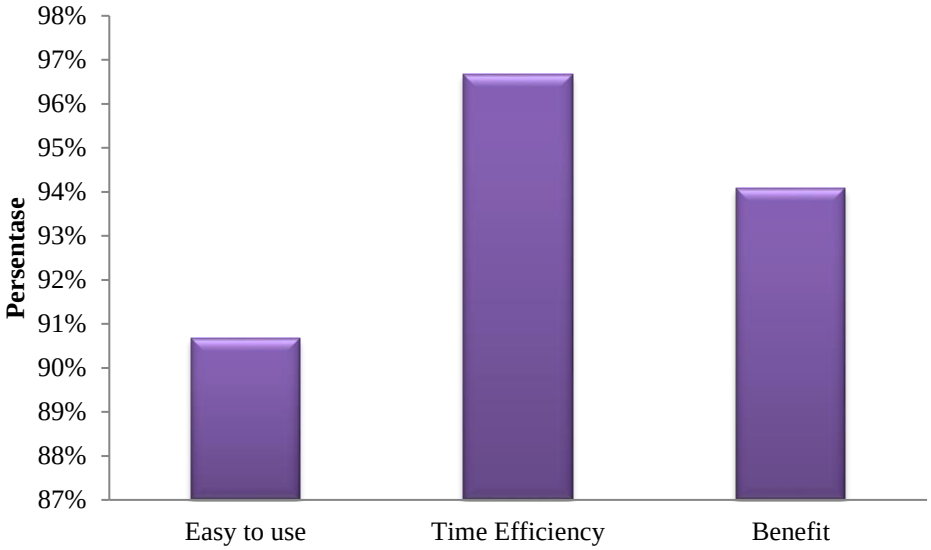

Figure 5. Teacher Practicality Result

The results of the data obtained are in accordance with the expectations of the literature review. From the results of the research, it can be seen that the flipped classroom makes students more flexible to understand the material and repeat lessons at home, this can be seen from students access in Moodle, students access Moodle more than once. So that students can easily remember the subject matter. Then, the use of the guided inquiry model can increase students' activeness and critical thinking skills, this can be seen from the students' answers in moodle which shows that students have been active during learning. Evenmore, the use of Moodle will expand students' knowledge of technology, so that students can keep up with the times.

Therefore, based on the results of the research, it shows that the development of a guided inquiry-based flipped classroom learning system using Moodle in a buffer

solution material can be used as an alternative to online learning and is also in accordance with the era of the industrial revolution 4.0.

▪ CONCLUSION

Based on the results of research on the flipped classroom learning system based on guided inquiry using Moodle on the buffer solution material, it is concluded that the learning system result is valid with an average V value = 0.86 from the material expert validator and an average V value = 0.91 of the media expert validators. Then, based on the assessment of the small group, the level of practicality is very practical with the average percentage value of students = 94% and the average percentage of teachers is also 94%. These results indicate that the learning system developed is valid and practical to be used as an alternative learning that supports the era of the industrial revolution 4.0.

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