



# Effectiveness of a Flipped Classroom Based on Guided Inquiry Learning System on Acid-Base Solutions

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**Abstract:** This study aims to determine the effectiveness of flipped classroom based on guided inquiry learning system on acid-base solutions toward students learning outcomes of XI class senior high school students that had been tested valid and practical. This type of research is quasi-experimental with a Non-Equivalent Control Group Design. The sample class used was XI Mipa 1 as a control class and XI Mipa 2 as an experimental class, with the total of students were 69 using the purposive sampling technique. The instrument used in this study was a multiple choices question to assess students learning outcomes in the cognitive domain. The result of this study to obtain the N-gain value from the experimental class and control class with the values are 0.80 and 0.73, respectively, which indicates the value of experimental class is higher than control class. Furthermore, for the t-test, the value is 3.18, and the t-table value is 1.99. It concludes that using flipped classroom based on guided inquiry learning system on acid-base solutions improve students learning outcomes effectively.

**Keywords:** Effectiveness; Flipped Classroom; Guided Inquiry; Acid-Base Solution; Learning Outcomes

## Introduction

The era of the industrial revolution 4.0 (technology disruption era) is an era of transformation in all aspects involving the use of technology through the development of digital system (Rymarczyk, 2020). In line with the story of the industrial revolution, a country's human resources also have quality in terms of critical thinking and problem-solving skills. Efforts that can make to improve human resources are through education. One of the efforts made by the government of the Republic of Indonesia is to roll out the 2013 Curriculum, which aims to equalize global education and remains based on norms (Mawardi et al., 2019).

The Covid-19 pandemic has significantly impacted aspects of life, especially in the field of education. Based on this urgency, the Minister of Education, Culture, Research and Technology of the Republic of Indonesia issued Circular Letter 4 of 2020 regarding the transition from face-to-face learning to technology-based distance learning (Kemendikbud, 2021; Yen, 2020). Other policies are also implemented, such as reducing the allocation of

learning time that affecting teachers and students' interactions. Therefore, a learning model is needed to accommodate all learning activities during the pandemic to continue as they should. Blended learning is the one of the solutions that can be used.

Blended learning can combine face-to-face learning and online learning by utilizing interactive electronic technology (Duhaney, 2007). The application of blended learning makes students active inside and outside the classroom. Blended learning combines two learning settings that are synchronous and asynchronous. Synchronous learning is a learning activity between educators and students simultaneously. Asynchronous learning is a learning activity that they can do anywhere and anytime (Chaeruman, 2013). Blended learning has four classifications: rotation model, flex model, self blend, and enriched virtual model. The rotation model consists of four sub-models, one of them is the flipped classroom.

The flipped classroom is a modern learning where students learn the teaching materials before class (online) and discuss it in face-to-face learning

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(Chaeruman, 2013). In the asynchronous stage, students are learning at home. It will facilitate students with teaching materials that contain models and questions so that students are required to be able to identify, analyze and draw concepts independently. In the synchronous stage, the implementation of learning that will carry out in class will lead to more confirmation actions to educators regarding concepts obtained at the asynchronous stage (Chaeruman, 2013). During the COVID-19 pandemic, students can carry out learning by utilizing a learning management system (LMS) that can optimize the learning process.

LMS is software for activities in the network. The LMS used in this online learning is Edmodo. Edmodo is a free and secure online learning platform (Pedaste et al., 2015). Using Edmodo can help teachers to manage classes and enable students to connect with classmates anywhere and anytime (Balasubramanian et al., 2014; Sapitri, 2021). For flipped classroom-based learning and following the 2013 Curriculum that the learning process is a student-centered, a scientific approach, namely a guided inquiry model (Mawardi et al., 2021).

The inquiry learning model consists by four of sub-models that one of them is guided inquiry learning. Guided inquiry learning can stimulate, teach and invite students to think higher to find concepts of the various problems expressed independently, while the teacher's role includes providing learning materials and concerns for guiding students in confirming the ideas (Heather & Randi, 2008; Mawardi et al., 2020). The positive impact of guided inquiry learning on students is making students active in learning by found the concept independently (Mawardi et al., 2020).

One of the essential competencies found in XI class of SMA/MA in even semesters is a basic competence 3.8 regarding acid-base solutions. Students consider it is difficult because the concepts are abstract and have great conceptual difficulties. The concept of acid-base solutions also emphasizes the algorithmic component. In addition, the acid-base solutions also includes three levels of chemistry representation, such as macroscopic, submicroscopic, and symbolic (Sari & Helsy, 2018).

The study that related to flipped inquiry learning (FGIL) as a learning system to overcome the learning problems during the COVID-19 pandemic by utilizing the Edmodo as a LMS on the reaction rate material (Ramadhansyah & Mawardi, 2021) and chemical bonding materials (Syafei & Mawardi, 2022) showed that valid and practical results in the high categories. In addition of using the Edmodo, an open source LMS for flipped guided inquiry learning (FGIL) is Moodle. Moodle has a complete and more adequate menu that is web-based. The existing chemical materials such as salt hydrolysis material (M. U. Sari & Mawardi, 2022) and acid-base materials (Fani & Mawardi, 2022), showed that are valid and practical results as well. Other studies

also implement learning model in guided inquiries using Student Worksheet teaching materials on a balance of chemical materials to obtain validity, practicality, and effectiveness, which are very important in the learning process (Kardena & Mawardi, 2021).

Research conducted by Guswita & Mawardi (2021) showed that the Development of a Flipped Classroom Based on Guided Inquiry Learning System on Acid-Base Solutions for XI Class of SMA obtained an average validity result from experts review for content and media, 0.84 and 0.87, respectively. The practicality test from the teachers and students are 89% and 92%, respectively. However, the level of effectiveness had not been tested on learning outcomes. Thus, this study aims to determine the Effectiveness of Flipped Classroom based on Guided Inquiry Learning System on Acid-Base Solutions for XI Class SMA.

## Method

This type of research is quasi-experimental research with Non-equivalent Control Group Design. This research was conducted at SMA Negeri 8 Padang. The population in this study was XI class Mipa students who were registered in the even semester of the 2021/2022 academic year.

**Table 1.** Non-equivalent control design

Group	Pretest	Treatment	Posttest
(R)*	O <sub>1</sub>	X	O <sub>2</sub>
(R)	O <sub>3</sub>	Y	O <sub>4</sub>

(Sugiyono, 2013)

Information:

- (R)\* : Experiment Class
- (R) : Control Class
- X : Learning by using certain treatment FGIL Learning System and guided inquiry-based
- Y : Learning uses Student Worksheets (LKPD) from schools and is not based on guided inquiry.
- O<sub>1</sub> : Pretest for the experimental class
- O<sub>2</sub> : Final test (posttest) for the experimental class
- O<sub>3</sub> : Pretest for the control class
- O<sub>4</sub> : The final test (posttest) for the control class

The sampling is taking by the purposive sampling technique. The sample class used in this study was class of XI MIPA 1 as a control class and class of XI MIPA 2 as an experimental class with the total of sampling were 69 students. The instruments used are pretest and posttest. The type of the instruments used is a multiple choices question consisting of 20 questions with five answer choices with a test for validity, reliability, discrimination index, and difficulty index. The effectiveness of the learning system can be determined through N-gain

testing, normality, homogeneity, and hypotheses in the proof. These tests are described as follows:

*Normalized Gain (N-Gain)*

The level of understanding and mastery of students' concepts related to the material that can be seen through the N-Gain Test. The value of each pretest and posttest value in the sample class is compared as formula 1:

$$N - Gain = \frac{score\ posttest - score\ pretest}{100 - score\ pretest} \quad (1)$$

*Normality Test.*

The normality test aims to determine whether the sample data is normally distributed or not. The normality test is carried out using the Lilliefors test as Formula 2:

$$[F_{(z_0)} - S_{(z_0)}] \quad (2)$$

The data can be said to be normal if  $L_{table} > L_0$  and if  $L_{table} < L_0$  then the data can be said to be not normally distributed.

*Homogeneity Test*

This test aims to determine whether the sample data has a homogeneous variant or not. The F test is carried out as Formula 3:

$$F = \frac{S1^2}{S2^2} \quad (3)$$

Information :

- F : Data frequency
- S1<sup>2</sup> : The largest variation of learning outcomes data
- S2<sup>2</sup> : The smallest variation of learning outcomes data

The significant level used is 0.05. If the value of  $F_{count} \leq F_{table}$  then the two groups have homogeneous variance and vice versa.

*Hypothesis Test*

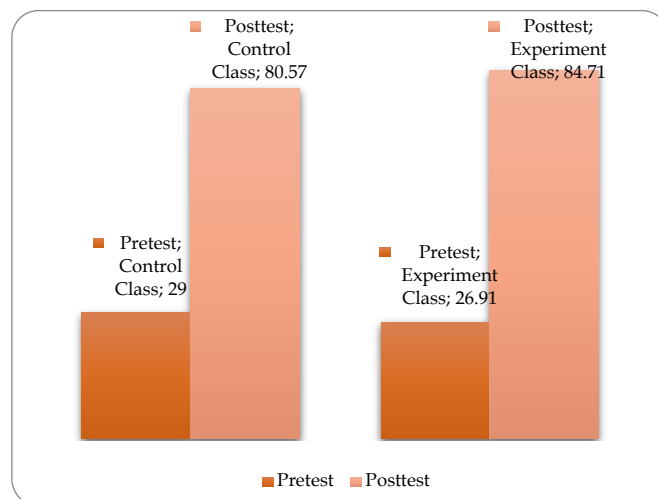
Hypothesis testing is done by using the t test. If the results of data analysis are obtained on the initial variable and the final variable is at the sig level < 0.05 where  $t_{count} > t_{table}$  then the hypothesis can be accepted and shows significant results.

**Result and Discussion**

This research was conducted at SMA Negeri 8 Padang using two classes of XI MIPA samples. This study began with a multiple-item test of validity, reliability, discrimination index, and difficulty index

(Latisma, 2011). The data processing of questions is analyzed by using Microsoft Excel. Based on the results, out of 35 questions only 20 questions have been obtained that meet the conditions of validity, reliability, difficulty index, and discrimination index. Each question consists of five answer choices that have been adjusted to the indicators of achievement of competence in acid-base solutions. Students who answer correctly will get a score of 1 with 5 points per each, and students who answer incorrectly will give a score of 0 with 0 point. This question will use as a pretest and posttest for effectiveness analysis.

The effectiveness of a learning system can take a look at the acquisition of learning outcomes. Before starting the lesson, students will take a pretest to determine whether to understand the knowledge. After that, a posttest aims to assess the extent to which students mastered the material after the learning process (Latisma, 2011). The results of the pretest and posttest data analysis are available in Figure 1.



**Figure 1.** Sample Class Pretest and Posttest

Based on Figure 1, there was a significant increase in the pretest-posttest scores in the experimental class compared to the control class. That happened because of the different treatments in both the control and experimental classes. The control class had treatment using a face-to-face learning system or those commonly applied in learning at the school. The experimental class had treatment using a guided inquiry-based flipped classroom learning system that had been written by Guswita & Mawardi (2021).

The flipped classroom is a learning activity in which learning activities in the classroom become activities at home. The flipped classroom has two stages, namely the introduction and concept stage before the class takes place (asynchronous) and the stage related to concept evaluation during the course (synchronous) (Chaeruman, 2013). The guided inquiry model is associated with the process of critical thinking, analysis,

and answers independently (Mawardi Mawardi et al., 2021). According to Hanson (2005), guided inquiry learning consists of five stages that are: (1) orientation, (2) exploration, (3) concept formation, (4) application, and (5) closing.

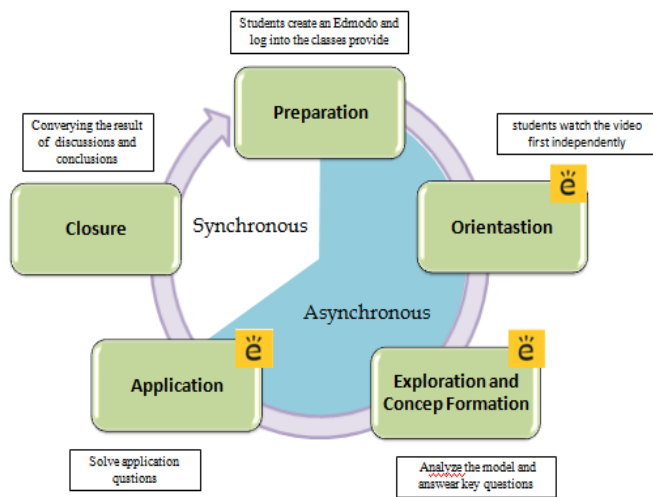


Figure 2. Flipped Classroom On Guided Inquiry Learning System

Based on Figure 2, Exploration, concept formation, and application are asynchronous for the orientation stage, while the closing stage is part of synchronously. The description of activities of each stage is explained as follows:

The first stage is orientation. At the orientation stage, the teacher prepares students to start learning activities. Students looked at orientation video that consists of motivation, apperception, indicators of learning competence, learning objectives, and introductory materials designed by the teacher and uploaded into the homepage of the Edmodo. In the video, learning objectives and motivation can attract students' curiosity regarding the material to be studied (Hanson, 2005; Susanti & Hamama Pitra, 2019). At this stage, students watch the video first independently.

The second stage is exploration and concept formation, while the stage is interrelated. At the exploration stage, students can explore, analyze the model, and collect information related to the model representing the concept. The process is followed by answering key questions that lead students to gain a conceptual understanding tailored to the learning objectives (Hanson, 2005). Out of 34 students divided into 6 study groups, three have been chosen to represent the variation of answers related to the model. An example of one of the models that will use in this study is available in Figure 3.

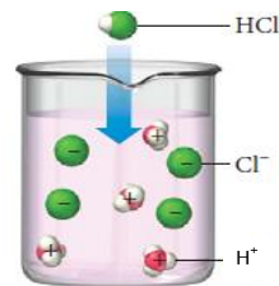


Figure a. HCl (Tro,12)

Figure 3. Exploration and Formation of Concepts model 1

Figure 3 is a model that illustrates the multi-representation of chemistry related to the Arrhenius theory of acids. Arrhenius acid is a compound that produces  $H^+$  ions in water to increase the concentration of  $H^+$  ions. Based on the model presented in Figure 2, students can observe that HCl can be ionized to form ions (Theodore Brown, 2017). According to Nivaldo, (2019), HCl is a covalent compound and does not contain ions. However, when HCl is dissolved in water, HCl can form positive ions and negative ions. The ions are  $H^+_{(aq)}$  and  $Cl^-_{(aq)}$ . The  $H^+_{(aq)}$  ion formed is reactive. There the following reaction in an aqueous solution is formed:



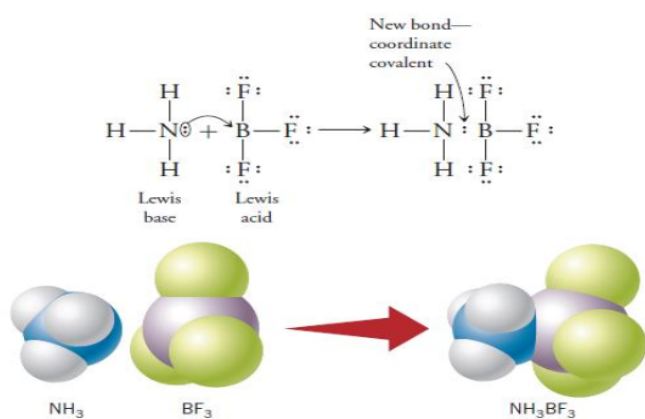
Based on the equation for the reaction, the resulting  $H^+$  ions prove that HCl is acidic according to the Arrhenius theory. The results of the analysis of student answers are available in Table 2.

Table 2. Analysis of student answers to model 1

Student 1	In the model, it can observe that $HCl_{(aq)}$ is ionized with the following equation: $HCl_{(q)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$ $H^+$ ions as cations and $Cl^-$ ions as anions. So Student 1 can draw the concept that an acid is a substance that, when dissolved in water ( $H_2O$ ), produces $H^+$ ions and the rest.
Student 2	$HCl_{(aq)}$ can be ionized. The reaction equation of the model is: $HCl_{(q)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$ Based on the reaction equation, there are $H^+$ ions and $Cl^-$ ions. The cation in the reaction equation is the $H^+$ ion. So student 2 can draw the concept that Arrhenius acid is a compound that, when dissolved in water, can produce $H^+$ ions.
Student 3	$HCl_{(aq)}$ can be ionized. By making the reaction equation not according to the model presented but knowing the $HCl_{(aq)}$ cation is the $H^+_{(aq)}$ ion. So student 3 draws the concept that it can draw concept that Arrhenius acid is a compound that, when dissolved in water, can produce $H^+$ ions.



Based on the student 1, 2, and 3 answers, it can be seen that students 1 and 2 can analyze the model and think critically in answering key questions. Student 1 and student 2 can determine that the HCl in the model can be ionized and be able to write the equation for the reaction. Student 1 and student 2 also identified  $H^+$  ions from the HCl solution. So that it can guide students in drawing concepts related to the acid, according to Arrhenius. Student 3 can know that HCl ionizes to form  $H^+$  ions in a solution based on the model presented. However, student 3 was unable to write the reaction equation correctly. Hence, student 3 drew the concept of acid according to Arrhenius only based on the model. In contrast, student 1 and student 2 could draw the concept of the acid theory according to Arrhenius based on the model and write the reaction equation.



Gambar h. Reaksi  $NH_3$  dengan  $BF_3$

(Brady, 2009 : 629)

Figure 4. Exploration and Formation of Concepts model 2

Figure 4 is a model that illustrates the multi-representation of chemistry related to the Lewis acid-base theory. Based on Figure 3, students are required to observe the model, the bonds formed, and draw concepts based on critical thinking and analysis that has been done. The reaction between  $BF_3$  and  $NH_3$  forms Lewis acid-base neutralization. Neutralization is the formation of a coordinating covalent bond between the donor (base) and acceptor (acid). From the reaction between  $BF_3$  and  $NH_3$ , a bond is formed between Nitrogen (N) and Boron (B), creating a coordination covalent bond where Nitrogen will donate its proton and Boron acts as a proton acceptor. Therefore, according to Lewis, an acid is an ionic compound or any molecule that can accept an electron pair in forming a covalent bond. At the same time, a Lewis base is an ionic compound or molecule that can donate an electron pair to create a coordinating covalent bond. So based on the model,  $NH_3$  is Lewis base, and  $BF_3$  is Lewis acid (James E. Brady, 2012), so the data obtained from students answers are available in Table 3.

Table 3. Analysis of student answers to model 2

Student 1	According to the model, $NF_3$ has a lone pair of electrons and acts as a Lewis base, while $BF_3$ does not have a lone pair and acts as a Lewis acid. Because $NF_3$ has one lone pair of electrons, then $NF_3$ donates electrons to $BF_3$ so that a Covalent Covalent bond is formed. Based on this answer, student one can draw the concept that Lewis acid is a substance that can accept an electron pair (acceptor), and Lewis base is a substance that can donate an electron pair (donor).
Student 2	If $NF_3$ is reacted with $BF_3$ , then $NH_3BF_3$ will be obtained with the type of bond formed as a covalent bond. Based on these answers, student 2 can draw the concept that acids are electron pair acceptors and bases are electron pair donors.
Student 3	Because $NF_3$ has a lone pair of electrons, $NF_3$ acts as a lone pair donor to $BF_3$ as a lone pair acceptor. Thus, a coordinating covalent bond is formed. Based on these answers, student 3 can draw the concept that an acid is a compound that can accept an electron pair or an acceptor, and a base is a compound that can donate an electron pair or a donor.

Based on the results of the comparative analysis of student answers, it can be seen that student 1 and student 3 can correctly analyze the changes that occur in the model where  $NF_3$  has one lone electrons pair while  $BF_3$  has no lone pair electrons.  $NF_3$  donates its electron pair to  $BF_3$  and forms a coordinating covalent bond. Student 2, it seems, does not understand the instructions for key questions related to changes in the model and is less specific in answering the bonds formed from the model presented. Based on the analysis of these answers, students 1, 2, and 3 were able to draw concepts related to Lewis acids and bases. Based on the research, each student provides answers and various scores related to the analysis. When students explore the model and think critically in answering key questions, students can find the concepts contained in the model so that students can achieve the learning objectives that have been set.

The next stage is the application. In this stage, identifying concepts that have been obtained, students can strengthen and clarify the concepts acquired in the previous stage by working on questions in the exercises at the application stage. Students can be integrated with other concepts if the concepts applied to the practice questions are successful.

The last stage is closing. In this stage, students conclude the concepts that have been found. In addition, students also provide a protest, feedback, and input. At the same time, the teacher will confirm and deliver reinforcement related to the concepts that students have obtained. The effectiveness of the flipped classroom learning system based on guided inquiry on acid-base

solutions, it can be seen by conducting tests such as the following:

*Normalized Gain (N-Gain)*

The measurement of the N-gain value aims to determine the increase in the understanding of the sample class. N-gain processing is derived from the difference between the post-test and pretest scores obtained by students in both the experimental and control classes. According to Hake (1998), N-gain has three criteria: high criteria with  $g > 0.7$ , medium criteria with  $0.7 > g > 0.3$ , and low criteria with  $g < 0.3$ . After carrying out the pretest-posttest, the N-gain results are available in Table 4.

**Table 4.** Normality Test Results

Sample	N	pretest	posttest	Average Gain
Experiment	34	26.91	84.71	0.80
Control	35	29	0.57	0.73

Based on Table 4, the average N-gain value for the experimental class is 0.80, and the control class is 0.73. The average value obtained from the experimental and control classes belongs to the high criteria according to the criteria (Hake, 1998). It states that the guided inquiry-based flipped classroom learning system is effective on student learning outcomes. Furthermore, the normality test, homogeneity, and T-test are helpful as a requirement in concluding whether the hypothesis is accepted or not.

*Normality Test.*

The normality test is to know whether the data that is obtained is normally distributed or not (Sudjana, 2005). The data can be concluded to be normally distributed if the value of  $L_o < L_t$ , using the significance level ( $\alpha$ ) is 0.05. Based on the data processing that has been out, the normality test results are available in Table 5.

**Table 5.** Normality Test Results

N	$\alpha$	$L_o$	$L_t$	Interpretation
34	0.05	0.141	0.151	Normal
35	0.05	0.123	0.149	Normal

Based on Table 5, the results were obtained for the experimental class with a value of  $L_o = 0.141$  and a value of  $L_t = 0.151$ , while for the control class with a value of  $L_o = 0.130$  and a value of  $L_t = 0.149$ . It shows the value of  $L_o < L_t$  at the significance level ( $\alpha$ ) is 0.05. In line with the opinion according to Sudjana (2005) that the distribution of values in the two sample classes as normal.

*Homogeneity Test*

The homogeneity test processing is available in Table 6.

**Table 6.** Homogeneity Test Results

$\alpha$	$F_{hitung}$	$F_{tabel}$	Interpretation
0.05	1.24	1.76	Homogeneous

Table 6 shows that the value of  $F_{count} = 1.24$  and  $F_{table} = 1.76$ , so it can be through that the value of  $F_{count} < F_{table}$ . So that the analysis of the data is obtained that the data are normally distributed and have homogeneous variations.

**Hypothesis Test**

The last data analysis is to test the hypothesis by using the t-test. T-test can be done if the data from the yields of students' pretest and posttest are normally distributed and homogeneous. Hypothesis testing determines whether the researcher's hypothesis can be accepted or rejected. The results of the t-test data processed using Microsoft Excel that available in Table 7.

**Table 7.** Hypothesis Test Results

Class	$t_{count}$	$t_{table}$	Information
Experiment	3.18	1.99	Hypothesis accept
Control	3.18	1.99	Hypothesis accept

Based on table 7, the difference in pretest-posttest values shows that the t-count is more significant than the t-table. According to Sudjana (2005), if the value of  $t_{count} > t_{table}$ , then  $H_0$  is rejected. In other words, this value shows the learning outcomes of the experimental class that applies the guided inquiry-based flipped classroom learning system on acid-base solutions are higher than the control class.

The findings of this study are in line with research of Akhmalia et al (2018), which states that the application of learning using flipped classroom on the guided inquiry model in XI Science class can significantly improve learning outcomes in experimental class with an N-gain value of 0, 83 compared to the control class with a value of 0.72. This is because flipped classroom learning with an inquiry-based learning model emphasizes the active role of students in finding concepts independently by using LKPD teaching materials and can provide time for students to prepare themselves optimally for class learning. The same result was also obtained by the research of Hidayati et al (2018) conducted at SMA Bandar Lampung, getting an N-gain value (0.84 > 0.70) which stated that the use of an LMS-based blended learning approach with a guided inquiry model was able to improve The concept of students with excellence is to provide students with interest in independent learning because they can access information via the internet anywhere and anytime.

Using FGIL can benefit students because students can learn anytime and anywhere at the asynchronous

stage. In addition, by using a learning management system in the learning process, digitalization of education has been carried out by utilizing technological developments to support the learning process. Students can also learn anytime and anywhere at their own pace and with learning strategies (Guswita & Mawardi, 2021). In Edmodo, there are already learning videos and worksheets that using in colorful and attractively designed.

Positive learning outcomes are generated through the solutions that have been taken. The use of the flipped classroom based on guided inquiry learning system in acid-base solutions for class of XI SMA can improve student learning outcomes with a high level of effectiveness category is 0.80.

## Conclusion

Based on the research that had been done, the N-gain value for the experimental class was 0.80 and the control class was 0.73 which was included in the high category. In the t-test which was carried out to draw the results of the hypothesis, it was obtained that the value of  $t_{\text{count}}$  was greater than  $t_{\text{table}}$  with 3.18 and 1.99, respectively. Overall, the results of the study indicate that the use of a flipped classroom based on guided inquiry learning system on acid-base solutions is effective because it improves students learning outcomes.

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## References

- Akhmalia, N. L., Suana, W., & Maharta, N. (2018). Efektivitas Blended Learning Berbasis LMS dengan Model Pembelajaran Inkuiri pada Materi Fluida Statis terhadap Penguasaan Konsep Siswa. *JIPFRI (Jurnal Inovasi Pendidikan Fisika Dan Riset Ilmiah)*, 2(2), 56–64. <https://doi.org/10.30599/jipfri.v2i2.299>
- Balasubramanian, K., Jaykumar, V., & Fukey, L. N. (2014). A Study on "Student Preference towards the Use of Edmodo as a Learning Platform to Create Responsible Learning Environment." *Procedia - Social and Behavioral Sciences*, 144, 416–422. <https://doi.org/https://doi.org/10.1016/j.sbspro.2014.07.311>
- Chaeruman, U. A. (2013). Merancang Model Blended Learning Designing Blended Learning Model. *Jurnal Teknodik*, 17, 399–409. <https://doi.org/https://doi.org/10.32550/teknodik.v17i4.577>
- Duhaney, D. C. (2007). Blended Learning In Education, Training, and Development', *Performance Improvement. Performance Improvement*, 43(8), 35–38.
- Fani, V. G., & Mawardi, M. (2022). Flipped classroom learning system based on guided inquiry using moodle on acid-base solutions. *Jurnal Pijar Mipa*, 17(3), 361–368. <https://doi.org/10.29303/jpm.v17i3.3476>
- Guswita, Z., & Mawardi, M. (2021). Validity of Flipped Classroom on Guided Inquiry in Acid and Base Solution. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, 28(1), 124–127. <https://doi.org/http://dx.doi.org/10.52155/ijpsa.t.v28.1.3337>
- Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66(1), 64–74. <https://doi.org/10.1119/1.18809>
- Hanson, D. M. (2005). Designing Process-Oriented Guided-Inquiry Activities. *Pacific Crest, January 2007*.
- Heather, B., & Randi, B. (2008). The Many Levels of Inquiry. *Science and Children*, 26–29. [www.teachersource.com](http://www.teachersource.com)
- Hidayati, N., Leny, & Rilia Iriani. (2018). Pengaruh Model Pembelajaran Inquiry Based Learning dengan Pendekatan Flipped Classroom Terhadap Self Efficacy dan Hasil Belajar Kesetimbangan Ion Dalam Larutan Garam. *Journal of Physics: Conference Series*
- James E. Brady. (2012). *Chemistry :The Molecular Nature of Matter 6th Edition*. McGraw-Hill.
- Kardena, H., & Mawardi, M. (2021). The development of guided inquiry based student worksheet of chemical equilibrium towards student activities. *Journal of Physics: Conference Series*, 1788(1), 12037. <https://doi.org/10.1088/17426596/1788/1/012037>
- Kemendikbud. (2021). *Satuan Pendidikan di Wilayah PPKM Level 1-3 Dapat Laksanakan PTM terbatas*. Retrieved from <https://www.kemdikbud.go.id/main/blog/2021/08/satuan-pendidikan-di-wilayah-ppkm-level-13-dapat-laksanakan-ptm-terbatas>
- Latisma, D. (2011). *Evaluasi Pendidikan*. UNP Press.
- Mawardi, M., Aisyah Fitri Rusiani, J., & Yani, F. H. (2020). Effectiveness of student worksheets based guided inquiry on acid base material to improve

- students higher order thinking skill (HOTS). *Journal of Physics: Conference Series*, 1481(1), 12083. <https://doi.org/10.1088/1742-6596/1481/1/012083>
- Mawardi, M., Bahrizal Bahrizal, & Fitriza, Z. (2019). The Guided Inquiry Learning Materials Based on Multiple Chemical Representations As One of Chemistry Learning Strategies Centered on Students. *Pelita Eksakta*, 2(2), 140. <https://doi.org/10.24036/pelitaeksakta/vol2-iss2/55>
- Mawardi, M., Fitriza, Z., Suryani, O., Sukmawati, S., & Aumi, V. (2021). Penerapan Model Pembelajaran Flipped Classroom Berbasis Guided Inquiry (FGIL) Pada Pembelajaran Kimia SMA di Kabupaten Agam Sebagai Model Untuk Pembelajaran Digital di Masa Pandemi Covid 19. *Jurnal Pelita Eksakta*, 4(2), 176-180. <https://doi.org/10.24036/pelitaeksakta/vol4-iss2/170>
- Nivaldo J.Tro. (2019). *Chemistry: A Molecular Approach 5th Edition*. Pearson.
- Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, 14, 47-61. <https://doi.org/http://dx.doi.org/10.1016/j.edur ev.2015.02.003>
- Ramadhansyah, & Mawardi. (2021). Development Of Guided Inquiry-Based Flipped Classroom Learning System On Reaction Rate For 11th Grade Senior High School Students. *International Journal of Progressive Sciences and ...*, 27(2), 597-601. <https://doi.org/http://www.ijpsat.es/index.php/ijpsat/article/view/3339>
- Rymarczyk, J. (2020). Technologies, Opportunities and Challenges of the Industrial Revolution 4.0: Theoretical Considerations. *Entrepreneurial Business and Economics Review*, 8(1), 185-198. <https://doi.org/10.15678/EBER.2020.080110>
- Sapitri, M. (2021). Media Pembelajaran Daring Menggunakan Aplikasi Edmodo. *Jurnal Sosial Teknologi*, 1(5), 383-389. <https://doi.org/10.36418/jurnalsostech.v1i5.66>
- Sari, C. W., & Helsy, I. (2018). Analisis Kemampuan Tiga Level Representasi Siswa Pada Konsep Asam-Basa Menggunakan Kerangka DAC (Definition, Algorithmic, Conceptual). *JTK (Jurnal Tadris Kimiya)*, 3(2), 158-170. <https://doi.org/10.15575/jtk.v3i2.3660>
- Sari, M. U., & Mawardi, M. (2022). Development of a Guided Inquiry-Based Moodle E-Learning System on the Topic of Salt Hydrolysis. *Jurnal Pendidikan MIPA*, 23(1), 244-255. <https://doi.org/10.23960/jpmipa/v23i1.pp244-255>
- Sudjana. (2005). *Metode Statistik*. Tarsito.
- Sugiyono. (2013). *Metode Penelitian Kuantitatif Kualitatif dan Kombinasi (Mixed Methods)*. Alfabeta.
- Susanti, L., & Hamama Pitra, D. A. (2019). Flipped Classroom Sebagai Strategi Pembelajaran Pada Era Digital. *Health & Medical Journal*, 1(2), 54-58. <https://doi.org/10.33854/heme.v1i2.242>
- Syafei, S. S., & Mawardi, M. (2022). POGIL Model Integrated Flipped Classroom Assisted Learning Management System (LMS) for Learning Solution in ERI 4.0. *Jurnal Penelitian Pendidikan IPA*, 8(2), 444-451. <https://doi.org/10.29303/jppipa.v8i2.1298>
- Theodore L. Brown. (2017). *Chemistry: The Central Science 14th Edition*. Pearson.
- Yen, T.-F. (TF). (2020). The Performance of Online Teaching for Flipped Classroom Based on COVID-19 Aspect. *Asian Journal of Education and Social Studies*, 8(3), 57-64. <https://doi.org/10.9734/ajess/2020/v8i330229>