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The Effectiveness of the Guided Inquiry Learning Model with the help of a Virtual Laboratory to Increase Students' Concept Mastery in Acid-Base Material

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Abstract: The Effectiveness of the Guided Inquiry Learning Model with the help of a Virtual Laboratory to Increase Students' Concept Mastery in Acid-Base Material. The purpose of this research is to increase students' concept mastery in acid-base material by applying guided inqury learning model with the help of virtual laboratory. The research was conducted using a non-equivalent (Pretest-Postest) control group design. The sample was taken by using purposive sampling technique and the population is all students in grade XI MIPA SMA Negeri 14 Bandar Lampung for 2021/2022 academic year and it was obtained the XI MIPA 1 as the control class and XI MIPA 2 as the experimental class. The results showed that the average n-Gain of students' concept mastery for the control class was 0.63 with 'medium' criteria and the experimental class was 0.72 with 'high' criteria. Based on the two-average difference test that has been carried out, the results of hypothesis testing obtained information that the average value of the n-Gain value of students' conceptual mastery in acid-base material in the experimental class was higher than the average value of the n-Gain value of students' conceptual mastery in the experimental class so that it can be concluded that the guided inquiry learning model with the help of a virtual laboratory in acid-base material can improve students' mastery of concepts.

Keywords: guided inquiry, virtual laboratory, concept mastery, acid-base

Abstrak: Efektivitas Model Pembelajaran Inkuiri Terbimbing dengan Bantuan Laboratorium Virtual untuk Meningkatkan Penguasaan Konsep Peserta Didik pada Materi Asam Basa. *Tujuan dari penelitian ini adalah untuk meningkatkan penguasaan konsep peserta didik dengan menerapkan model inkuiri terbimbing berbantuan laboratorium virtual. Penelitian dilakukan dengan menggunakan non-equivalent (pretes-postes) control group design. Pengambilan sampel dilakukan dengan menggunakan teknik purposive sampling dan populasi dalam penelitian berasal dari seluruh peserta didik kelas kelas XI MIPA SMA Negeri 14 Bandar Lampung tahun ajaran 2021/2022 yang berjumlah 179 peserta didik dan ditetapkan kelas XI MIPA 1 sebagai kelas kontrol dan XI MIPA 2 sebagai kelas eksperimen. Hasil penelitian menunjukkan bahwa rata-rata n-Gain penguasaan konsep peserta didik untuk kelas kontrol adalah 0,63 dan kelas eksperimen adalah 0,72. Berdasarkan uji perbedaan dua rata-rata yang telah dilakukan, hasil pengujian hipotesis diperoleh informasi bahwa rata-rata nilai n-Gain penguasaan konsep peserta didik pada materi asam basa pada kelas eksperimen lebih tinggi dibandingkan rata-rata nilai n-Gain penguasaan konsep peserta didik pada kelas kontrol sehingga dapat disimpulkan bahwa model pembelajaran inkuiri terbimbing dengan bantuan laboratorium virtual pada materi asam basa dapat meningkatkan penguasaan konsep peserta didik.*

Kata kunci: *asam basa, penguasaan konsep, model pembelajaran inkuiri terbimbing, laboratorium virtual*

- **INTRODUCTION**

At the beginning of 2020 the world was shocked by the presence of a new deadly virus variant. On February 11, 2020, WHO announced the name of this virus, Corona Virus Disease (Covid-19). This virus can be transmitted from human to human, until on March 12, 2020, WHO declared Covid-19 a pandemic. In order to reduce the spread of this dangerous virus, the Government of Indonesia has issued a few policies related to the Covid-19 pandemic. One of them, the prohibition of people to gathering and doing outdoor activities. The policy is also applied to the education sector, based on the Ministerial Decree Number 3 of 2021 concerning Guidelines for the Implementation of Learning during the Corona Virus Diseases-19 (Covid-19) pandemic, in the circular it is explained that the learning process is carried out with limited face-to-face learning while still applying health protocols; and/or distance learning.

The COVID-19 pandemic has demanded changes in the social order of society and has affected a learning process. Physical restrictions and social activities prohibition on a large scale make learning process can not carried out in full face-to-face, and it has a major impact on learning activities that must be carried out practically. One of the lessons that require practical or practical activities is chemistry. Chemistry can not be separated from experiments (Kurniawati & Fatisa, 2016).

The learning process that occurs in the classroom should not only dominated by teachers but also involve students so that students are no longer objects but subjects of study. The fact that is happening at this time, the learning process carried out has not been able to create a class atmosphere that is able to increase activity and mastery of concepts by students. In the chemistry learning process, students must play an active role in finding concepts. Concepts are one of the initial knowledge that students must have because concepts are the basic for formulate principles. In the preparation of science, it is necessary to have the ability to develop basic concepts that can be described continuously. Concept mastery means understand or know how to use knowledge, intelligence, and so on (Fitriani, 2012).

Concepts are the main things that become the overall basis of the results of human abstract thinking about objects, facts, events that explain many experiences (Sagala, 2003). According to Turnip in Zubaidah (2010), the concept is a category of experience which is then formulated into an expression consisting of attributes and labels. Slameto (2010) says that learning is essentially a business process carried out by a person in order to get a new behavior change as a whole. Only with good mastery of concepts teaching and learning process be improved more optimally (Djamarah & Zain, 2006).

Outcomes of observations and interviews with one of the chemistry teacher in SMA Negeri 14 Bandar Lampung, obtained a few informations of the chemistry learning process in SMA Negeri 14 Bandar Lampung. During the Covid-19 pandemic, chemistry learning was carried out using Whatsapp Group and Google Meet. The learning process is also limited to the provision of materials and practice questions by educators. During pandemic, students rarely have opportunities to discuss and express their opinions to find and solve problems because learning is only dominated by teachers.

One of the materials studied by students of class XI MIPA is acid and base. The basic competencies that students must have based on the revised 2013 curriculum are K.D 3.10 analyzing the properties of solutions based on the concept of acid-base and/or pH solutions. To be able to achieve these basic competencies, students are encouraged to do practicum, but practicum cannot be done due to the limited allocation of learning time. The model that will be used in this research is a guided inquiry learning model. The guided learning model is a student-centered model or student center. Inquiry is defined as the process of asking and finding out an answer to a scientific question that has been asked or given. Scientific questions are questions that can lead to investigation activities on the object of the question, therefore inquiry can also be interpreted as a process to obtain information by observe or do experiment to find answers or solve problems using the ability critical and logical thinking (Amri, 2010).

Piaget in Mulyasa (2006) said the inquiry model prepare students to situations that conduct independent experiments extensively in order to see what is happening, want to do something, ask questions, and find answers on their own. The stages of the guided inquiry learning model according to Gulo in Trianto (2010) are asking questions or problems for students to solve, students making hypotheses, collecting data, analyzing data, and making conclusions.

In the guided inquiry model, teacher guide students to identify a problem, teacher guide students to be able to formulate their own hypotheses, students are asked to determine the steps that need to be taken to prove the hypotheses that have been made, teacher guide students to obtain information through experiments, and students draw conclusions as a form of problem solving. These stages help students understand concepts and connect them to scientific phenomena.

The use of virtual laboratories to assist the learning process can be a solution to various problems that occur when carrying out practicum in real laboratory or hindering the implementation of practicum due to virtual face-to-face learning. A virtual laboratory is a computer-based laboratory that contains simulations of activities in a chemistry laboratory. Educational simulations (virtual laboratory) can be carried out in cyberspace, but they must be designed and implemented strictly. Pure learning simulations may not be that much fun. The program may have three-dimensional graphics and motion capture animations from computer games, but the content may be boring. Virtual laboratories (simulations) need to be made according to the assumptions of students about what content should be and their experiences of the virtual world (Aldrich, 2009). Laboratory media will help the teacher during learning process. Laboratory media can generate motivation and interest in students, improve understanding, interpretation of data and information (Sawitri et al., 2015).

Some research related to the effectiveness of the guided inquiry learning model conducted by Rachmawati (2016) said that the increase in students' conceptual mastery after participating in the overall learning experience increased with the acquisition of an n-Gain value of 73% in the high category. Rahmawati et al. (2014) said that the mastery of the concepts of students in the three schools increased. In addition, in the research of Hermansyah et al (2015) it is said that the mastery of the n-Gain value of the experimental class is 0.5%, while the n-Gain value of the control class is 0.2%, it can be concluded that the use of virtual laboratories has an effect on the participants' mastery of concepts. learn about vibrations and waves.

Based on the explanation that has been explained by the researcher, a study was conducted with the title "The Effectiveness of Guided Inquiry Learning Models with the Assistance of Virtual Laboratories to Improve Students' Concept Mastery on Acid-Base Materials".

- **METHOD**

This research was conducted in SMA 14 Bandar Lampung on January until February 2022. The population used was all students in grade XI MIPA SMA Negeri 14 Bandar Lampung for 2021/2022 academic year and it was obtained the XI MIPA 1 as the control class and XI MIPA 2 as the experimental class. The research method used in this research is quasi-experiment with Non-Equivalent Pretest-Postest Control Group Design. Research carried out in two classes, namely experimental class using learning with guided inquiry models assisted by virtual laboratories and control class using conventional learning methods. The sampling technique was carried out by purposive sampling. Purposive sampling is sampling technique with certain considerations, for example, the person is considered to know the most about the research subject (Sugiyono, 2013).

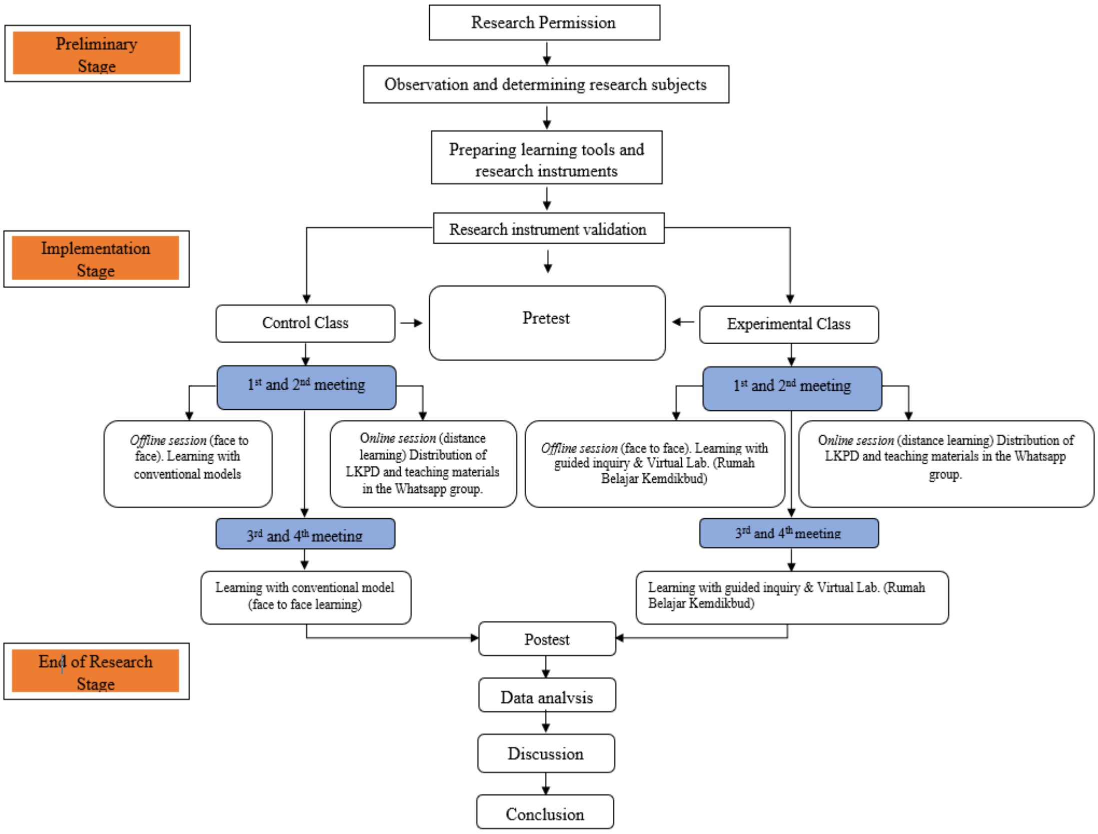

Figure 1. Research Implementation Procedures

The research data obtained in the form of pretest-postest scores were then analyzed using SPSS 25.0 and Microsoft Excel. Each score of the pretest and postest calculated with the following formula:

$$\text{Score} = \frac{Total\ Score}{Maximun\ Score}\ x\ 100\%$$

The increase in students' concepts mastery is gain by the scores pretest and postest, the n-Gain value can be calculated using the formula:

$$\langle g \rangle = \frac{postest\ score - \ pretest\ score}{100 - pretest\ score}$$

With the n-Gain criteria according to Hake (1998), they are:

a. "high" n-Gain is if the value of n-Gain > 0,7
b. "medium" if the value is 0,3 < n-Gain ≤ 0,7
c. "low" n-Gain if the value of n-Gain ≤ 0,3

Then, a hypothesis test is carried out, namely normality, homogeneity, and the two-means differences of students' concepts mastery from the two samples. The normality and homogeneity test was tested with the *Shapiro-Wilk* Test with a significant level > 0.05. The difference test of the two-means was carried out using an Independent

Sample T-test for the average n-Gain score of students' concepts mastery. Based on the test results of the difference between the two-means, after that the effect size calculation was carried out to find out how much influence the guided inquiry with the help of a virtual laboratory improve students' concepts mastery. According to Jahjouh (2014), the effect size formula is:

$$\mu^2 = \frac{t^2}{t^2+df}$$

▪ RESULT AND DISCUSSION

Instrument Validity and Reliability Test

According to Arikunto (2013), a good instrument must have two criterias, namely valid and reliable. The validity test was carried out on the test instrument in the form of a pretest postest for concepts mastery consisting of five questions. The results of the validity test of the questions are shown in the table 1.

Table 1. The Results Of The Validity Of The Concept Mastery Instrument

Butir Soal	Koefisien Korelasi	r_{tabel}	Keterangan
1	0,739		Valid
2	0,697		Valid
3	0,608	0,514	Valid
4	0,723		Valid
5	0,832		Valid

Based on Table 1, it can be seen that r_{hitung} is greater than r_{table}. This shows that the concept mastery test instrument on acid-base material is declared valid. Then, in the reliability test using SPSS 25.0, Alpha Cornbach was obtained at 0.750. This shows that Alpha Cornbach > r_{table}, so the concept mastery test instrument is declared reliable. After the concept mastery test instrument is declared valid and reliable, the instrument can be used to test students' conceptual mastery.

After the research was completed, the data obtained from the experimental class and control class in the form of pretest and postest scores were analyzed statistically. Students' mastery concepts was measured using a pretest and postest on acid-base material given to all students in class XI MIPA 1 (control class) and XI MIPA 2 (experimental class). Students' mastery concepts increase is shown through n-Gain, which is the difference between the postest score and the pretest score calculated using the Hake (1998) formula.

Based on the results of the analysis obtained an average value of the pretest and postest scores of concepts mastery of the two research classes. The average value of the pretest and postest students' concept mastery is presented in Figure 2.

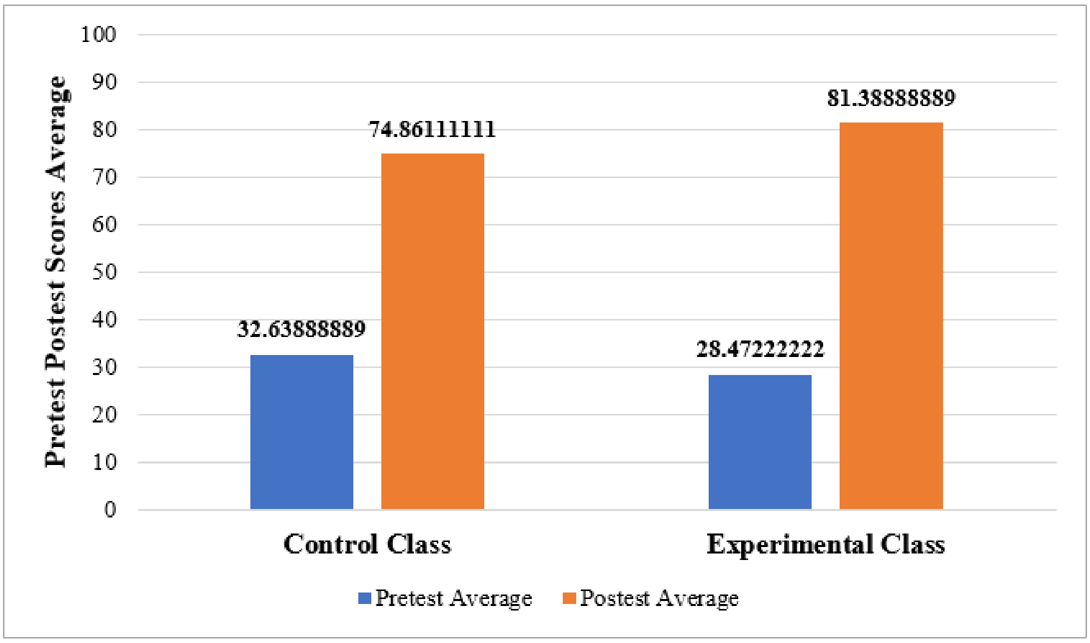

Figure 2. Average Pretest And Postest Scores for Concepts Mastery

Based on Figure 2, it shown that the average pretest value of the control class and experimental class students' concept mastery does not have a significant difference, this shows that the students' conceptual mastery in the control class and the experimental class is almost the same. After learning process is carried out in the two classes with different treatments, there was an increase in the average postest score in both classes, the results obtained that the average postest score of students in the experimental class was higher than in the control class. The difference in average pretest and postest scores in each class indicates an increase in mastery of concepts in both classes.

According to Bloom (2013) in Astuti (2017) concept mastery is an ability to capture meanings, such as being able to express a material that is presented in a form that is more understandable, able to provide interpretation and be able to apply it. Furthermore, mastery of concepts is the ability of students who not only understand, but can also apply the concepts given in solving a problem, even to understand new concepts. Mastery of concepts in students can be seen in the results of students' answers to the pretest and posttest.

The increase in students' conceptual mastery can be seen in the average n-Gain mastery of the control and experimental class concepts presented in Figure 3.

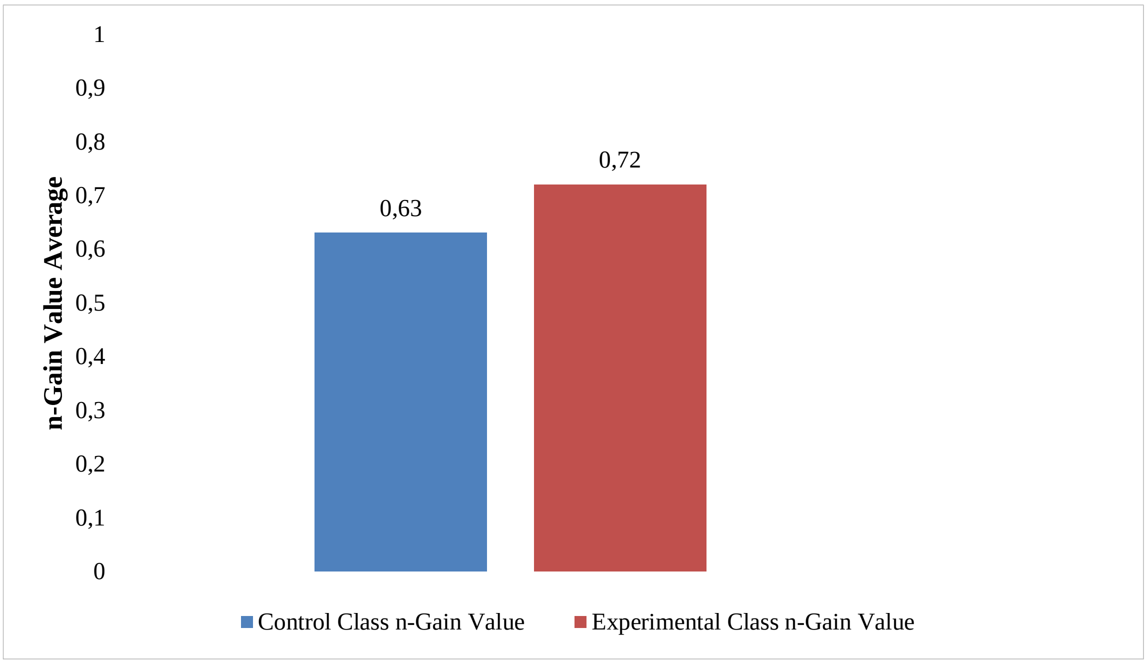

Figure 3. Average n-Gain Score Diagram for Experimental and Control Class

Based on Figure 3, it can be seen that the average n-Gain in the control class is lower than the experimental class. The average n-Gain of concept mastery in the control class has a "medium" category and the average n-Gain of concept mastery in the experimental class has a "high" category. This shows that learning with the guided inquiry model with the help of a virtual laboratory can further improve students' conceptual mastery than without the guided inquiry model and virtual laboratory.

Furthermore, data analysis of the implementation of learning was carried out using a guided inquiry model with the help of a virtual laboratory. The implementation of learning is measured through an assessment of the implementation of learning using a guided inquiry model with the help of a virtual laboratory in the form of an observation sheet filled out by two observers. The results of observations are presented in Table 2, below:

Table 2. Learning Implementation Data

Observation Aspect	**Percentage of Achievement of the LKPD -**		**Average**
	1	**2**	
Introduction	95,83	91,67	93,75
Asking Question	81,25	87,50	84,375
Formulating Hypotheses	87,50	93,75	90,625
Collecting Data	93,75	91,67	92,71
Analyze Data	87,50	100	93,75
Draw a conclusion	91	91	91
Closing	93,75	100	96,875
Time Management	95,83	91,67	93,75
Average	91	97	92
Criteria	**Very High**	**Very High**	**Very High**

According to Table 2, it can be seen that average percentage of learning implementation in experimental class in the first LKPD to the second LKPD, there is a significant increase with the criteria of "very high". This shows that learning with the guided inquiry model with the help of a virtual laboratory has been carried out well. It fits with research conducted by Nugroho (2011) that the use of virtual laboratory is effective in making students learn actively to think systematically.

In addition, to observing the implementation of learning using a guided inquiry model with the help of a virtual laboratory in the experimental class, students' activities were also observed at each meeting. The results are presented in Figure 4.

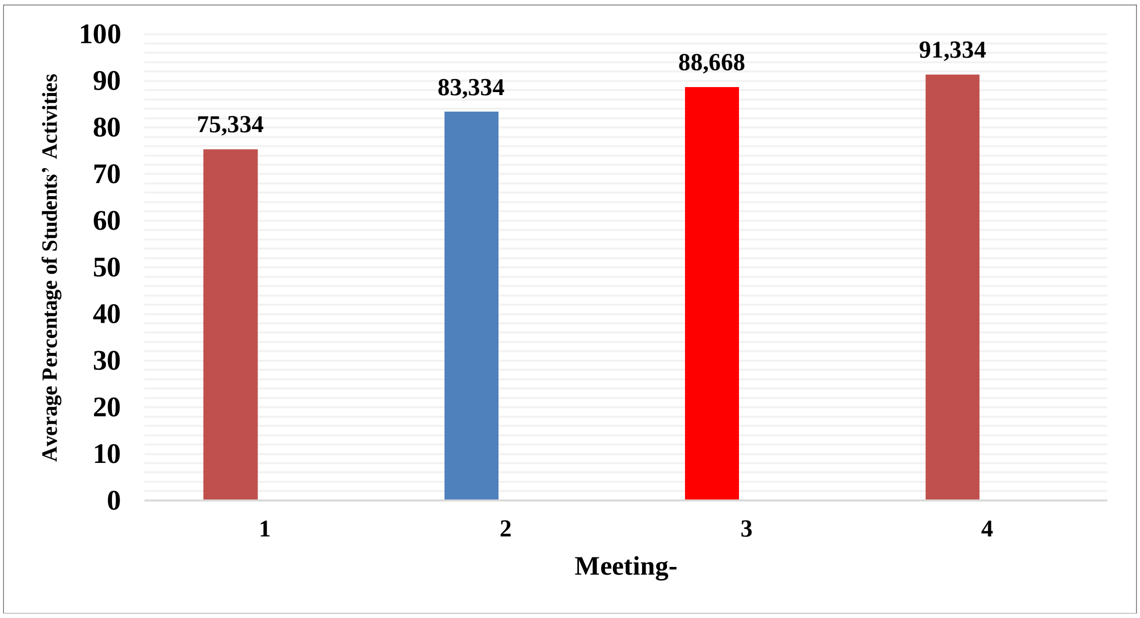

Figure 4. Average Percentage of Students' Activities

According to Figure 4, it can be seen that the average percentage of students' activities during the learning process by applying a guided inquiry model with the help of a virtual laboratory at each meeting has increased. At the first meeting, it was 75.334% with the "high" criteria, the second meeting was 83.334% with the "very high" criteria, the third meeting was 88.668% with the "very high" criteria, and the fourth meeting was 91.334% with the "very high" criteria.

Hypothesis Test

The hypothesis testing conducted by the researcher was the difference test of two averages using the Independent Sample T-Test, it is necessary to test the prerequisites, namely the normality test and the homogeneity test. Both tests were carried out on the pretest and postest scores. In the normality test for this study, the Shapiro Wilk test was used. The test criteria for the normality test are to accept H_0 if the sig value of the Shapiro-Wilk test > 0.05. The results of the calculation of the normality test in the experimental class and control class are presented in Table 3.

Table 3. Results of the n-Gain Normality Test for Students' Concept Mastery

Class	**Average of n-Gain**	**N**	**Description**	
			***sig.* Value**	**Test Criteria**
Control	0,63	36	0,763	*Sig.* > 0,05
Experimental	0,728	36	0,652	*Sig.* > 0,05

Based on Table 3, the results of the normality test on the acquisition of the average n-Gain concepts mastery of students in the control class and experimental class can be seen that the significant value is > 0.05 in both classes so that the test decision is to accept H_0 and reject H_1 which means the sample comes from from a normally distributed population.

After the normality test, homogeneity test was performed using SPSS Statistics 25.0. This test was conducted to determine whether the sample used came from a population with homogeneous variants. The results of the homogeneity test of students' conceptual mastery in the control class and experimental class are presented in Table 4

Table 4. Results of the n-Gain Homogeneity Test for Students' Concept

Class	Average of n-Gain	N	Description	
			***sig.* Value**	**Test Criteria**
Control	0,63	36	0,322	*Sig.* > 0,05
Experimental	0,728	36		

Based on Table 4, the results of the homogeneity test on the acquisition of the average n-Gain mastery of the concepts of students in the control class and experimental class can be seen that the significant value is > 0.05 so that the test decision is to accept H_0 and reject H_1, which means that the sample comes from a different variant. homogeneous.

Two-Means Difference Test (T-test)

The two-means difference test was conducted to see whether the average value of the n-Gain in the concepts mastery of students' in the experimental class was higher than the control class. It was carried out using SPSS Statistics 25.0, namely the Independent Sample T-test.

Table 5. Results of the Difference between Two Means of n-Gain Mastery Concepts

Class	n-Gain Average	N	Description	
			***sig.* (2-tailed) Value**	**Test Criteria**
Control	0,63	36	0,001	*Sig.* (2-tailed) < 0,05
Experimental	0,728	36		

Based on Table 5, the results of the two-means difference test on the average acquisition of n-Gain students‘ concept mastery in the control class and experimental class can be seen that the significant value is <0.05 so the test decision is to accept H_1 and reject H_0, which means the average n-Gain concepts mastery in the acid-base experimental class is higher than the average n-Gain concepts mastery in the control class.

Effect Size Test

The effect size test was conducted to determine the magnitude of the learning effect in the experimental class and the control class. The results of the effect size test (μ) are presented in Table 6.

Table 6. Results of the Effect Size Test of Students' Concept Mastery

Class	T	t^2	Df	M	Criteria
Control	-14.662	214.9781	70	0.86	Large Effect
Experimental	-20.288	411.6208	70	0.92	Large Effect

From Table 6, shown that the effect size of concepts mastery obtained by the experimental class is 0.92 with “large effect” criteria and the control class is 0.86 also with “large effect” criteria. Based on Jahjouh statement in Pitaloka (2020), the effect size obtained by the control class shows a percentage of 87% of concept mastery is influenced by conventional learning methods and in the experimental class 92% of concept mastery is influenced by learning with guided inquiry models with the help of a virtual laboratory.

The magnitude of the influence category of learning with a guided inquiry model assisted by a virtual laboratory in the experimental class and conventional learning in the control class can be distinguished from the achievement of increasing n-Gain of students' conceptual mastery. Table 6 also provides information that 92% of students' mastery of concepts in the experimental class is influenced by learning with a guided inquiry model assisted by a virtual laboratory with high n-Gain. In the control class, 86% of the students' conceptual mastery was influenced by conventional learning with moderate n-Gain.

In the experimental class, the large effect criteria is interpreted as a large positive criteria, meaning that the learning process using a guided inquiry model with a virtual laboratory is able to make students more dominant in the learning process. This is because in the guided inquiry model there are stages of learning (identifying problems, making hypotheses, collecting data, analyzing data, and making conclusions) so that students are more active in learning. On the other hand, virtual laboratory assistance makes students able to experience learning in the laboratory easily, can be accessed anywhere, and anytime so that students' mastery of concepts increases as a result of the application of guided inquiry models and virtual laboratory assistance. The benefits of carrying out experimental or demonstration activities using virtual laboratory are practicum activities or experiments become more efficient and inexpensive because each stage of the experiment is already available in learning software, does not require expensive maintenance costs, practicum activities become more effective and efficient because there is nothing which can harm the practitioner (Arianti et al, 2016).

The criteria “large effect” in the control class is interpreted as a large negative criteria, meaning that the learning process in the conventional model class makes educators more dominant during learning. This is because in the conventional model there are no stages of learning that can support students to be active in class. Based on this, it can be concluded that the increase in students' mastery of concepts in the control class is caused by the dominant role of educators in learning with conventional models. Based on the explanation that has been presented, it can be concluded that the application of the guided inquiry model with the help of a virtual laboratory has great effectiveness in increasing students' mastery of concepts.

▪ CONCLUSION

Conclusion that can be drawn based on analysis of data and discussion, learning by using a guided inquiry model with the help of a virtual laboratory is effective in increasing students' concepts mastery in acid-base material. The criteria of effect size in the class that used a guided inquiry model with the help of a virtual laboratory is “large effect” so that it has a positive effect in increasing students' mastery of concepts on acid-base material.

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