11(3), 2022, 92-103 DOI: 10.23960/jppk.v11.i3.2022.11

Jurnal Pendidikan dan Pembelajaran Kimia

e-ISSN: 2714-9595 | p-ISSN: 2302-1772

http://jurnal.fkip.unila.ac.id/index.php/JPK/index

The Effectiveness Of Guided Inquiry Learning Model Using The Virtual Laboratory On Acid-Base Materials To Improve Science process skills

Elci Oktaria[1], Ila Rosilawati[2], Nina Kadaritna[3]

Chemical Education Study Program, Faculty of Mathematics and Science, Universitas of Lampung, Lampung-35141, Indonesia

*Correspondinge-mail: elcioktaria@gmail.com

Received: November 14th, 2022 Accepted: December 26th, 2022 Online Published: December 31th, 2022

Abstract: Based on the results of interviews with 11th-grade chemistry teachers at senior high school 9 Bandar Lampung, for the last two years, the learning process has been carried out online. The learning process carried out is more centered on the teacher with conventional learning so that students are not guided to find the concept. For materials that require practicum, students only watch videos from YouTube. There is no scientific process that has a major impact on the low Science process skills of students. Based on this description, there is a need for innovative learning that is able to train students' Science process skills. This study aims to describe the effectiveness of the guided inquiry learning model using the virtual laboratory on acid-base materials to improve science process skills. This research is a quasi-experimental research with The Matching Only Pretest-Posttest Control Group Design. The research instrument was in the form of pretest and posttest science process skills questions. Testing the hypothesis in this study used a similarity test of two means and a test of differences between two means using SPSS 25.0 with Independent Samples t-Test. The results showed that the average post-test score of the experimental class was higher than that of the control class and the experimental class had an average n-gain which was in the "high" category. Furthermore, the results of this test indicate that there is a significant difference in the average post-test between the experimental class and the control class. This shows that the guided inquiry learning model using a virtual laboratory on acid-base material is effective in improving science process skills.

Keywords: Virtual Laboratory, Guided Inquiry, Acid Base, Science process skills

Abstrak: Berdasarkan hasil wawancara dengan guru kimia kelas 11 di SMA Negeri 9 Bandarlampung, selama dua tahun terakhir ini proses pembelajaran dilakukan secara daring. Proses pembelajaran yang dilakukan lebih terpusat pada guru dengan pembelajaran konvensional sehingga peserta didik tidak dibimbing untuk menemukan konsep. Pada materi yang membutuhkan praktikum, peserta didik hanya mengamati video dari *YouTube*. Hal tersebut tentunya tidak terjadi proses ilmiah yang berdampak besar pada rendahnya KPS peserta didik. Penelitian ini bertujuan untuk mendeskripsikan efektivitas model pembelajaran inkuiri terbimbing menggunakan laboratorium virtual pada materi asam basa untuk meningkatkan keterampilan proses sains. Penelitian ini merupakan penelitian kuasi eksperimen dengan *The Matching Only Pretest-Posttest Control Group Design*. Instrumen penelitian berupa soal pretes dan postes untuk me-ngukur keterampilan proses sains peserta didik dan lembar pengamatan aktivitas belajar peserta didik. Pengujian hipotesis pada penelitian ini menggunakan uji ke-samaan dua rata-rata dan uji perbedaan dua rata-rata menggunakan *Independent Samples t-Test.* Hasil penelitian menunjukkan bahwa rata-rata nilai postes kelas eksperi-men lebih tinggi daripada kelas kontrol dan pada kelas eksperimen memiliki rata-rata n-gain yang berkategori “tinggi”. Selanjutnya hasil *Independent Samples t-Test* menggunakan SPSS 25.0 menunjukkan bahwa terdapat perbedaan rata-rata postes yang signifikan antara kelas eksperimen dan kelas kontrol. Hal ini menun-jukkan model pembelajaran inkuiri terbimbing menggunakan laboratorium virtual pada materi asam basa efektif meningkatkan keterampilan proses sains.

Kata Kunci: *Laboratorium Virtual, Inkuiri Terbimbing, Asam Basa, Keterampilan Proses Sains*

▪ INTRODUCTION

In the 21st century, education is one of the important needs that must be met in order to have the skills to survive in the face of life (Robbia and Fuadi, 2020). To support this, the government has made various efforts to improve the quality of education, one of which is through the learning process using the 2013 curriculum. The 2013 curriculum used emphasizes three aspects, namely products, processes, and attitudes (Kurnia, 2013). This is in accordance with science learning which pays attention to these three aspects (Karyadi, 2005).

Chemistry is a part of science that has all three components that are closely related to each other. Chemistry lessons are closely related to scientific processes which include ways of thinking, attitudes, and steps of scientific activities carried out in order to obtain chemical products such as conducting observations, experiments, and rational analysis (Trowbridge and Bybee, 1990). Mastery of scientific processes in learning is included in science process skills (Semiawan, 1992). By using Science process skills , students can independently find and develop facts and concepts (Komikesari, 2016).

Based on the results of interviews with 11^{th}-grade chemistry teachers at senior high school 9 Bandar Lampung, for the last two years, the learning process has been carried out online. The learning process carried out is more centered on the teacher with conventional learning so that students are not guided to find the concept. For materials that require practicum, students only watch videos from YouTube. Of course, there is no scientific process that has a major impact on the low Science process skills of students.

Based on this description, there is a need for innovative learning that is able to train students' Science process skills . The Science process skills can be trained through a learning process on one of the materials in class XI, namely acid-base material. The material is included in the basic competence (KD) 3.10 Explaining the concepts of acids and bases as well as their strengths and ionizing equilibrium in solution and KD 4.10 Analyzing the pH change trajectories of several indicators extracted from natural materials through experiments. To achieve KD students are given a problem or phenomenon, one of which is about some acidic solutions that can be felt and acid solutions that cannot be felt, some alkaline solutions that taste bitter and slippery when touched by hand, and some untouchable alkaline solutions. In this case, the Science Process skill that can be trained is observing.

Based on these problems, students are expected to be able to formulate hypotheses so that science process skills in the form of predicting or predicting skills can be trained for students. Then to prove the hypothesis, students can conduct experiments so that the data results are obtained which are then analyzed to make a conclusion. In this case, the student's science process skills that can be trained are the skills to observe, classify, conclude, and even communicate. To reach these stages and train students' science process skills in these basic competencies, it can be accommodated through one of the learning models, namely guided inquiry.

Learning with the guided inquiry model involves students finding and using various sources of information to improve their understanding of the concepts being studied (Gunawan et al., 2019). In the early stages of learning, students are asked to ask questions or problems. In the second stage, students are asked to make hypotheses. In the third stage, students conduct experiments to prove the predetermined hypothesis. Then in the fourth stage, students analyze the data that has been obtained. Finally, students make conclusions from the results that have been obtained based on the problems that occurred. All of these steps lead students to think through teacher instructions (Gunawan et al., 2019).

In the learning process, the acid-base material requires an experiment. This is the most important part of learning chemistry because it can build chemical concepts more easily understood and learning objectives can be achieved. However, the facts in the field are that chemical experiments in laboratories are rarely carried out because there are obstacles to their implementation. The obstacle is in the form of limited practicum facilities and infrastructure (Reny, Sugiarti, and Salempa, 2018). In addition, there are restrictions on interactions during the global Covid-19 pandemic, causing most activities to be carried out online as well as the learning process (Firman and Rahayu, 2020). Based on these conditions, in order for the practicum to continue and learning to be more effective and interesting, the use of Science and Technology is used, one of which is a virtual laboratory.

The results of research related to this study are research conducted by Cahyaningrum et al., (2020). The study stated that there was an effect of the guided inquiry-based practicum method assisted by a virtual laboratory on science process skills as seen from the differences in students' science process skills in the experimental class and control class and the effect of applying the treatment on students' science process skills was 7,9% which analyzed using the coefficient of determination. In addition, the results of another study by Rusliati and Retnowati (2019) stated that guided inquiry lessons with virtual laboratories could improve students' mastery of concepts and science process skills . Other studies have also shown that virtual laboratories can be more effective than passive teaching methods, but show equal or greater effectiveness than live laboratories (Chan et al., 2021).

The virtual laboratory is one of the uses of practicum-based learning media. Therefore, so that practicum activities can run smoothly and the use of laboratory equipment can be optimal, it is necessary to strive for the use of virtual laboratories. A virtual laboratory is a system that supports conventional practicum, providing opportunities to practice through computers and experiments that can be done anywhere (Ibrahim et al., 2022. In the process, virtual laboratory-assisted learning will become more meaningful and can minimize memorization (Falode, 2018). Virtual laboratories provide a simulated version of traditional laboratories and students are given objects which are virtual representations of real objects used in traditional laboratories. This makes a positive contribution to achieving learning objectives, especially abstract concepts (Abdjul & Ntobuo, 2018; Zaturrahmi et al., 2020; Faour & Ayoubi, 2018).

▪ METHOD

The population in this study were all students of class XI natural science at senior high school 9 Bandar Lampung for the 2021/2022 academic year spread over 7 classes, is 9th-grade majoring in natural science 1 to 9th-grade majoring in natural science 7. The sampling technique used in this study was purposive sampling. Purposive sampling is a sampling technique based on certain considerations (Sudjana, 2007).

Based on information from the chemistry teacher, it was considered that the students of 9th-grade majoring in natural science 6 were the control class using conventional learning and students in 9th-grade majoring in natural science 7 as an experimental class with a guided inquiry learning model using a virtual laboratory. This research is a quasi-experimental research with The Matching Only Pretest-Posttest Control Group Design. The research design used in this study can be seen in Table 4 as follows:

Table 4. Research design

Treatment group	M	O	C	O
Control group	M	O	X	O

Information:
M = Matching, which means there is an adjustment in each class
O = Pretest conducted before learning
C = Treatment in the form of conventional method learning
X = Treatment in the form of learning with a guided inquiry model using a virtual laboratory
O = posttest conducted after learning
(Fraenkel et al., 2012)

Daltal Alnallysis Techniques

1. Data analysis of students' science process skills

The purpose of data analysis is to provide meaning or meaning used to draw conclusions related to problems, objectives, and hypotheses that have been formulated previously.

a. Calculation of student scores

The pretest and posttest scores on the science process skills assessment are as follows:

$$\text{Final score} = \frac{\text{the total answer scores obtained}}{\text{max score}} \times 100$$

b. Calculation of each students' n-gain

How to calculate the effectiveness of the guided inquiry learning model in improving science process skills by analyzing the n-gain value of students from the sample class. According to Hake (1998), the n-gain formula is as follows:

$$\langle g \rangle = \frac{\%\langle S_f \rangle - \%\langle S_i \rangle}{100 - \%\langle S_i \rangle}$$

Description :
$\langle g \rangle$ = n- *gain*
$\langle S_i \rangle$ = pretest score
$\langle S_f \rangle$ = posttest score

c. Calculating the average n-gain for each class

After obtaining n-gain from each student, then the average n-gain for each sample class is calculated which is formulated as follows:

$$\text{Average } n\text{-gain class } (\langle g \rangle) = \frac{\text{The total of n-gain at one class}}{\text{The total of students}}$$

The results of the average n-gain are then interpreted using the criteria of Hake (1999). The n-gain classification criteria are as follows:

1) n-gain is high category, if (<g>) ≥ 0,7
2) n-gain is moderate category, if 0,3 ≤ (<g>) < 0,7
3) n-gain is low category, if (<g>) < 0,3

2. Prerequisite testing

The analysis prerequisite test is in the form of a normality test and homogeneity test obtained from pretest and post-test data to determine students' initial abilities

a. Normality test of pretest and posttest science process skills data

The normality test was carried out to determine whether the sample came from a population that was normally distributed or not, so the normality test in this study used SPSS 25.0.

The hypothesis for normality test:
H_0 : both samples come from a normally distributed population
H_1: both samples come from populations that are not normally distributed

Test criteria using SPSS 25.0: accept H_0 (normally distributed) if the value of sig. > 0,05 and reject H_0 if the value of sig. < 0,05.

b. Test of homogeneity of pretest and posttest science process skills

The homogeneity test aims to determine whether the research sample comes from a homogeneous population or not, which is then to determine the statistics to be used in hypothesis testing. The homogeneity test in this study used SPSS 25.0.

Hypothesis for homogeneity test:
$H_0 = \sigma_1^2 = \sigma_2^2$: both research samples have homogeneous population
$H_1 = \sigma_1^2 \neq \sigma_2^2$: both research samples have inhomogeneous populations

Test criteria using SPSS 25.0: accept H_0 if the value of sig. > 0,05 and reject H_0 if the value of sig. < 0,05.

3. Test the similarity of the two averages

The similarity test of two averages is used to determine whether the average similarity of the students' pretest scores is significant or not. Based on the prerequisite test, accept H_0 which means the sample comes from a population that is normally distributed and homogeneous, then the similarity test of the two averages in this study is calculated by means of the Independent Samples t-Test which is carried out using SPSS 25.0.

The hypothesis for the similarity test of two means is:
H_0 : $\mu_{1x} = \mu_{2x}$: The average science process skills pretest score of students in the experimental class is the same as the average science process skills pretest score of students in the control class on acid-base material.
H_1 : $\mu_{1x} \neq \mu_{2x}$:The average science process skills pretest scores of students in the

experimental class are not the same as the average science process skills pretest scores of students in the control class on acid-base material.

Test criteria using SPSS 25.0: accept H_0 if the value of sig. > 0,05 and reject H_0 if the value of sig. < 0,05.

4. The two-average difference test

The two-average difference test was used to determine the effectiveness of the guided inquiry learning model in improving students' science process skills on acid-base material. Based on the prerequisite test, the post-test data obtained were normally distributed and homogeneous, so the difference between the two averages in this study was calculated by means of the Independent Samples t-Test which was carried out using SPSS 25.0.

The hypothesis for the two-average difference test is:

H_0: $\mu_{1x} \leq \mu_{2x}$: The average post-test score for students in the experimental class is lower than or equal to the average post-test score for students in the control class.

H_1: $\mu_{1x} > \mu_{2x}$: The average post-test score for students in the experimental class is higher than the average post-test score for students in the control class.

Test criteria using SPSS 25.0: accept H_0 if the value of sig. > 0,05 and accept H_1 if the value of sig. < 0,05.

5. Data analysis of Student activity

The student activities observed in the learning process were answering questions, asking the teacher, collaborating or discussing with groups, and responding to other groups' presentations. Analysis of student activities is carried out by calculating the percentage of each activity for each meeting with the formula:

$$\% \text{ students in activity i} = \frac{\sum \text{students who carry out activities of i}}{\sum \text{students}} \times 100\%$$

Information:

i : student activities observed in learning (answering questions, asking the teacher, cooperating or discussing with the group, and responding to presentations from another group).

Furthermore, interpreting the data by interpreting the price of the percentage of student activity (Sunyono, 2012) as follows:

Table 5. Student activity criteria

Percentage	Criteria
80,1%-100,0%	Very high
60,1%-80,0%	High
40,1%-60,0%	Medium
20,1%-40,0%	Low
0,0%-20,0%	Very low

▪ RESULT AND DISCUSSION

Based on the research that has been carried out on the control class (9^{th}-grade majoring in natural science 6) and the experimental class (9^{th}-grade majoring in natural science 7), the research data was obtained in the form of pretest and posttest values of science process skills and data on student activities during the research.

1. The results of the similarity test of two averages

The average pretest value of students' science process skills in the control class and experimental class is presented in Figure 2.

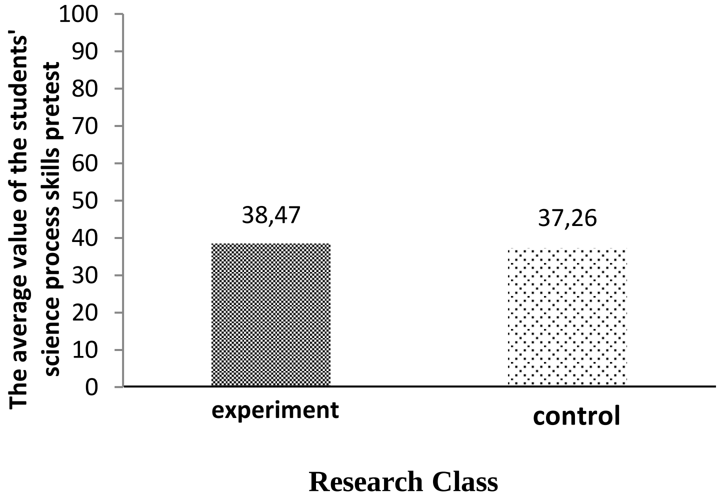

Figure 2. The average pretest value of students' science process skills in the experimental class and control class

Based on Figure 2, it can be seen that the average pretest value of science process skills in the experimental class is 38,47 and in the control class is 37,26. This shows that the average pretest score in the experimental class is almost the same as the average pretest score for the control class. To test whether the average similarity of the students' pretest scores is significant or not, a statistical test is carried out with the similarity test of two averages. However, previously, there were prerequisite tests, namely normality tests and homogeneity tests on the pretest scores of the control and experimental classes.

The first prerequisite test performed was the normality test on the pretest scores of the control and experimental classes. This test aims to determine whether the research sample comes from a population that is normally distributed or not. Based on the results of calculations using SPSS 25.0, the values in the control and experimental classes are presented in Table 6.

Table 6. Normality test results of science process skills pretest scores

Class	Average pretest value	df	The value of sig.	Test Criteria	Description
Experiment	38,47	21	0,145	Accept H_0 if sig > 0,05	Accept H_0
Control	37,26	19	0,312		Accept H_0

Based on Table 6, the results of the normality test on the average pretest value of students' science process skills in the experimental and control classes have a significance value > 0,05 so the decision to accept H_0 and reject H_1 means that the research sample comes from a normally distributed population. The second prerequisite test is the homogeneity test of the experimental and control class pretest scores. This test aims to determine whether the research sample has a homogeneous variance or not. Based on the calculation results, the significance value is obtained as presented in Table 7.

Table 7. Homogeneity test results of science process skills pretest scores

Class	Average pretest value	df	The value of sig.	Test Criteria	Description
Experiment	38,47	21	0,414	Accept H_0 if a *sig. based on mean* > 0,05	Accept H_0
Control	37,26	19			

Based on table 7, it is known that the results of the homogeneity test that have been carried out on the average pretest value of students' science process skills obtained a sig value. based on mean > 0,05 so the decision to accept H_0 and reject H_1. That is, the two research classes have homogeneous variance. Based on the normality test and homogeneity test, it was found that the pretest data obtained were normally distributed and homogeneous so further tests of the similarities between the two averages were carried out on the average pretest value of students' science process skills . This test uses SPSS 25.0 that is using the Independent Sample T-test. The following data on the results of the similarity test of the two averages are presented in Table 8.

Table 8. The results of the similarity test of the two average pretest scores of science process skills

Class	Average pretest value	df	The value of sig. *(2-tailed)*	Test Criteria	Description
Experiment	38,47	21	0,754	Accept H_0 if *Sig. (2-tailed)* > 0,05	Accept H_0
Control	37,26	19			

Based on table 8, shows that the value of sig (2-tailed) > 0,05. Acceptance test criteria H_0 if the value of sig. (2-tailed) > 0,05. Thus, the results of the average test score for the pretest science process skills of the experimental class and control class students received h0, meaning that the average pretest value of the science process skills students in the experimental class was significantly the same as the average science process skill pretest score of the particnatural sciencents. students in the control class on acid-base material.

2. The results of the difference test of the two averages

The difference test of the two averages was conducted to find out whether the average post-test value of the science process skills of students in the experimental class was higher than the average value of the post-test of science process skills of students in the control class. This test uses SPSS 25.0 which is using the Independent Sample T-test.

The difference test of the two averages was carried out based on the average posttest value of the students' science process skills . The following is the average data for the post-test scores of students' science process skills in the experimental and control classes:

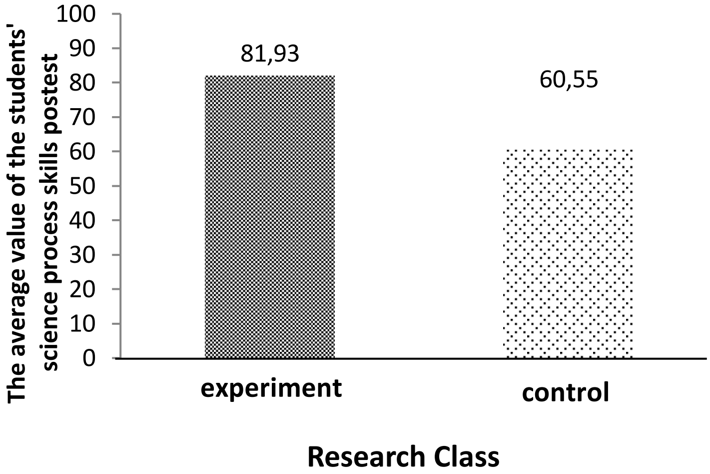

Figure 3. The average value of the posttest science process skills of students in the experimental and control classes.

Based on Figure 3, it can be seen that the average post-test value of the experimental class students' science process skills was higher than the control class, namely 81,933 > 60,55. This shows that the average posttest value in the experimental class is different from the average posttest value in the control class. To test whether the difference in the average post-test scores of students is significant or not, a statistical test is carried out with a two-average difference test. However, previously, there were prerequisite tests, namely the normality test and homogeneity test on the post-test scores of the experimental and control classes.

The first prerequisite test that was carried out was the normality test on the post-test scores of the control and experimental classes. Based on the results of calculations using SPSS 25.0, the values in the control and experimental classes are presented in Table 9.

Table 9. Results of the normality test of science process skills posttest scores

Class	Average postest value	df	The value of sig.	Test Criteria	Description
Experiment	81,93	21	0,280	Accept H_0 jika sig > 0,05	Accept H_0
Control	60,55	19	0,420		Accept H_0

Based on table 9, the results of the normality test on the average post-test value of students' science process skills in the experimental and control classes have a sig value. > 0,05 so the test decision is to accept H_0 and reject H_1. That is, the research data obtained are normally distributed. The second prerequisite test is the homogeneity test of the experimental and control class posttest scores. Based on the calculation results, the significance value is obtained as presented in Table 10.

Table 10. The results of the homogeneity test of science process skills posttest scores

Class	Average postest value	df	The value of sig.	Test Criteria	Description
Experiment	81,93	21	0, 319	Accept H_0 if *sig. based on mean* > 0,05	Accept H_0
Control	60,55	19			

Based on table 10, it is known that the results of the homogeneity test that have been carried out on the average post-test value of students' science process skills obtained a sig value. Based on a mean > 0,05 so that the decision to accept H_0 means that the research obtained comes from a homogeneous variance. Based on the normality test and the homogeneity test, it was found that the post-test scores for the science process skills of the students in both classes were normally distributed and homogeneous so that further differences in the two averages could be tested on the average post-test scores for the science process skills of the students. This test used SPSS. 25.0 using the Independent Sample T-test. The data on the results of the two mean differences are presented in Table 11.

Table 11. The results of the test of the difference between the average post-test scores of science process skills

Class	Average postest value	df	The value of sig. *(2-tailed)*	Test Criteria	Description
Experiment	81,93	21	0,000	Accept H_0 if *Sig. (2-tailed)* > 0,05	Accept H_0
Control	60,55	19			

Based on the table above, the sig value is obtained. (2-tailed) 0,000 < 0,05 so it can be concluded to reject H_0 and accept H_1. This means that the average post-test value of students' science process skills in learning acid-base material using a virtual laboratory with a guided inquiry model is higher than the average post-test value of students' science process skills in conventional learning on acid-base material.

3. Student activity data

The results of observing student activities in the experimental class are presented in four aspects that are assessed as presented in Table 12 below.

Table 12. Data on the results of student activities in learning

No.	Observed aspects	Percentage of student activity					
		1st meeting	2nd meeting	3rd meeting	4th meeting	5th meeting	Average
1.	Answer the teacher's questions	33,33	57,14	66,67	52,38	66,67	55,24
2.	Ask the teacher	38,10	47,62	71,43	52,38	71,43	56,19
3.	Cooperate in working on LKPD or discuss with groups	33,33	61,90	76,19	38,10	61,90	54,28
4.	Responding to other group presentations	42,86	61,90	71,43	47,62	66,67	58,10
Average percentage of student activity		36,90	57,14	71,43	47,62	66,67	55,95
Criteria		low	medium	high	medium	high	medium

Based on Table 12, it can be seen that the average percentage of student activity from the first, second, third, and fifth meetings tends to increase. However, at the fourth meeting, there was a decrease in student activity. This is because at the fourth meeting the learning was carried out online through google meet while the first to third meetings were conducted in a mixture of online and offline and the fifth meeting was offline. Overall the criteria for the average percentage of student activity is 'medium'.

Based on the results of data analysis shows that learning using a virtual laboratory with a guided inquiry model on acid-base material is effective in improving students' science process skills . This is supported by the research of Cahyaningrum et al., (2020) which states that there is an influence of guided inquiry-based practical methods assisted by virtual labs on science process skills as seen from the differences in students' science process skills in the experimental class and control class and the magnitude the effect of applying the treatment on students' science process skills was 7,9%. In addition, the results of Aldhi Kurnia's research (2020) also state that the application of virtual labs in guided inquiry-based learning is able to improve student learning outcomes. Other research also shows that the application of the guided inquiry model can improve science process skills and students' cognitive learning outcomes (Suwardani, 2021).

▪ CONCLUSION

Based on the research that has been done, it can be concluded that the guided inquiry learning model using a virtual laboratory is effective in improving students' science process skills on acid-base material. This is indicated by the significant difference in the post-test average between the experimental class and the control class and the experimental class has an average n-gain which is categorized as "high". By using Science process skills, students can independently find and develop facts and concepts (Komikesari, 2016). This research is one of the solutions to students' low science process skills during the COVID-19 pandemic.

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