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The Effectiveness of Guided Inquiry Learning Model using the Virtual Laboratory on Acid-Base Materials to Improve Analyzing Skills

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Abstract: The Effectiveness of Guided Inquiry Learning Model using the Virtual Laboratory on Acid-Base Materials to Improve Analyzing Skills. This study aims to describe the effectiveness of the guided inquiry learning model using the Virtual Laboratory on acid-base material in improving students analyzing skills. This research method is quasi-experimental with the Matching-only pretest-posttest control group design. Sampling was carried out using purposive samplingtechnique. Hypothesis testing used a difference test of two averages (t-test) on the posttest value of the experimental class and the control class. The results showed that the average posttest value of the experimental class was higher than that of the control class and that the experimental class had a high average n-Gain category. Furthermore, the results of the average difference test using the t-test showed that there was a significant average difference between the experimental class and the control class. It can be concluded that the use of a guided inquiry learning model using the Virtual Laboratory on acid-base material is effective for improving students analyzing skills.

Keywords: Guided Inquiry, Virtual Laboratory, Acid-Base, Analyzing Skills

Abstrak: ***Efektivitas Model Pembelajaran Inkuiri Terbimbing Menggunakan Laboratorium Virtual Pada Materi Asam Basa untuk Meningkatkan Keterampilan Menganalisis.*** *Penelitian ini bertujuan untuk mendeskripsikan efektivitas model pembelajaran inkuiri terbimbing mengunakan laboratorium virtual pada materi asam basa dalam meningkatkan keterampilan menganalisis peserta didik. Metode penelitian ini adalah kuasi eksperimen dengan the Matching-only pretest-posttest control group design. Pengambilan sampel dilakukan menggunakan teknik purposive sampling.Pengujian hipotesis menggunakan uji perbedaan dua rata-rata (uji-t) pada nilai postes kelas eksperimen dan kelas kontrol. Hasil penelitian menunjukkan bahwa rata-rata nilai postes kelas eksperimen lebih tinggi daripada kelas kontrol serta pada kelas eksperimen rata-rata n-gain yang berkategori tinggi. Selanjutnya hasil uji perbedaan dua rata-rata menggunakan uji-t menunjukkan bahwa terdapat perbedaan rata-rata nilai postes yang signifikan antara kelas eksperimen dan kelas kontrol. Dapat disimpulkan bahwa penggunaan model pembelajaran inkuiri terbimbing menggunakan laboratorium virtual pada materi asam basa efektif untuk meningkatkan keterampilan menganalisis peserta didik.*

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

• INTRODUCTION

The 21st century education curriculum was developed to improve 21st century skills, namely the skills needed to face the life of a global society (Muakhirin, 2022). This skill is not possessed by a person since birth, but this skill can be obtained from the process of learning, practice, and experience (Redhana, 2019). The thinking skills proposed by Anderson and Krathwohl are divided into two, namely

Lower Order Thinking Skills (LOTs) and Higher Order Thinking Skills (HOTs) (Anderson & Krathwohl, 2001). Where, the main goal of learning in the 21st century is to develop and improve higher order thinking skills (Yen & Halili, 2015).

Higher order thinking skills or HOTs will be seen when students are faced with problems that they did not know before. Higher order thinking skills require critical thinking skills and related reasoning skills (Muakhirin, 2022). Higher order thinking skills have thinking processes at a higher cognitive level, not only memorizing and then restating known information. Higher order thinking skills include cognitive ability to analyze (C4), evaluate (C5), and create (C6) (Anderson & Krathwohl, 2001). One indication of the success of increasing human resources in the field of education is that students have good high-level thinking skills (Arifin & Retnawati, 2015). In addition, higher order thinking skills are abilities in the cognitive domain that are currently a concern in the 2013 curriculum (Kemendikbud, 2017).

In the 2013 curriculum, one of the basic competencies that must be mastered by students in the XI Science chemistry subject is KD 3.10 which is explaining the concepts of acids and bases as well as their strengths and ionizing equilibrium in solution and KD 4.10 is analyzing the pH trajectory of several extracted indicators. from natural materials through experiments (Composing Team, 2013b). Based on KD, students are expected to be able to analyze the nature of acid and alkaline solutions related to phenomena in life, the observed phenomena can be in the form of color changes, such as testing the pH of an acid or base solution that we can encounter in everyday life using natural indicators that we meet in everyday life, for example turmeric, hibiscus flowers and so on. In acid-base learning activities, practical activities are needed to identify solutions using appropriate indicators as a determination of acid-base strength in group discussions. To teach acid-base material, students are given a phenomenon or problem, then conduct experiments, and analyze experimental data so that they can practice students analytical skills.

Learning with the guided inquiry model invites students to be involved in the process of analyzing problems and solving problems directly (Sikko et al., 2012). The guided inquiry model can be synergized with higher-order thinking skills activities to develop logical, critical, analytical, and systematic thinking skills so that students can find concepts independently. The guided inquiry learning model provides direct opportunities for student to learn how to find facts, concepts and principles through their experiences (Mulyana et al., 2018).

Based on the results of interviews and observations conducted with chemistry subject teachers in class XI IPA SMA Negeri 9 Bandarlampung, learning chemistry at SMA Negeri 9 Bandarlampung applies the 2013 curriculum learning but in the teaching and learning process it is still teacher-centered using conventional learning. In addition, during the learning process it is carried out through online media (online) so that students do not do practicum but only observe practicum videos from Youtube after students get the concept of the material, so that students do not get the concept on the material themselves. The absence of practical activities due to the coronavirus (COVID-19) pandemic requires a solution so that the transfer of higher-order thinking skills can take place. This alternative form can be in the form of using the Virtual Laboratory as a learning medium.

Virtual laboratories are media that can be used to assist conventional experiments. A virtual laboratory can be referred to as a virtual-lab that can be applied and sent anywhere, to anyone and at any time (Grenberg & Research, 2004). Virtual-lab has several advantages, namely increasing scientific problem-solving skills and creative thinking skills, increasing students mastery of concepts, and developing ICT skills (Hermansyah et al., 2015). Some of the results of research on virtual laboratories include Nugroho (2021) with virtual laboratories becoming active learning objects, with an organized learning flow so that many students enjoy the learning process with virtual laboratories. The results of Kurnia's research (2020) that the application of virtual-labs in guided inquiry learning is able to improve student learning outcomes. The results of Aini &

Yonata's research (2020) that guided inquiry learning models are effective in training students higher-order thinking skills.

Based on the explanation above, it is necessary to conduct a research entitled "The Effectiveness of Guided Inquiry Learning Model using the Virtual Laboratory on Acid-Base Materials to Improve Analyzing Skills".

• METHOD

The method used in this research is a quasi-experimental design with The Matching-Only Pretest-Posttest Control Group Design (Frankel, et al. 2012). The variables in this study are independent variables, namely a virtual laboratory with a guided inquiry model for the experimental class and conventional methods for the control class. control variables, namely acid-base materials and teachers. the dependent variable, namely the students analyzing skills.

The population in this study were all students of class XI IPA SMAN 9 Bandarlampung for the 2021/2022 academic year. Sampling using purposive sampling technique. The sample was obtained by class XI IPA 6 as the control class and XI IPA 7 as the experimental class.

The type of data used in this study is primary data in the form of analyzing test results obtained from pretest and posttest, as well as student data and activities. This data is sourced from all students in the control class and the experimental class. There are two research instruments used, namely pretest and posttest questions which are equipped with an assessment rubric and observation sheets for student activities in learning using the Virtual Laboratory with a guided inquiry model.

Data analysis technique was carried out by calculating the pretest and posttest scores with the following formula:

$$\text{Total Final} = \frac{\textit{Score total answer score obtained}}{\textit{Total maximum score}} \text{ x } 100$$

Then calculating the n-gain based on the Hake formula (1998) as follows:

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

Analysis of pretest data for control and experimental class students used the two-average similarity test with t-test, with prerequisite tests analysis in the form of normality test and homogeneity test. The normality test of the data in this study uses the Chi square test with the acceptance criteria H_0 (data is normally distributed) $\chi^2_{count} < \chi^2_{table}$. The homogeneity test uses the F test with the acceptance criteria H_0 (data has homogeneous variance) if $F_{count} < F_{table}$ (Sudjana, 2005).

Analysis of post-test data for control and experimental classes used the difference test of two averages with t-test, with analysis prerequisite tests in the form of normality test and homogeneity test. The normality test of the data in this study uses the chi square test with the acceptance criteria H_0 (data is normally distributed) $\chi^2_{count} < \chi^2_{table}$. The homogeneity test uses the F test with the acceptance criteria H_0 (data has homogeneous variance) if $F_{count} < F_{table}$.

Student activity data was obtained from observations which contained indicators for each aspect studied. Descriptive analysis of student activity in learning is done by calculating the total score given by the observer for each aspect of the observation, then calculating the percentage of achievement with the formula:

$$\text{\% Students in activity I} = \frac{\sum \textit{Students who do activity i}}{\sum \textit{Students}} \text{ x } 100\%$$

Next, interpreting the data by interpreting the percentage of student activity (Sunyono, 2012) in Table 1 below.

Table 1. Category of student activity

Persentage	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

The results of the study obtained data in the form of pretest and posttest values of analyzing skills which are seen in Figure 1 as follows:

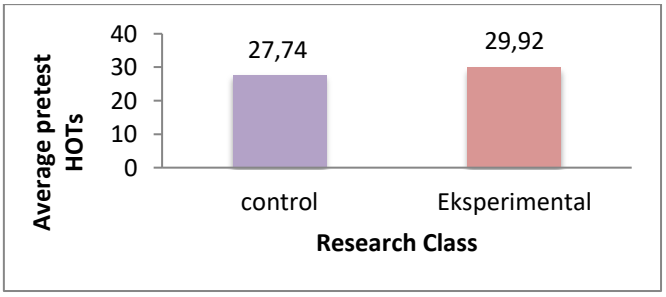

Figure 1. The average value of the pretest of analyzing skills

Viewed from Figure 1 shows that the initial analyzing skills of the two classes tend to be the same. To determine the initial ability of students in the control and experimental classes, a similarity test of the two averages was carried out with a t-test. Previously, the prerequisite tests were carried out including the normality test with the chi square test and the homogeneity test with the F test. The results of the pretest normality test for analyzing skills are presented in the following table:

Table 2. Normality test results

Class	X^2_{count}	X^2_{table}	Test criteria
Control	4,15	5,99	Normal
Exsperimental	4,40		Normal

In Table 2 it can be seen that both classes come from a normally distributed population. The results of the homogeneity test obtained that the$_{calculated}$ was 1.73 and the F_{table} was 2.15, so it was concluded that the two classes had homogeneous variances.

Then the t test was carried out, the value of $t_{count} = 0.38 < t_{table} = 2.02$ based on the test criteria, it can be concluded that accept H_0, meaning that the initial ability between the control class and the experimental class is statistically the same.

Then in the experimental class learning is carried out using the Virtual Laboratory with a guided inquiry learning model and in the experimental class conventional learning is carried out. Furthermore, posttest was conducted in both classes to determine the differences in the students analyzing skills with the t-test in the posttest. The following is the average data for the post-test of students analyzing skills:

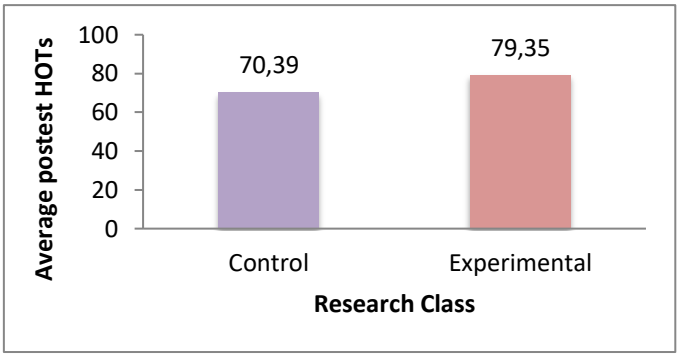

Figure 2. The average value of the post-test of analyzing skills

In Figure 2 it can be seen that the average post-test of analyzing skills in the experimental class is higher than the control class. To find out that a virtual laboratory with a guided inquiry learning model can improve analyzing skills, a t-test was carried out. Before conducting the t-test, prerequisite tests were carried out, namely normality test and homogeneity test. The following is the normality data for the post-test scores for students analyzing skills.

Table 3. Normality test results

Class	X^2_{count}	X^2_{table}	Test criteria
Control	4,45	5,99	Normal
Exsperimental	2,97		Normal

From Table 3 it can be seen that both classes come from a normally distributed population. The results of the homogeneity test obtained that the$_{calculated}$ was 0.86 and the F_{table} was 2.15, so it was concluded that the two classes had homogeneous variances.

Then the t test was carried out, the value of $t_{count} = 2.84 > t_{table} = 2.02$ based on the test criteria, it can be concluded that rejecting H_0, this indicates that the virtual laboratory with the guided inquiry model is effective in improving students analyzing skills. This can also be seen from the average value of the n-Gain of analyzing skills as follows:

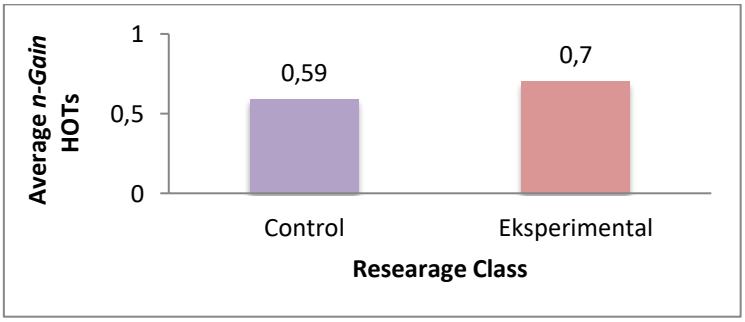

Figure 3. The average *n-Gain* of analyzing skills

Based on Figure 3, it can be seen that the average *n-gain* in the experimental class is higher than the control class.criterion *n-gain* in the experimental class is 'high'.control class *n-gain* , the criteria obtained are 'medium'. This shows that the improvement of students analyzing skills in the experimental class is better than the control class.

The results of the observer's observations on the activities of students while learning using a guided inquiry learning model with a virtual laboratory are obtained in the data presented in the following

Table 4. Data on the results of students activities

No.	Observed	Number of students who doing activities					
		Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Average
1.	Answer teacher 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 student worksheets or discuss groups	33,33	61,90	76,19	38,10	61,90	54,28
4.	Respond to other group presentations	42,86	61,90	71,43	47,62	66,67	58,10
Rata-rata persentase aktivitas peserta didik		36,90	57,14	71,43	47,62	66,67	55,95
Criteria		Low	Medium	High	Medium	High	Low

Based on Table 4, it can be seen that the average number of students who carried out activities from the first meeting was 36.90 with low criteria, at the second meeting 57.14 with moderate criteria, at the third meeting 71.43 with high criteria, at the third meeting it was 71.43 with high criteria. the fourth meeting was 47.62 with moderate criteria, and at the fifth meeting it was 66.67% with high criteria. The criteria for the average number of students who carry out activities are moderate.

Based on the results of the research and the test of the difference between the two averages, it shows that the use of guided inquiry learning model with a virtual laboratory on acid-base material is effective in improving students analyzing skills. This is supported by research by Muspawi et al.(2019) namely the application of guided inquiry learning models to improve students analyzing skills, as well as research by Madhuri & Goteti (2022) that the use of virtual laboratories can improve students conceptual understanding through various steps involved in the process. guided inquiry learning so as to improve students higher order thinking skills.

To describe the effectiveness of virtual laboratories with learning models Guided inquiry on acid-base material then carried out a five-step study of the learning model, namely asking questions, formulating hypotheses, collecting data, analyzing data, and drawing conclusions.

At the stage of asking questions or problems, students are required to identify phenomena (discourses) by finding problems and then connecting the information obtained and then formulating problems. At this stage the ability to analyze is trained on students, namely on attributing indicators by orienting students to the problems discussed through discourse which will lead students to identify, focus, and choose the appropriate issues as the formulation of the problem. In this process, students will find the essence of the problem to be solved and points that can help students to describe the problems in the discourse by relying on their analytical skills. This is in accordance with Aini and Yonata (2020), higher order thinking skills can be trained through activities to identify problems, formulate problems, identify experimental variables, determine tools and materials and perform data analysis.

At this stage students have difficulty at the first meeting, seen from the number of errors in formulating problems. Reading discourse and then formulating problems is a new thing for students, so students are not accustomed to expressing their opinions. At the first meeting, the school implemented a hybrid learning where learning was combined between online and face-to-face learning. Students with online learning are not active in asking and answering statements, and are less visible in working together on LKPD. The teacher guides students in finding problem concepts in formulating problems by providing directions that arouse students curiosity. Then at the second meeting there was an increase in the average percentage of student

activity where the school still applied the hybrid learning, from the first meeting in the low category to the medium category. At the second meeting when working on worksheets, students experienced increased interest in learning and actively asked and answered questions in teaching and learning activities because students were getting used to the use of virtual laboratories and guided inquiry learning models.

In the next stage, namely formulating hypotheses, students are guided to write temporary answers to the problem formulations that have been made by students based on the knowledge or information they get. The preparation of the hypothesis is done by looking for information that is relevant to the written problem formulation, where this information can be obtained from various sources such as books and. This activity can train students analyzing skills in the form of analytical skills, namely differentiating of important and unimportant information, relevant and irrelevant then paying attention to important information and in accordance with the problem formulation that has been made.

At this stage, students have difficulty determining the appropriate hypothesis because the formulation of the problem made is not as expected. However, at the next meeting, students are used to and able to formulate hypotheses that are in line with expectations.

Furthermore, at this stage of collecting data, students test the truth of the hypothesis by collecting data through experiments and/or seeking information relevant to the formulation of the problem through books and the internet and then writing down the results of the experimental data. The analytical indicator that is trained is differentiating.

At this stage, students conduct experiments using virtual laboratories, students are very enthusiastic about the applications that are distributed, students often repeat experiments using virtual laboratory applications and actively ask questions because students are not accustomed to using virtual laboratory applications, it is very visible that the cooperation of students in using the application then record the observations that have been obtained. However, students with online learning showed less interest in learning when collecting data and were less active in asking and answering questions and then less cooperation in doing practicums. Cooperation between students in groups is trained when conducting experiments using virtual laboratory media. According to Hermansyah et al. (2019), the application of a virtual laboratory with a guided inquiry learning model has a significant influence on students understanding of concepts.

At the data analysis stage, the teacher guides students to be able to prove the truth of the hypotheses they have written. At this stage, students analyze the information obtained from the data search stage to find concepts about acids and bases. The analytical indicator that is trained at this stage is the organizing. At this stage, with the guidance of the teacher, students do not experience difficulties and can answer well and can determine the final answer based on hypothesis testing.

In the next stage, namely drawing conclusions, students determine the final answer based on hypothesis testing conducted by students. Students write their answers based on the results of the experiments carried out and analyze the data from the results of these experiments. Conclusions are drawn by rematching with the hypotheses that have been written, this is to determine whether the hypotheses made are appropriate or not. The analytical indicator that is trained at this stage is attributing.

• CONCLUSION

The development of instruments on chemical literacy is carried out to the stage of development in the ADDIE development model. The result of developing a chemical literacy assessment instrument fullfill the criteria of content validity and empirical validity. The average content validation by expert validators shows a percentage of 98.8% which is categorized as excellent. Empirical validity shows that as many as 25 items of chemical literacy questions are

declared valid with a very high level of reliability (0,797). All question items have a very good difference with 3 questions categorized as difficult and 22 questions categorized as medium. The results of the chemical literacy questions that have been developed can be used as an evaluation of students' chemical literacy, especially on electrolyte and nonelectrolyte solution topic. Furthermore, the chemical literacy question instrument developed is expected to train students to think critically, creatively, and apply chemical concepts in solving problems and challenges in the 21st century.

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