



Improving Students' Critical Thinking Skills Using *the Inquiry Lesson Model*

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Abstract: This study aims to describe the effectiveness of the inquiry lesson model on the buffer solution material to improve students' critical thinking skills. The research sample was grade XI students of a senior highschool in Bandarlampung which obtained by using purposive sampling technique. In the control class, direct instruction learning was applied and in the experimental class was the inquiry lesson. The research used a quasi-experimental design with The Matching-Only Pretest- Post-test Control Group. The research data were analyzed using the n-gain calculation and parametric statistics with the t-test. The results showed that the post-test average score of critical thinking skills in the experimental class and the control class had a significant difference and the average n-gain in the experimental class was 0.48 (moderate category). Thus, it can be concluded that the Inquiry Lesson model is effective for improving students' critical thinking skills.

Key words: Inquiry lesson, buffer solution, critical thinking skills

Abstrak: Penelitian ini bertujuan untuk mendeskripsikan efektivitas model inquiry lesson pada materi larutan penyangga untuk meningkatkan keterampilan berpikir kritis siswa. Populasi dalam penelitian ini adalah seluruh siswa kelas XI IPA sebuah SMA Negeri di Bandarlampung yang diperoleh dengan teknik purposive sampling. Pada kelas kontrol diterapkan pembelajaran langsung dan pada kelas eksperimen diterapkan inquiry lesson. Metode penelitian yang digunakan adalah kuasi eksperimen dengan desain The Matching-Only Pre-test - Post-test Control Group. Data penelitian dianalisis menggunakan perhitungan n-gain dan statistik parametrik dengan uji t. Hasil penelitian menunjukkan bahwa skor rata-rata postes keterampilan berpikir kritis kelas eksperimen dan kelas kontrol memiliki perbedaan yang signifikan serta n-gain rata-rata di kelas eksperimen sebesar 0,48 (berkategori sedang). Dengan demikian, dapat disimpulkan bahwa model Inquiry Lesson efektif untuk meningkatkan keterampilan berpikir kritis siswa.

Kata kunci: Inquiry Lesson, larutan penyangga, keterampilan berpikir kritis.

• INTRODUCTION

In the era of the industrial revolution 4.0, there are several skills that are needed, namely communication skills, creativity, innovation, critical thinking, problem-solving, as well as collaboration (National Education Association, 2012). Critical thinking skills are considered the foundation of other skills, including communication, collaboration, global awareness, technology, life, and career skills, and learning and innovation abilities (Friedel, Irani, Rudd, Gallo, Eckhardt, & Ricketts, 2008). Critical thinking skills can be improved through education (Marjan, Arnyana & Setiawan, 2014), including the

application of learning models (Mahardini *et al.*, 2019; Trisdiono *et al.*, 2019). In many subjects, one of the models that many examine its influence in improving critical thinking skills is inquiry learning (Fijar *et al.*, 2019; Rusmansyah *et al.*, 2019; Hasan *et al.*, 2019; Wale & Bishaw, 2020; Aiman *et al.*, 2020; Maknun, 2020; Nurdiansyah *et al.*, 2021; Sari *et al.*, 2021; Sutiani *et al.*, 2021) Pre-experiments in the form of interviews with chemistry teachers in Bandar Lampung showed that chemistry learning on buffer solution materials still applies many lecture methods with the help of *powerpoint* so that communication tends to occur one way only. For this reason, research was carried out as an alternative to improve students' thinking skills, especially in buffer solution materials.

The buffer solution is one of the materials in the class XI chemistry lesson in even semester with Basic Competency of Knowledge (KD 3.13) Analyzing the role of buffer solutions in the body of living beings and Basic Competency of Skills (KD 4.13) Designing, conducting and concluding, and examining the results of experiments to determine the properties of buffer solutions. To achieve the KD, students are required to go through a series of scientific processes such as observing, formulating problems, making observations, making hypotheses, conducting experiments, and drawing conclusions (Sund & Trowbridge, 1973; Bybee, 2006). The series of processes are in accordance with the inquiry lesson model because an inquiry lesson is a series of learning activities that involve the maximum of all students' abilities to search and investigate systematically, critically, logically, and analytically, so that they can formulate their own discoveries (Wenning, 2010). By applying the *inquiry lesson* model to the material, students automatically practice critical thinking in solving problems in the learning process. The critical thinking skills that are trained include simple explanations (*elementary clarification*), basic skills (*basic support*), inference, further explanation (*advance clarification*), and making strategies and tactics. Therefore, Costa, 1985; Ennis, R., 1995, 1996 *the inquiry lesson* is appropriate to be applied to the buffer solution material.

There are several studies related to learning with the inquiry lesson model. Based on the results of the study shows that inquiry lessons are effective in improving students' critical thinking skills on human excretion system materials (Susilowati, Sajidan, & Ramli, 2018), improving students' critical thinking ability on human immune system material (Elisanti *et al.*, 2018), increase scientific creativity (Zulaichah *et al.*, 2021), increase activity, creativity, critical thinking (Hasan *et al.*, 2019), improve science literacy process dimensions and learning outcomes competencies skills in the material of the digestive system (Utomo, 2018), as well as improving the learning outcomes of chemistry on acid-base matter (Jauhariningsih, 2017). Based on the results of pre-experiments and literature studies, no one has studied the inquiry lesson model on the buffer solution material in improving students' critical thinking skills. Therefore, this study was conducted to recognize the Effectiveness of *The Inquiry Lesson Model On Buffer Solution Materials To Improve Students' Critical Thinking Skills*.

• METHOD

This research involved 70 students in one of the Bandar Lampung High Schools which consists of two classes, namely Class XI MIPA 2 with 35 students as the experimental class and Class XI MIPA 4 with 35 students as the control class. In the control class, the method used in learning was a lecture with the help of PowerPoint, while in the experimental class, an inquiry lesson model was used.

The types of data used in this study are main data and supporting data. The main data are test scores for critical thinking skills before the application of learning (pre-test) and test scores for critical thinking skills after the application of learning (posttest).

Supporting data in the form of student activity data. The source of data in this study is all students in the control class and experimental class.

The method of this study is an experimental study using The Matching Only Pre-test-Post-test Control Group Design. Matching in this study is that the research subjects are not randomly assigned but by matching subjects who are in the experimental group with the control group on the research variables. The purpose of matching is to ensure that both groups are equivalent and homogeneous in the variable (Fraenkel et al., 2012). The outlines can be shown in Table 1.

Table 1. Research Design

Research Class	Treatment			
Experiment	M	O	X	O
Control	M	O	C	O

Information:

M = *Matching*, which means that in this design there are matching samples

O = Pretes and postes given in both research classes

X = Treatment in the form of applying the *Inquiry Lesson* model

C = Control class with the application of lecture method learning

Before the treatment was applied, statistical matching was carried out in the control class and the experimental class by means of pretests. Then the pre-test results on the two study samples were statistically matched through a similarity test of two averages. Then in the experimental class, it was treated by applying the inquiry lesson model, and in the control class conventional learning was applied. Next, both classes are given a posttest. The research data were analyzed using n-gain calculations and parametric statistics with a t-test to see the effectiveness of the treatment given.

• RESULT AND DISCUSSION

The average score of the pre-test of students' critical thinking skills in the experimental class and control class can be seen in Figure 1.

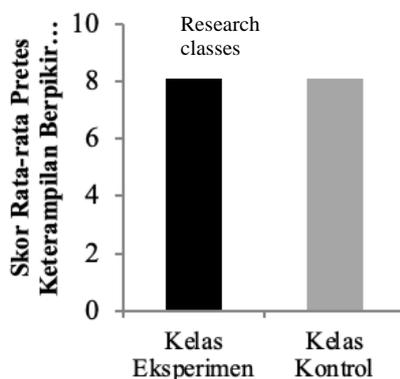


Figure 1. Pre-test average scores of students' critical thinking skills in control classes and experimental classes

Based on Figure 1, it is known that the average score of critical thinking skills pretests in the experimental class was 8.11, and in the control-class was 8.08. To find out whether the scores of students' critical thinking skills in these two classes did not differ significantly, a two-average similarity test was carried out, which had previously been tested for normality and homogeneity against students' pre-test scores in both research classes. The normality test is carried out by a chi-squared test with test criteria, accept H_0 if $\chi^2_{\text{calculated}} \leq \chi^2_{\text{tables}}$ with a level of $\alpha = 5\%$. After calculating the pre-test data of critical thinking skills, a score of $\chi^2_{\text{calculated}}$ and χ^2_{tables} can be obtained which can be seen in Table 2.

Table 2. Normality test results pre-test students' critical thinking skills

Kelas	Nilai		Kriteria Uji	Keputusan Uji
	χ^2_{hitung}	χ^2_{tabel}		
Kontrol	1,08	5,99	Jika $\chi^2_{\text{hitung}} < \chi^2_{\text{tabel}}$ maka terima H_0	Terima H_0
Eksperimen	2,11	5,99		Terima H_0

Based on Table 2, it appears that both classes have a value of $\chi^2_{\text{calculated}}$ smaller than χ^2_{table} . Using the test criteria, the test decision received H_0 , which means that these two classes of studies came from normally distributed populations. To find out whether the two classes of studies have homogeneous or inhomogeneous variance, a homogeneity test was carried out, with test criteria, accepting H_0 if $F_{\text{counts}} < F_{\text{table}}$ at the level of $\alpha = 5\%$. Based on the results of the homogeneity test on the pre-test score, an $F_{\text{calculated}}$ value for students' critical thinking skills was obtained at 0.024. This value is less than the F_{table} with a 3.98 correlation. So, the test decision is to accept H_0 , that is, both research classes have homogeneous variances.

Based on the results of the normality and homogeneity test showing that the data were normally distributed and had a homogeneous variance, a two-average similarity test was carried out using a parametric test (t-test), with test criteria accept H_0 if $t_{\text{calculation}} < t_{\text{Table}}$ with a degree of freedom $d(k) = n_1 + n_2 - 2$ at the level of $\alpha = 5\%$.

The results of the two average similarity tests obtained a $t_{\text{calculated}}$ value of 1.28 and a t_{table} of 1.99. Based on the test criteria, it can be concluded that the test decision receives H_0 , meaning that the average score of the pre-test of critical thinking skills of students in the experimental class is equal to the average score of the pre-test of students' critical thinking skills in the control class or both classes do not differ significantly. However, they are not significantly different, the two classes can be used as research classes.

The average score of post-tests of critical thinking skills of students in experimental classes and control classes is presented in Figure 2.

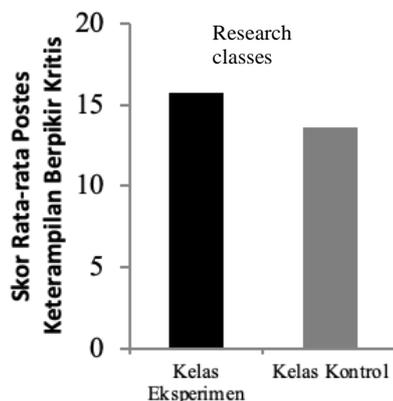


Figure 2. Pre-test average scores of students' critical thinking skills in control classes and experimental classes

In Figure 2, it can be seen that the average score of critical thinking skills posts in the experimental class was 15.71 while the average score of critical thinking skill posttests in the control class was 13.65. This shows that students in the experimental class who were taught with the inquiry lesson model had a greater average score of critical thinking skills posttests than the average score of posttests critical thinking skills of control class students taught with conventional learning.

The inquiry lesson model is said to be effective if the average score of critical thinking skills Post-test in the experimental class is statistically greater than the average score of critical thinking skills post-test in the control class. To find out whether the average score of the post-test differs significantly or not statistically, hypothesis testing is carried out using a two-average difference test. Before the difference test of the two averages is carried out, a normality test and a homogeneity test are first carried out against the post-test score to find out the parametric or nonparametric test to be carried out. The normality test on the post-test of critical thinking skills of students in the experimental class was carried out with the Chi-Squared test, with the criteria of the test accepting H_0 if $\chi^2_{\text{calculated}} \leq \chi^2_{\text{tabel}}$ with a level of $\alpha = 5\%$. Based on the results of the normality test on the post-test score, the scores of $\chi^2_{\text{calculated}}$ and χ^2_{tabel} for students' critical thinking skills in the experimental class were presented in Table 2.

Table 3. Normality test results critical thinking skills post-test

Kelas	Nilai		Kriteria Uji	Keputusan Uji
	χ^2_{hitung}	χ^2_{tabel}		
Kontrol	3,05	7,81	Jika $\chi^2_{\text{hitung}} < \chi^2_{\text{tabel}}$ maka terima H_0	Terima H_0
Eksperimen	4,88	7,81		Terima H_0

In Table 3 it is seen that the value of $\chi^2_{\text{calculated}}$ the critical thinking skills of students in the experimental class and in the acquired control class is smaller than χ^2_{table} . Based on the test criteria, the test decision received H_0 or in other words the post-test data of the two research classes, namely the control class and the expectation class came from the population normally distributed. To find out whether the two classes have homogeneous variances, a homogeneity test is carried out, with test criteria, accept H_0 if $F_{\text{calculated}} < F_{\text{table}}$ at the level of real 5%.

Based on the results of the homogeneity test calculation of the post-test score, a $F_{\text{calculated}}$ score for students' critical thinking skills was 2.32. The value is smaller than F_{table} which is 3.98. Then the test decision is to accept H_0 , that is, both research classes have a homogeneous variance.

Based on the results of the normality test and homogeneity test showed that the two classes of the study came from a population that was normally distributed and had a homogeneous variance, a different test of two was carried out. average using a parametric test (t-test). The t-test has the criteria of the accepted test H_0 if $t_{\text{calculated}} < t_{\text{table}}$ with degrees of freedom $d(k) = n_1 + n_2 - 2$ and the degree of $\alpha = 5\%$.

Based on the results of the two-average difference test, a $t_{\text{calculated}}$ value for students' critical thinking skills was obtained at 4.04. The value is greater than the t_{table} of 1.99. Based on the test criteria, it can be concluded that the post-test score data of the two classes reject H_0 , meaning that the average score of post-test of critical thinking skills of students in the class applied by the inquiry lesson model is greater than the average score of the

average score Post-test students' critical thinking skills in the classroom that conventional learning is applied so that it can be said that the inquiry lesson model is effective in improving students' critical thinking skills.

After obtaining data on students' pre-test and post-test scores of critical thinking skills, the data were used to calculate the *n-gain* of students in both research classes to see the improvement that occurred in students after the learning process. The average *n-gain* of critical thinking skills students is presented in Figure 3.

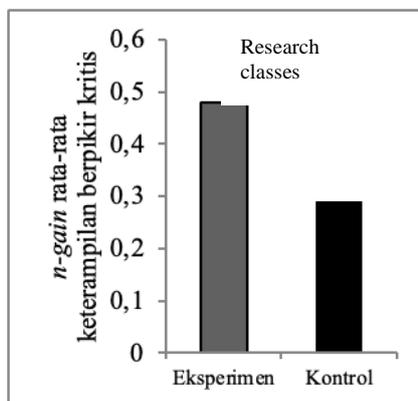


Figure 3. *n-gain* the average creative thinking skills of students in control classes and experimental classes.

In Figure 3, it can be seen that the average *n-gain* of the experimental class is 0.48 which is medium category and the average *n-gain* of the control class is 0.29 low category. Based on the results of the *n-gain* calculation, it can be concluded that the *inquiry lesson model* is effective in improving students' critical thinking skills.

The improvement that occurs in each critical thinking indicator can be done by analyzing the average score of pre-tests and post-tests. In the analysis of the average score of pre-test and posttest, students in the experimental class experienced an improvement in each indicator of critical thinking skills. The critical thinking skills studied include the skills of clarifying the basics, searching for information, referring, as well as clarifying further. The average scores of pretests and posttests of students' creative thinking skills on each indicator in the experimental class can be seen in Figure 4.

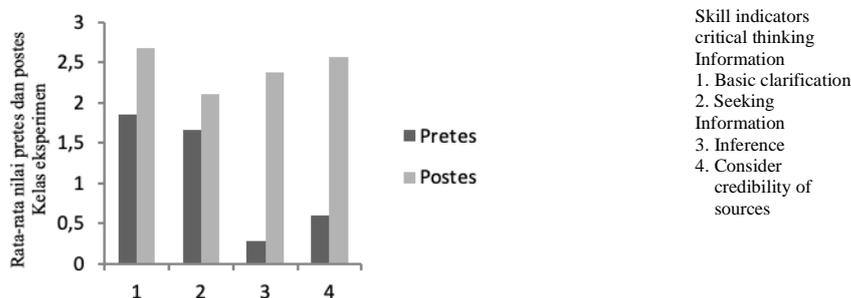
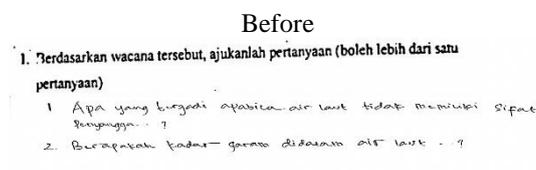


Figure 4. The average score of the pre-tests and post-test of each critical thinking indicator



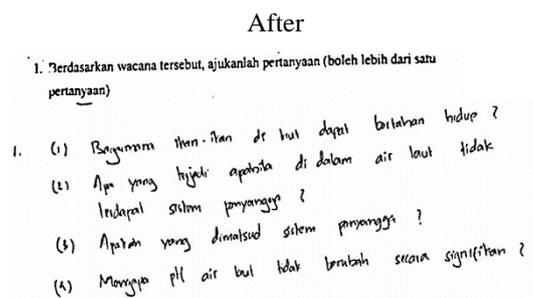


Figure 5. Basic Clarifying Skills Before and After Guidance.

Based on Figure 4, it can be seen that all indicators have improved compared to before learning. In Figure 5, it can be seen that the increase in students' ability in this case is the ability to ask questions. Zubaidah (2017) revealed the characteristics of a person who has critical thinking skills, one of which is that they can raise important questions and problems and formulate them clearly and just right. At this stage, students read the discourse given by the teacher, namely about buffer solutions in seawater and about the problem of consuming acid food and alkaline food. After reading the discourse, students write questions about what things they do not yet understand. After students are guided in the process of identifying problems and understanding the root causes in the discourse, students will better understand how to make appropriate and directed questions. Likewise, for the second indicator, namely the stage of finding information and considering the credibility of sources of information, students are more targeted in exploring information that is in accordance with the previously asked questions with credible sources as shown in Figure 6.

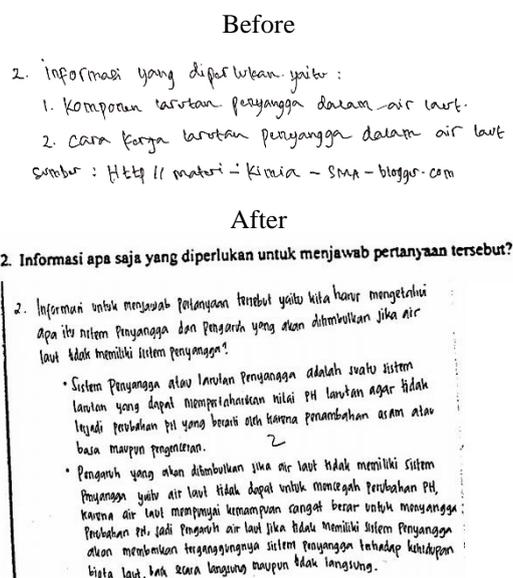


Figure 6. Skills to Gather Information Before and After Guidance

Students conduct literature studies by reading other people's research related to the nature of buffers in seawater, in addition to that, students also conduct buffer solution experiments/ experiments. This allows students to combine their old knowledge with new knowledge and develop information-gathering skills (Akinoglu & Tandogan, 2007).

The skill of referring has increased the most compared to the skills of seeking

information, inference, and considering the credibility of sources as shown in Figure 7. This is because the complexity of the thinking skills used is simpler. At this stage, students carry out information processing to find the relationship between one information and another, so that they can draw various conclusions from the linkage of information said (Asabe & Joseph, 2016). This increase in ability can be seen in the suitability and accuracy of the conclusions made with the objectives of the experiment.

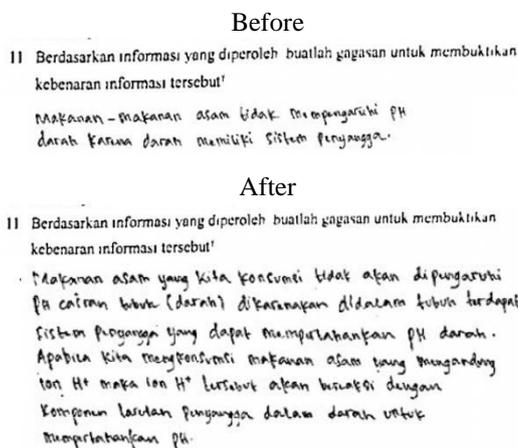


Figure 7. Inference Skills Before and After Guidance

In addition to a significant increase in the average score of post-test and n-gain of critical thinking skills of moderately categorized students in the experimental class, the relatively high Post-test score is also supported by student activity data. The activities of the students who are suspended are activities during the teaching and learning process. The average score of student activity on each activity assessment criterion applied in the inquiry lesson model can be seen in Figure 8

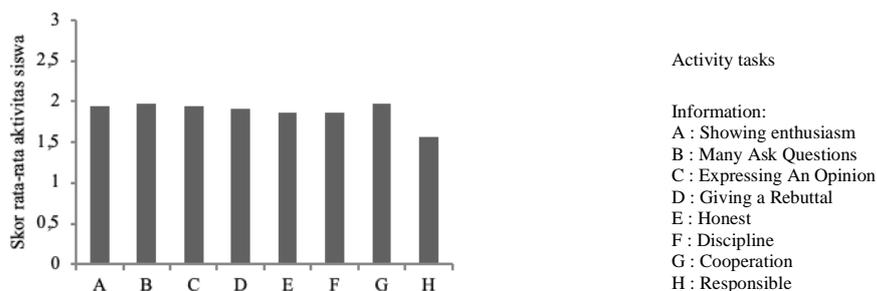


Figure 8. Average student activity score on each task

Based on Figure 8, it can be seen that the highest average student activity score is found in tasks B and G, which is asking a lot and collaborating. While the lowest average score is found in task H.

• **CONCLUSION**

Based on the results of calculations and discussions, it can be concluded that the inquiry lesson model is effective in improving students' critical thinking skills. It can be seen from the percentage of the average n-gain of critical thinking skills of students in the moderate category experimental class, as well as the average score of critical thinking skills in the experimental class is greater than that of the control class.

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