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The Effectiveness of Using Problem Based Learning through Audio Visual Media to Improve Students' Critical Thinking in Colloidal Material

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Abstract: The Effectiveness of Using Problem Based Learning through Audio Visual Media to Improve Students' Critical Thinking in Colloidal Material. *This research aims to the effectiveness of using audio-visual media based on problem-based learning to improve students' critical thinking ability on colloidal material course. The population of this research is XI MIPA students at SMAN 14 Bandar Lampung. The sample of this research is XI MIPA 6 as the experimental class and XI MIPA 4 as the control class. In this research, the method used is quasi experiment with the pretest-posttest control group design. The effectiveness of using problem based learning through audio visual media to improve students' critical thinking ability on colloidal materials is measured by the significant average of the n-Gain score between experiment and control class. The result shows that the n-Gain score of students' critical thinking in the experimental class is 0.81 that is categorized "high", and for the control class is 0.63 that is categorized "medium". The effect size test results show that problem based learning through audio visual media has a "big" impact in improving students' critical thinking ability on colloidal materials. Based on these results, it can be concluded that problem based learning through audio visual media has a positive impact and effective in improving students' critical thinking ability on colloidal materials.*

Keywords: *effectiveness, audio visual media, problem based learning, critical thinking, colloid.*

Abstrak: Efektivitas Penggunaan Media Audio Visual Berbasis Problem Based Learning untuk Meningkatkan Kemampuan Berpikir Kritis Siswa pada Materi Koloid. Penelitian ini bertujuan untuk mendeskripsikan efektivitas penggunaan media audio visual berbasis problem based learning untuk meningkatkan kemampuan berpikir kritis siswa pada materi koloid. Populasi dalam penelitian ini adalah siswa kelas XI MIPA SMA Negeri 14 Bandar Lampung. Sampel dalam penelitian ini yaitu kelas XI MIPA 6 sebagai kelas eksperimen dan kelas XI MIPA 4 sebagai kelas kontrol. Pada penelitian ini digunakan metode kuasi eksperimen dengan desain pretest-postest control group. Efektivitas penggunaan media audio visual berbasis problem based learning untuk meningkatkan kemampuan berpikir kritis siswa pada materi koloid diukur dari perbedaan rata-rata nilai n-Gain yang signifikan antara kelas kontrol dan eksperimen. Hasil

penelitian menunjukkan bahwa nilai n-Gain kemampuan berpikir kritis siswa pada kelas eksperimen sebesar 0.81 termasuk ke dalam kriteria "tinggi" dan pada kelas kontrol sebesar 0.63 termasuk ke dalam kriteria "sedang". Hasil uji effect size menunjukkan bahwa media audio visual berbasis problem based learning berpengaruh "besar" dalam meningkatkan kemampuan berpikir kritis siswa pada materi koloid. Berdasarkan hasil penelitian tersebut, dapat disimpulkan bahwa media audio visual berbasis problem based learning berperngaruh positif dan efektif untuk meningkatkan kemampuan berpikir kritis siswa pada materi koloid.

Kata kunci: efektivitas, media audio visual, problem based learning, kemampuan berpikir kritis, koloid.

▪ INTRODUCTION

The 21st century is identified with technology and information that grows rapidly so it affects every aspect of life. To prepare students in the 21st century to be able to compete in the future, all the education around the world emphasizes several ability to face the challenges of the development of the 21st century. These ability known as 4Cs include critical thinking and problem solving, collaboration, communication, and creativity. Integrating 21st century ability into the learning process effectively becomes very important which aims training and preparing students to master these ability, especially critical thinking (Sari and Trisnawati, 2019).

Critical thinking is a skill that includes the ability to access, analyze, synthesize the information that can be learned, trained, and mastered (Redecker et al, 2011). Critical thinking ability is a fundamental ability in the learning process in 21st century. Considering the importance of critical thinking ability to face this era, it is expected that students will be creative, cultivated, and mastering these critical thinking ability. In fact, based on the results of the interviews with the chemistry teachers at SMA Negeri 14 Bandar Lampung, students' critical thinking ability are still poorly trained. One of the causes is the implementation of the online learning. This online learning caused by the Covid-19 pandemic which aimed to prevent the transmission of the disease.

Based on the interview, it was also found that some platforms such as Telegram, Whatsapp, and Google Meet support the online learning class during the pandemic. The three platforms are used by the teachers to provide course materials, discussion, and give assignments in the learning process. The problem that occurs in the online learning is that the students tend to act according to the instruction by the teachers only, and become independent in the learning progress because they have to build the knowledge by themselves. Another problem is online learning also tends to be teacher-centered, monotonous, and makes students bored during the learning process so that it is less effective. As a result, students have the lack of ability to generalize, connect concepts with other related concepts, and apply the concepts from the material that they have learned to their daily life. The effect is students have low critical thinking ability. Thus, this character is not suitable to the expected learning character of the 21st century.

Materials in chemistry courses require critical thinking ability to master, one of the examples is colloidal material. Colloidal material is closely related to everyday life. We find many applications of colloidal properties in the fields of industry, agriculture, and medicine (Sudarmo and Mitayani, 2016). In colloidal materials there are concepts that require deep understanding and memorization from students such as understanding of colloids in general, types of colloids, colloidal properties, and ways of making colloids. Colloidal course is an important material, because of its relation with our daily life, but students are only taught by the teacher to simply memorize without making them understand the concept in depth understanding. This can make students less interested in learning it (Totiana et al, 2012). Colloidal material is also often considered boring and uninteresting by the students as it taught in a conventional way without having variations to learn it (Sari and Vebrianto, 2017). As the result, students are less interested in the material, passive in discussions, and the worst is low mastery of concepts and low critical thinking ability (Kristina, 2020). Problem based learning can be an alternative learning model to train students' critical thinking ability. Problem based learning is a learning method where the main center is students or student-centered learning. In the problem based learning, students are guided to solve a problem on their own, and the teacher guides students as the facilitators (Amir, 2013).

Learning use problem based learning (PBL) models can be packaged more attractively with the aim of attracting students' attention. To make it more interesting, audio visual media can be used to support the PBL model (Susilowati et al., 2018). Learning media is a tool that supports the learning process and aims to clarify the meaning of the information conveyed so that students can achieve learning objectives with good and perfect results (Kustandi et al., 2013). The use of audio visual media as a tool in the classroom learning process is useful for motivating students to improve their learning outcomes (Sidi and Mukminan, 2016).

Previous researches concluded that problem based learning is an effective method for learning chemistry in improving students' critical thinking and problem solving ability in South Africa (Aidoo et all., 2016). Subsequent research shows that the increase in student learning outcomes through PBL models assisted by audio visual media on acid-base materials is higher than student learning outcomes through PBL models assisted by real laboratories (Hikmi et al., 2019).

Based on the description above, this article will describe the effectiveness of using problem based learning through audio visual media to improve students' critical thinking ability on colloidal materials.

▪ METHOD

This research was conducted at SMAN14 Bandar Lampung on March 29 – April 19, 2021. The population used in this research was all XI grade students of MIPA department at SMAN14 Bandar Lampung which has seven classes. The sample was class XI MIPA 4 as the control class, and class XI MIPA 6 as the experimental class. The sample was obtained by using a purposive sampling technique assisted by a chemistry teacher at SMAN 14 Bandar Lampung. The method used in this study is a quasi-experimental method using a pretest-posttest control group design. The design in this study finds the differences in pretest and posttest between the control and experimental classes, before and after getting the treatments. The design of this research can be seen in Table 1.

Table 1. Research design pretest-posttest control group

Experimental class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_1	C	O_2

Note:
O_1 : Experimental and control classes are given a pretest
C : The control class is taught with a problem based learning model without audio visual media
X_1 : The experimental class is taught using problem based learning through audio visual media.
O_2 : Experimental and control classes are given posttest

The independent variable in this research is the use of problem based learning model without audio visual media and problem based learning through audio visual media. The dependent variable in this study is the ability to think critically. The control variable in this study is the given material (colloidal system).

The stages carried out in the implementation of this research are (a) the preliminary stage, (b) the preparation stage, (c) the implementation stage, and finally (d) the final stage of the research. The first stage, namely the preliminary stage, was carried out by the procedure of (1) conducting a literature study of related research and (2) observing and determining the research subject. The second stage is the preparation stage which includes preparing learning tools such as syllabus, lesson plans, worksheets, and research instruments in the form of critical thinking pretest-posttest questions and student response questionnaires towards the attractiveness of problem-based learning through audio visual media. The third stage is the implementation stage. At this stage, the research was conducted in two classes, they are class of XI MIPA 4 as the control class and the class of XI MIPA 6 as the experimental class. The sequence of steps at the implementation stage were (1) giving pretest questions of critical thinking to the experimental and control classes; (2) carry out learning activities with the subject material of colloid system. Learning activity was held online. In the experimental class, problem based learning through audio visual media will be used. While in the control class, learning activities was using a problem based learning model without audio visual; (3) provide students response questionnaires towards problem based learning through audio visual media; (4) provide the post-test questions of critical thinking for the experimental and control classes. The last stage is the final stage of research carried out with the procedures (1) data analysis; (2) writing discussion, and; (3) write a conclusion.

The result data processed with the assist of SPSS 23 version a software for Windows and Microsoft Excel. Data analysis of students' critical thinking ability on colloidal material can be seen from the n-Gain value obtained from the pretest and posttest scores. The results of the pretest and posttest obtained are still in the form of a score, not a value, it furthermore should be converted into the value. The pretest and posttest scores were obtained by the following formula:

$$\text{Score} = \frac{\text{Total score}}{\text{Maximum score}} \text{ x } 100$$

The increase in critical thinking ability is gain by the scores obtained by the students in the pretest and posttest, the n-Gain value can be calculated using the formula:

$$n \text{ score} - Gain = \frac{\text{posttest score} - \text{pretest score}}{100 - \text{pretest score}}$$

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

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

After processing the data, an analysis of the n-Gain value was done using SPSS 23.0 version to obtain normality, homogeneity, and differences in the two averages of students' critical thinking abilities from the two samples. The normality test of the data was tested with the Kolmogorov Smirnov Test with a significant level of > 0,05. Homogeneity test of the data was used the Levene Test with a significant level > 0,05. The difference test of the two averages was carried out using an independent sample t-test for the average n-Gain score of students' critical thinking abilities. Based on the test results of the difference between the two averages of students' critical thinking ability,

then the effect size calculation was carried out to find out how much influence the problem based learning through audio-visual media brought to improve students' critical thinking ability. The effect size relates to the success rate of the treatment applied in the lesson. The effect size formula according to Jahjouh (2014) is:

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

▪ RESULT AND DISCUSSION

Based on research that has been conducted at SMAN 14 Bandar Lampung, the main data obtained were in the form of pretest and posttest results of students' critical thinking ability in the control and experimental classes, and supporting data in the form of student response questionnaires regarding problem based learning through audio-visual media.

After conducting the research, the results of the pretest-posttest of the students' critical thinking ability were obtained. The average of the pretest-posttest results of students' critical thinking ability in the control and experimental classes can be seen in Figure 1 below:

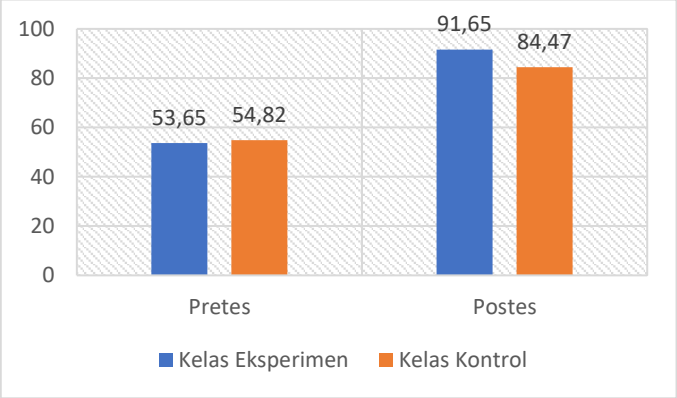

Figure 1. The Average Score of Students' Critical Thinking

Based on Figure 1, the average pretest value of the experimental class is 53.65 and the control class is 54.82. There is no big difference between the pretest score of the experimental class and the control class because both classes have the same baseline knowledge. The posttest results of the experimental class had a higher score with the average of 91.65 compared to the control class with an average posttest score of 84.47. There was a huge increase in the average score from pretest to posttest of students' critical thinking ability. The experimental class had an increase of 38.00 while the control class was 29.65.\

The average score of n-Gain obtained in this data analysis is shown in the graph in Figure 2 below.

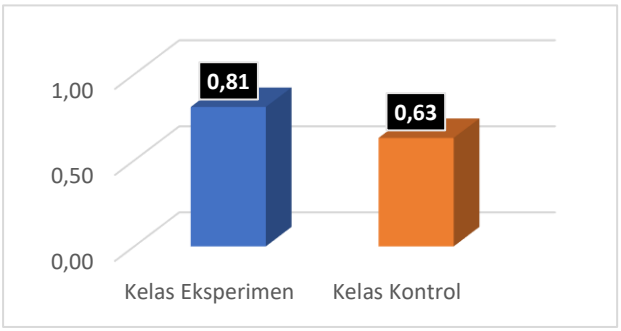

Figure 2. The Average *n-Gain* Score of Students' Critical Thinking

Based on Figure 2, the average n-Gain score obtained by the experimental class is 0.81 and the average n-Gain score for the control class is 0.63. Take a look from this, it can be seen that the average n-Gain score of students' critical thinking ability in the experimental class is in the "high" criteria, while the control class has the "medium" criteria. Based on these data, it can be seen that the average n-Gain score for the experimental class is higher than the average n-Gain score for the control class. It can be concluded that learning using problem based learning through audio visual media is effective for improving students' critical thinking ability on colloidal material.

Based on the results of the pretest and posttest, the percentage of achievement of each indicator of students' critical thinking ability were also obtained in the control and experimental classes. The percentage of achievement of each indicator of students' critical thinking ability can be seen in Table 2 below:

Table 2. Percentage of Achievement of Indicators Students' Critical Thinking Ability

No	Indicator of Critical Thinking Ability	Experimental class		Control class	
		Pretest (%)	Postest (%)	Pretest (%)	Postest (%)
1	Analyzing Arguments	50.6%	92.4%	52.4%	86.5%
2	Observing and considering the results of the observations	45.3%	88.2%	49.4%	79.4%
3	Making deductions and considering the results of it	55.3%	99.4%	55.3%	94.7%
4	Making inductions and considering the results	78.2%	95.9%	63.5%	86.5%
5	Identifying assumptions	38.8%	82.4%	53.5%	75.3%

Referring to the data contained in Table 2, it shows that the highest indicator in the experimental class pretest at 78.2% and the control class at 63.5% is an indicator of

making induction and considering the results of it. The lowest indicator in the experimental class pretest is identifying assumptions of 38.8% while in the control class, observing and considering the results of observations with a percentage of 49.4% is the lowest.

Based on Table 2, it also can be seen that the achievement of the highest indicator for the post-test of critical thinking ability in both the experimental class (99.4%) and the control class (94.7%) is making deductions and considering the results of it. The lowest indicator of both the experimental class (82.4%) and the control class (75.3%) is identifying assumptions.

Comparison of achievement indicators of students' critical thinking ability based on posttest results in the experimental class and control class is presented in Figure 3 below:

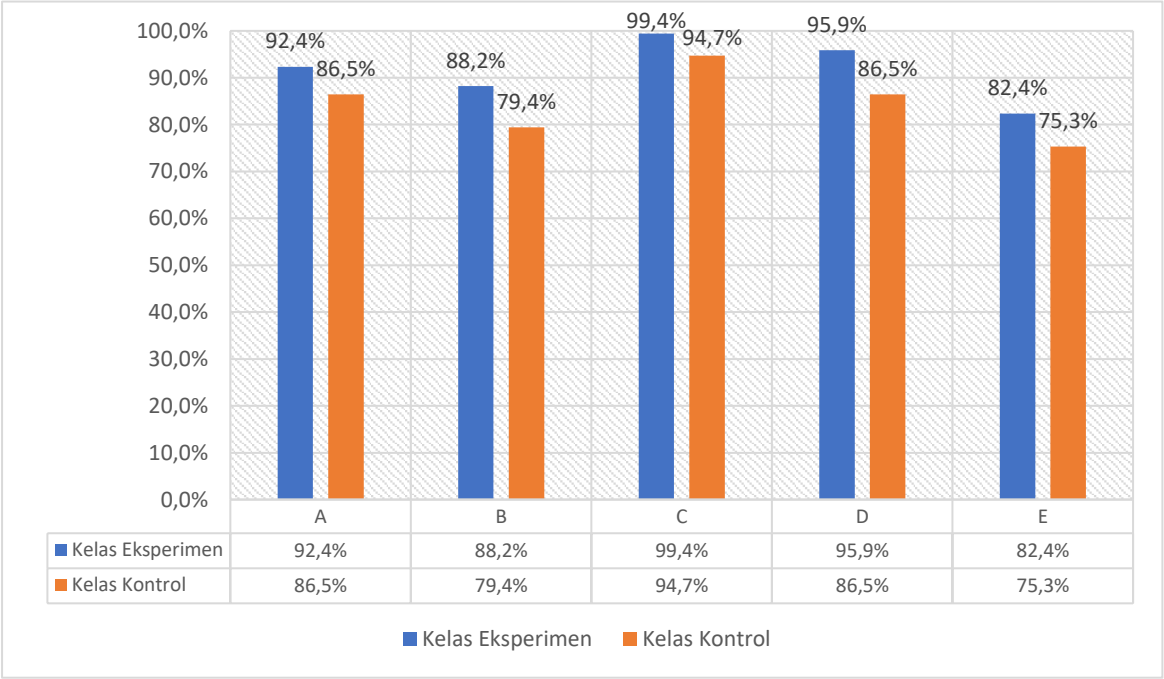

Figure 3. Comparison of Achievement of Students' Critical Thinking Indicators in Control and Experiment Class

Description: A = Analyzing arguments, B = Observing and considering the results of observations, C = Making deductions and considering the results of the deductions, D = Making inductions and considering the results of the inductions, E = Identifying analysis.

Figure 3 shows that the comparison of the percentage of achievement indicators of students' critical thinking ability in colloidal material in the experimental class is higher than the control class. This means that the indicators of critical thinking ability of students in the experimental class are generally very good, this shows that problem based learning model through audio visual media can be used to train students' critical thinking ability in the experimental class on colloidal material.

The effect of learning using problem based learning through audio-visual media is also seen from students' interest responses in the learning class. The analysis of this data was measured through students' response questionnaires towards problem based learning through audio visual media. This analysis aims to measure student responses to the application of problem based learning through audio visual media. in learning. Figure 4

below can represent how the percentage of student responses toward the application of problem based learning through audio visual media:

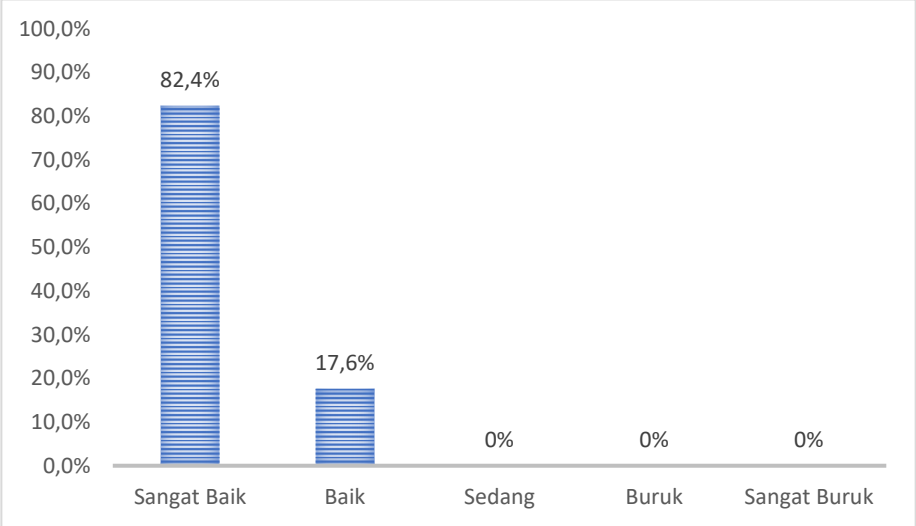

Figure 4. Percentage of student responses to problem based learning through audio visual media

Based on the graph in Figure 4 above, it shows that 82.4% of students responded with "very good" criteria, and 17.6% of other students responded with "good" criteria. This means that students responded very well to the application of problem based learning through audio visual media in learning.

The results of the n-Gain normality test of the students' critical thinking ability in the experimental class have a significant score of 0.165 and the results of the control class have a significance score of 0.160. Based on this, both the experimental class and the control class have a score of Sig. > 0.05. It can be sum up that H0 is accepted and H1 is rejected which means that the research data obtained came from a normally distributed population.

The results of the n-Gain homogeneity test of the students' critical thinking ability in the experimental and control classes have a significance score of 0.067, which means the score of Sig > 0.05. It can be concluded that H0 is accepted which means that the research data obtained came from a population with a homogeneous variance.

The results of the normality test and homogeneity test state that the two samples are normally distributed and came from homogeneous variance, so based on this, the test used to test the parametric hypothesis by using the two-average difference test is the Independent Sample T-Test test. This test was conducted to determine whether the average n-Gain score of students' critical thinking ability in the experimental class was higher than the average n-Gain score of students' critical thinking ability in the control class. The results of the Independent Sample T-Test on the score of n-Gain critical thinking ability of experimental class and control class show that the significance score is less than 0.05. Thus, the test decision received is H1 accepted and H0 is rejected which means the average score of n-Gain of the critical thinking ability of students in the experimental class who applied problem based learning through audio visual media is higher than the average score of n-Gain. The critical thinking ability of students in the control class who applied the problem based learning model without audio visual media.

This shows that learning using problem based learning through audio visual media that has been carried out is effective in improving students' critical thinking ability on colloidal material.

The effect measurement of problem based learning through audio visual media in improving students' critical thinking ability was tested through the Effect Size test. The result in the experimental class that used problem based learning through audio visual media in learning, has an effect size score of 0.939 with the criterion of "big". Meanwhile, the control class that used a problem based learning model without audio visual media has an effect size score of 0.911 with the "big" criteria. Based on the μ score, the effect size in the experimental class has a greater value than the control class. Based on the results of the effect size test, 93.9% of the increase in students' critical thinking ability in the experimental class is influenced by learning using problem based learning through audio visual media, and 91,1% of the increase in students' critical thinking ability in the control class is influenced by learning using problem based learning without audio visual media. This means that learning in the experimental class using problem based learning through audio visual media on colloidal material has a greater influence than learning without the audio visual media.

▪ CONCLUSION

Based on the results analysis of the research and discussion, it can be concluded that: (1) The use of problem based learning through audio visual media is effective to improve students' critical thinking ability. This can be told from the significant difference between the n-Gain score in the experimental class and the control class, where the experimental class has a higher average in n-Gain score than the control class; (2) the effect size of using problem based learning through audio visual media to improve students' critical thinking ability is in the "big" criteria, so that it has a positive effect in improving students' critical thinking ability on colloidal material; (3) students' responses to the use of problem based learning through audio visual media in learning are very good, and the students prefer learning using audio visual media.

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