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THE EFFECT OF DISCOVERY LEARNING MODEL TO IMPROVING CRITICAL THINKING SKILLS XI GRADE STUDENTS ON ACID-BASE MATERIAL

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Abstract

Critical thinking ability is a 21st century skill that is very necessary and must be improved. Discovery Learning is one method that can develop critical thinking skills. This study aims to explore the impact of the Discovery Learning model on improving students' critical thinking skills in the Acid Base subject. This research was conducted in the Acid Base lesson of class XI MIPA at SMA Negeri 2 Tualang in the 2022/2023 Academic Year. This study applies a quasi-experimental method with a pretest-posttest design and non-equivalent control group designs. The population in this study included all class XI MIPA students at SMA Negeri 2 Tualang. The number of research samples was 31 students, consisting of a control group and an experimental group. In the experimental group, special treatment was given in the form of the Discovery Learning model. The sampling method in this study applied purposive sampling. This research tool consisted of 11 essay test questions, and data analysis was carried out using the t-test and the Kp test. The t-test showed a significance value of 0.001 which was smaller than 0.05, so it can be concluded that Ha is accepted and H0 is rejected. It could be concluded that there was an effect in the form of critical thinking ability increase of students taught by using Discovery Learning model on Acid Base lesson with the coefficient effect 10.3%.

Keywords : Effect, Discovery Learning, Critical Thinking Ability, Acid Base

Introduction

The 21st century is called the century of openness or the “century of globalization”, which means that human life in this century has experienced many fundamental changes that are different from the way of life in previous centuries. In this 21st century, technological advances have entered various aspects of life, including education. The increasingly rapid development of globalization and advances in science and technology require the Indonesian nation to have competitiveness and competitive advantages. This is due to the globalization era as a problem related to people's ability to think at a high level (Pusparini et al., 2018).

High-level thinking is one of the abilities that students need to have in order to face the increasingly rapid competition in the current era of globalization. Higher order thinking includes critical, logical, reflective, metacognitive and creative thinking (Miterianifa et al., 2021). Indeed, critical thinking skills have a very vital role in education and the work environment. Critical thinking is very helpful in dealing with various problems or challenges related to learning that they face in everyday life (Taher et al., 2018).

If students' critical thinking skills are not equipped, built and developed early on, then they will not be able to receive, process, analyze and evaluate the information needed to solve some of today's world problems (Nurjaman, 2020). The problem that arises is the low critical thinking ability of students caused by internal and external factors. Internal factors include the assumption in students that chemistry lessons are difficult to understand and comprehend. External factors are that in the learning process, teachers only use the same learning model for each material taught so that there is no variation in other learning models used (Kalsum et al., 2019). The results of interviews with teachers at SMAN 2 Tualang show that students' critical thinking skills have not been honed properly, this can be seen in the learning process, where students are not yet able to understand, explain, give meaning to data or information, analyze, evaluate, and draw logical conclusions.

Critical thinking skills are not only possessed by those who work in certain fields. Critical thinking is beneficial for everyone. Some of the benefits of critical thinking include clear and rational thinking, finding new ideas and opportunities, improving adaptability and presentation skills, increasing creativity, improving language skills, and self-development (Susanti et al., 2022).

The goal of critical thinking is to analyze an idea or view, including making decisions or thoughts based on the views expressed. Students will be taught how to choose various opinions to distinguish between relevant and irrelevant, and right and wrong. Their critical thinking skills can help them draw conclusions by considering data and facts in the field (Sutoyo & Priantari, 2019).

The factor that causes students' low critical thinking skills is because generally the teaching and learning process only focuses on the teacher, where the teacher only explains the material, while students only listen and note down what the teacher says. According to Polli, one of the causes of students' low analytical skills is that learning in schools still applies a teacher-centered system, where teachers are used as the only source of knowledge (Polli et al., 2022).This learning does not improve students' critical thinking skills and students' low understanding of the material presented, especially in chemistry, because chemistry material is abstract so that chemistry material is not liked (Hidayat et al., 2020). One of the materials in class XI that students consider difficult is acid-base material, because in the acid base material there are quite complex concepts. Acid base is also a material that is related to other materials, including ion equilibrium and pH of salt solutions, buffer solutions, and acid base

titration. Chemistry has sequential concepts, if students do not understand the basic concepts, then students will have difficulty in understanding the concept of chemical material. The main competency of acid-base material is to describe acid-base theories by determining the nature of the solution and determining or calculating the pH of the solution. Because basically this acid-base material is only delivered to students in oral form, teachers still use conventional learning models in the form of lectures so that students only remember the concepts given. This is in line with the opinion of Nugrahaeni, et al., who said that in chemistry learning it is expected not only to provide as much knowledge as possible to students, but to be able to stimulate thinking, be scientific and creative. In fact, memorizing concepts alone does not support students to be able to improve critical thinking skills.

The quality of the learning process can be seen from the ability of students to think critically in the learning process carried out or from the learning outcomes themselves, it is necessary to improve the quality of learning provided in schools (Yunita et al., 2018). In general, learning in schools does not direct students to actively acquire knowledge and critical thinking skills because some teachers still use conventional learning models so that students' critical thinking skills are often lacking (Hayati et al., 2019, p. 30). During the chemistry learning process, educators do not have to provide knowledge directly, but can stimulate students to think first (Nugrahaeni et al., 2017).

Chemistry and critical thinking are two things that cannot be separated. Basically, chemistry is understood through critical thinking and vice versa, because critical thinking is taught through chemistry learning (Astuti et al., 2018). One of the supporting factors for the success of the chemistry learning process is the need for teachers to help students improve their critical thinking skills and learning outcomes through learning models that are conducive to active student learning (Amijaya et al., 2018). The discovery learning model is an educational strategy that can integrate all students' abilities in searching for and finding information to solve problems they encounter logically, critically, and analytically (Kusumaningtyas et al., 2020).

This type of learning falls into the category of discovery learning. The learning process is carried out to grow and develop students' desire to learn, gain knowledge, and create their own concepts (Bayharti et al., 2019). According to Hidayat, discovery learning has advantages, namely making students more active in learning, students can really understand the concepts that have been learned and the answers obtained

create a sense of satisfaction in students. Discovery learning can also create a sense of pleasure in students and arouse students' curiosity, motivating students to continue working until they find the answer (Hidayat et al., 2020). The teacher's job is to provide guidance through suggestions, questions, and instructions to help students stay motivated in understanding the concepts they always remember. However, students are not only able to remember, but also understand and apply them in their daily lives.

The application of the discovery learning model in the educational process can improve learning outcomes, research skills, mathematical analogy skills, reduce misconceptions and improve concept understanding, and improve critical thinking skills (Ellizar et al., 2019). This is proven by the results of the research conducted that the increase in students' critical thinking skills in acid-base material using the discovery learning model. This is also in line with the results of research conducted by Kusumaningtyas, it is known that learning using the discovery learning model has been proven to improve students' critical thinking skills (Kusumaningtyas et al., 2020).

Methods

This study used a quasi-experiment method with a pretest-posttest research design, non-equivalent control group design (Kurniawati, 2019). This research was conducted at SMA Negeri 2 Tualang, in January in class XI MIPA even semester of the 2022/2023 school year. The object of this study is to improve students' critical thinking skills. The subjects of this study were students of class XI MIPA 1 and XI MIPA 5 of SMA Negeri 2 Tualang. The population in this study were all students of class XI MIPA of SMA Negeri 2 Tualang, totaling 6 classes with a total of 186 students. Sampling in this study used purposive sampling, namely sampling by considering certain characteristics (Mardianli et al., 2022). The purpose of taking samples like this is so that research can be carried out effectively and efficiently, especially in terms of supervision, subject conditions and research time.

In this study, the techniques used to collect data in the study were tests, documentation and observation. There are two tests in the form of pretest and posttest. Pretest is an initial test conducted to obtain data on experimental and control class students before using the discovery learning model and posttest is a test conducted to obtain data on experimental and control class students after using the discovery learning model in the experimental class and the conventional model in the control class. Documentation in this study is in the form of relevant data at the time of

research and observation sheets of teacher activities in the teaching and learning process.

The instrument used in this study is a test that measures students' critical thinking skills in the form of an essay test, which has been adjusted to the indicators of critical thinking skills as well as Core Competencies and Basic Competencies in the Content Standards for Chemistry Curriculum 2013 Acid-Base material. As for the others, such as the observation sheet for the implementation of the Discovery Learning learning model, it is as a support and reinforcement or evidence that this research was really carried out. Observation is used to obtain the level of practicality of the developed learning devices. Observation sheets are used to observe teacher activities in the teaching and learning process (Miterianifa, 2014).

Quantitative analysis was used to analyze the data of this study. This was done by calculation because it is related to numbers, namely the results of tests given to students (Sugiyono, 2015). n the initial stage, the data collected was tested for normality and homogeneity. Data is said to be normal if the Sig value is > 0.05 and is said to be abnormal if the Sig value is < 0.05. Meanwhile, the data is said to be homogeneous if the calculated significance value is greater than the 5% significance level or (Sig value > 0.05). Next, a t-test was conducted to test the hypothesis using an independent sample t-test with the help of SPSS version 29 software with the criteria for hypothesis testing H_0 rejected and H_a accepted if Sig < 0.05. Then proceed with the K_p test, which is the coefficient of influence to see how much influence the treatment has applied.

Results and Discussion

This study aims to determine the impact of the application of the Discovery Learning learning model on the critical thinking skills of grade XI students on acid and base material. This study uses four indicators to assess students' critical thinking skills. Critical thinking ability indicators used: 1) Interpretation, 2) Analysis, 3) Evaluation, and 4) Inference. The experimental class applies the Discovery Learning learning model, while the control class carries out traditional learning through lecture and question and answer methods. In this study, a pretest was first conducted on the pretest and posttest data, then continued with hypothesis testing and influence coefficient testing. This was done on the pre- and post-test data of the control and experimental classes using the Independent Samples T-test using SPSS software version 29.

The results obtained from the pretest data show that the samples taken have a normal distribution of variance (Shapiro Wilk) and homogeneous variance (Levene's test), based on the pretest value in the control class which is normally distributed with a Sig value of 0.151> 0.05, while the pretest value of the experimental class is also normally distributed with a Sig value of 0.286> 0.05, meaning that both sample classes have Sig values> 0.05, and the pretest data of the control and experimental classes are homogeneously distributed with a sig value. 0.121> 0.05. And the hypothesis test shows that H_0 is accepted, it can be interpreted that between the experimental class and the control class there is no difference in the average ability of students. So that both classes are worthy of being used as samples in the study.

Furthermore, the test results on the posttest data showed that the data was normally distributed and not homogeneous. Based on the posttest value in the control class, it was normally distributed with a Sig value of 0.813> 0.05, while the posttest value of the experimental class was also normally distributed with a Sig value of 0.226> 0.05, meaning that both sample classes had Sig values> 0.05. The posttest data of the control class and the experimental class were not homogeneously distributed with a sig value. 0.001 <0.05. In the independent sample t-test analysis test, the homogeneity test is not an absolute requirement, if there is data that is not homogeneous, the independent sample t-test can still be carried out. Results of the hypothesis test showed that Sig <α, which is 0.001 <0.05 at a significance level of 5%, so H0 is rejected and Ha is accepted. This means that there is a difference in the average critical thinking ability between students in the experimental class and the control class. This shows the influence of the discovery learning learning model on students' critical thinking abilities. The impact of the discovery learning learning model can be seen from the variation in the average value of critical thinking abilities based on the following post-test data:

Table 1. Average Posttest Score of Critical Thinking Ability

Description	**Posttest**	
	Control Class	**Experiment Class**
Highest Score	70	91
Highest Lowest	27	70
Average	**44**	**81**

Based on the data above, it can be seen that the average posttest score of critical thinking skills in the control class was 44, while the average critical thinking skills in the experimental class reached 81. This shows that there is an average difference between the control class and the experimental class. The difference in the average value of students' critical thinking skills is due to the learning model applied in the experimental class, namely using the discovery learning model and in the control class only using a conventional learning model. In the experimental class, special treatment was given, namely using the discovery learning model, during the learning process the experimental class used 6 syntaxes, namely: 1) Providing stimulus or stimulation, 2) Identifying problems or problem statements, 3) Collecting data or data collection, 4) Data processing or data processing, 5) Proving or verifying, 6) Drawing conclusions or generalizations (Muvid et al., 2020). While the control class only used conventional learning where the teacher explained the material from beginning to end to students, then students were asked to listen and understand then at the end of the material they would be given practice questions that would be worked on by the students.

This indicates that learning using the discovery learning model is better in building students' critical thinking skills compared to learning using conventional models. Based on the data obtained, it shows an r^2 value of 0.103 so that the Kp value obtained is 10.3%. So it can be concluded that in this study there is an influence of the discovery learning model on increasing the critical thinking skills of class XI students on acid-base material by 10.3%. This is in line with the research conducted by Kusumaningtyas, which found that learning using the discovery learning model was proven to improve students' critical thinking skills (Kusumaningtyas et al., 2020). The posttest scores of the control class and experimental class can be seen in the image below.

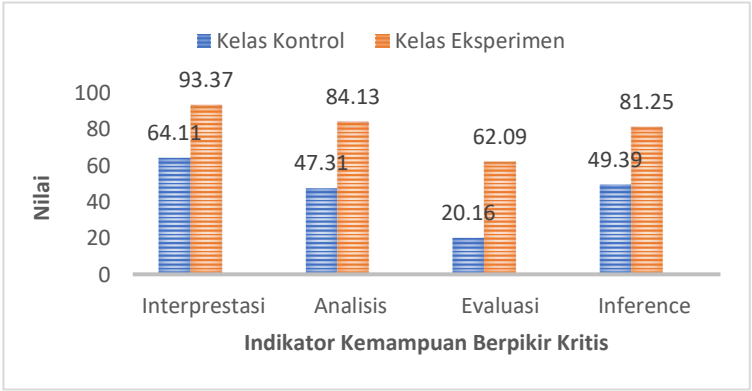

Figure 1. Percentage of Posttest Scores of Students' Critical Thinking Skills

From the Figure below, it can be seen that the posttest score of the experimental class is higher than that of the control class. The first indicator measured in this study is interpretation. The data above shows that the percentage of achievement of the interpretation indicator in the experimental class is 93.37% which is included in the very good category, while in the control class it is 64.11% which is included in the good criteria. The high percentage of achievement of the interpretation indicator in the experimental class is because students are guided to freely express ideas and find answers to problems in learning activities using the discovery learning model. Through these actions, students will be skilled in finding and solving problems based on critical thinking. Critical thinking skills can encourage students to come up with new ideas or thoughts about problems in the world (Sutoyo & Priantari, 2019). The second indicator of critical thinking skills in this study is the analysis indicator. The percentage of achievement of the analysis indicator in the experimental class is 84.13% which is included in the very good category, while in the control class it is 47.31% which is included in the sufficient criteria. The achievement of the experimental class indicator is higher than the control class because students are guided to identify the relationship of the information in the problem or question needed to express thoughts or opinions (Rani et al., 2018).

The third indicator of critical thinking skills in this study is the evaluation indicator. The percentage of achievement of the evaluation indicator in the experimental class was 62.09% which is included in the good category while in the control class it was 20.16% which is included in the bad criteria. The achievement of the experimental class indicator is higher than the control class because students are guided to use the right strategy in solving problems or questions. This is in line with the research of Wulandari & Ahmad (2020) where students have started to be active in asking questions and also giving opinions on a problem. In addition, students can find the final results from several opinions and from various points of view, so they are not fixated on one opinion.

The fourth indicator of critical thinking skills in this study is the inference indicator. The percentage of achievement of inference indicators in the experimental class was 81.25% which was included in the good category, while in the control class it was 49.39% which was included in the sufficient criteria. The achievement of the experimental class indicators was higher than the control class because students were guided to identify and obtain the elements needed to be able to draw conclusions from

relevant sources. This is in line with the research of Kusumaningtyas et al., (2020) which explains that the ability to draw conclusions must be based on strong reasons and evidence and test them using certain criteria.

The following is the average value of pretest and posttest based on indicators of students' critical thinking skills in the control and experimental classes.

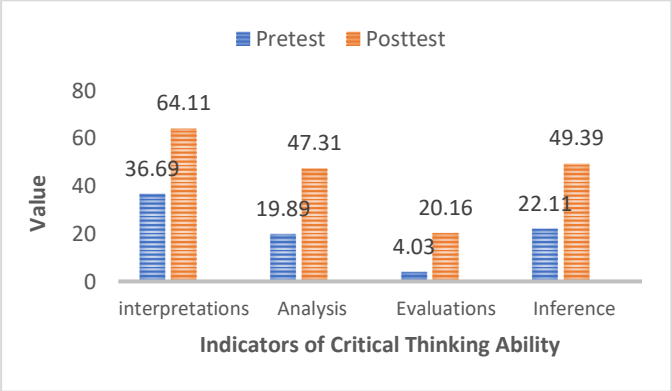

Figure 2. Average Pretest and Posttest Score per Indicator of Control Class

In this study, four indicators of students' critical thinking skills were applied based on Facione and Gittens. Based on the picture above, it can be seen that each indicator has increased. The highest average pretest score is in the interpretation indicator, while the lowest average pretest score is in the evaluation indicator. The highest average posttest score is in the interpretation indicator, while the lowest average posttest score is in the evaluation indicator. The highest difference in the average pretest and posttest results of students' critical thinking skills is in the interpretation indicator, while the lowest difference in the average pretest and posttest results of students' critical thinking skills is in the evaluation indicator. The average pretest and posttest scores per indicator of critical thinking skills in the experimental class can be seen in the following picture.

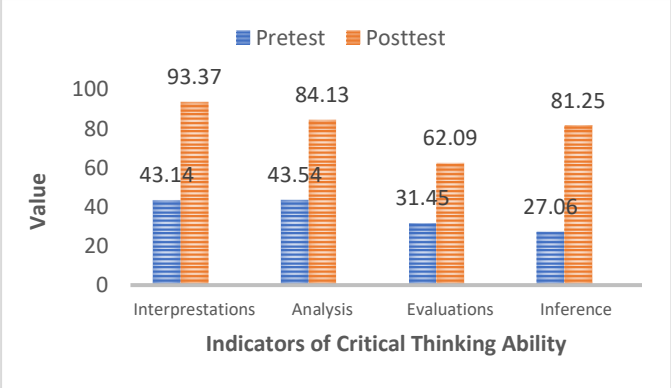

Figure 2. Average Pretest and Posttest Score per Indicator of Experimental Class

Based on the image above, it can be seen that the highest average pretest score is in the analysis indicator, while the lowest average pretest score is in the inference indicator. The highest average posttest score is in the interpretation indicator, while the lowest average posttest score is in the evaluation indicator.

Analyzing the impact of the discovery learning learning model on improving students' critical thinking skills in this study, the Kp test was applied. From the post data of students in the control class and the experimental class, the Kp value was 10.3%. Thus, it can be concluded that in this study there is an impact of the discovery learning learning model on improving the critical thinking skills of class XI students on acid-base material by 10.3%. This is in accordance with a study conducted by Mardiani, Perkasa, & Mutmainah (2022) which shows that the discovery learning learning model has an effect on improving students' critical thinking skills.

Based on the observation of the implementation of the model during the learning process, it is found that there is a big influence on students' critical thinking skills, this can be seen from the high posttest scores of the experimental class using the discovery learning model compared to the control class which only uses conventional learning models during the learning process. With the application of the discovery learning model, students will be more active and independent in finding answers to problems that occur. This corroborates previous research by Hidayat, Jofrishal and Seprianto (2020) which states that the learning process using the discovery learning model is more effective in improving critical thinking skills on colloidal system material compared to learning that does not use the discovery learning model. This is also in accordance with the research of Sutoyo and Priantari (2019) that the discovery learning model trains students to learn by themselves by discovering and exploring

themselves, solving problems that arise, thus training students to be able to think analytically and critically. And that way it can improve students' critical thinking skills.

Conclusions

Based on the research that the researchers have done, the conclusions are obtained, namely: Acid-base chemistry learning using the Discovery Learning model can improve students' critical thinking skills. This can be seen from the post-test results between the control and experimental classes. The average posttest score in the control class was 44 while the average posttest score in the experimental class was 81.

The Discovery Learning model has an impact on improving students' critical thinking skills, as indicated by the significant results of hypothesis, (2-tailed) of the posttest of <0.001 and shows that there is a significant difference between the control class and the experimental class. Because the significance value of 0.001 <0.05, it can be said that the alternative hypothesis is accepted. The magnitude of this influence can also be seen from the calculation of the coefficient of influence, which is 10.3%. This means that there is an increase in students' critical thinking skills by 10.3% in the experimental class with the application of the discovery learning model.

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