The Influence of the Discovery Learning Learning Model on Critical Thinking Abilities and Student Learning Outcomes in Buffer Solution Material

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Abstract: This research aims to determine the effect of the discovery learning model on critical thinking skills and student learning outcomes in buffer solution material for class XI MIPA at SMA Negeri 1 Kejobong. This research uses a quasi-experimental type of research which was carried out in March – April 2023. The sampling technique used was cluster random sampling. The population consists of three classes XI MIPA, totaling 101 students. The samples used were class XI MIPA 1 as an experimental class with a total of 31 students and class XI MIPA 2 as a control class with a total of 34 students. The instruments used were critical thinking ability questionnaires and multiple choice questions. The results of this research indicate that the use of the discovery learning model in learning buffer solution material can improve critical thinking skills and student learning outcomes. This is evident from the average critical thinking ability score of experimental class students of 58.32 while the control class is 55.29. The average value of student learning outcomes for the experimental class was 84.77 and the control class was 79.53. The conclusion from the results of this research is that there is an influence of the discovery learning model on critical thinking skills and student learning outcomes in buffer solution material for class XI MIPA at SMA Negeri 1 Kejobong.

Keywords: Critical Thinking Skills; Discovery Learning; Student Learning Outcomes.

Introduction

Education has a very significant role in a country, including Indonesia. Education must be developed following the times in order to improve the quality of education in Indonesia. Efforts made to improve the quality of education are changing the curriculum, improving the quality of teachers through seminars, training and upgrading, implementing new learning methods, as well as updating and providing adequate facilities and infrastructure. (Setyaningsih, 2011). Apart from improving the quality of education, these efforts can also improve the teacher's process of teaching students. In teaching students, teachers do not just transfer lesson material. However, teachers must be able to accommodate and use lesson material as a tool to provide space for thinking and discussion between students (Djidu & Jailani, 2016). Thinking is a mental process to obtain knowledge. Therefore, the cognitive process of thinking cannot be physically observed. The output of thinking can take the form of ideas, knowledge, procedures, arguments and decisions (Abdullah, 2016). The aim of teaching is to encourage students to think so that their thinking skills can be honed and make them intelligent and able to solve the various problems they face (Setyaningsih, 2011). When someone solves a problem, seeks understanding, or makes a decision, they are engaging in thinking activities (Surasa et al., 2017).

Critical thinking involves the process of searching, synthesizing, analyzing, and conceptualizing information to develop one's thinking, increase creativity, and dare to take risks (Simbolon et al., 2017). Critical thinking skills in Indonesia are still at a low level (Syafitri et al., 2021). One of the factors that causes students' low critical thinking abilities is students'

tendency to memorize material and formulas rather than understanding them (Arif et al., 2019). According to research conducted by Sianturi (2018), The lack of student activity and their tendency to memorize rather than understand the material causes students' critical thinking abilities to be poorly trained and undeveloped. The lack of students' active role can be seen from the lack of students who are active in asking questions and providing opinions. This shows that students focus more of their attention on the teacher without analyzing, criticizing or evaluating what the teacher conveys. According to Sulistiani and Masrukan (2016) states that students' ability to master critical thinking skills is very essential, because it can improve students' ability to make arguments, assess the validity of a source, and make decisions1 more carefully. Apart from that, critical thinking skills are very important for students so that they can solve various problems faced in everyday life. (Oktaviani et al., 2018).

Students' low critical thinking abilities influence student learning outcomes. Learning outcomes are the competencies and skills that students obtain after completing the learning process (Molstad & Karseth, 2016). In the learning process, students are expected to be able to achieve satisfactory learning outcomes. However, it turns out that there are still many students whose learning results are not as expected. In fact, according to Nurhasanah and Sobandi (2016) Student learning outcomes are important to see the abilities and qualities of students after following the learning process.

Improving critical thinking abilities and student learning outcomes can be done by using the discovery learning model in the learning process. This learning model involves direct activities, so that students are more interested in participating in learning and allows the formation of meaningful abstract concepts. Apart from that, the activities in this model are also more realistic (Rutonga, 2017). Based on the results of research conducted by Oktaviani et al. (2018) states that the application of the discovery learning model can improve critical thinking skills and learning outcomes. Apart from that, the results of research conducted by Nugrahaeni et al.(2017) states that the application of the discovery learning model in chemistry lessons can improve students' critical thinking abilities and learning outcomes.

Chemistry is a subject that has great benefits for human life. Chemistry is one of the subjects that is considered difficult for students because there are many abstract concepts that must be understood in a relatively short time, so many students experience failure in studying chemistry (Suyanti, 2010). One chemical material that is considered difficult is a buffer solution. Buffer solution material is considered difficult because it is complex and abstract. The microscopic aspect

contained in the solution is the main factor that makes the buffer solution material abstract (Alighiri et al., 2018). Based on research conducted by Mentari (2014) Students' difficulties in understanding buffer solutions are caused by misconceptions that occur in several concepts, such as the meaning and properties of buffer solutions, the components of buffer solutions, how buffer solutions work, how to make buffer solutions, and the pH of buffer solutions. Based on the results of interviews at SMA Negeri 1 Kejobong, it was stated that students' critical thinking skills in buffer solution material were still low.

The low critical thinking ability of students occurs because the learning method used still uses conventional learning models with PPT media in the form of lectures and questions and answers which encourage students to be active and critical in their opinions. However, in reality, the results of observations show that when students are encouraged to actively and critically argue in class, there are only a few active students who only answer briefly questions from the teacher. In conclusion, the learning model applied does not encourage active participation of students and focuses more on the role of the teacher (teacher-centered), so that students' critical thinking abilities are still relatively low. This is in accordance with research conducted by Dores et al. (2020) states that students' low critical thinking abilities are caused by several factors, such as the lack of student participation in the learning process by just staying silent, sitting, listening, taking notes and memorizing. This makes learning less interesting and unpleasant. The results of interviews at SMA Negeri 1 Kejobong stated that student learning outcomes in buffer solution material were still low or not good. This can be seen from the results of students' tests on buffer solution material, most of which are below the KKM. The KKM score for buffer solution material is 70, while the average score for remedial students is only 50-60.

Based on the problems in the background above, the researcher is interested in conducting research with the title The Effect of Discovery Learning Learning Models on Students' Critical Thinking Abilities and Learning Results on Class XI Mathematics and Natural Sciences Buffer Solution Material at SMA Negeri 1 Kejobong.

Method

This research is experimental research with a quasi-experimental method. The research design is a non-equivalent control group design. The research was conducted at SMA Negeri 1 Kejobong on 13 March – 15 April 2023. The population in this study was class XI MIPA students at SMA Negeri 1 Kejobong, consisting of 101 students. The sample used consisted of class XI

MIPA 1 with a total of 31 students as the experimental class and class XI MIPA 2 with a total of 34 students as the control class. The experimental class uses a discovery learning model, while the control class uses a conventional learning model. The research instruments used were lesson Plan, student worksheet, critical thinking ability questionnaire and multiple choice test questions. Before being used in research, the critical thinking ability questionnaire is tested for validity and reliability first. Meanwhile, the multiple choice test questions are tested for validity, reliability test, level of difficulty test, and different power test.

The technique for collecting data is through a pretest at the beginning of the meeting and a posttest at the end of the meeting as well as filling out a questionnaire. The learning result data in the form of pretest and posttest obtained was then analyzed using a descriptive analysis test using the IBM SPSS statistics 25 application, a normality test using the Kolmogorov-Smirnov test, a homogeneity test using the Levene Statiztic test, and a hypothesis test. If the data can be stated as data originating from a normally distributed population, then the statistical analysis used is parametric statistical analysis. However, if the data does not meet the assumption of normality or does not come from a normally distributed population, then non-parametric statistical analysis is used (Widana & Muliani, 2020).

Parametric tests can use the t test, while non-parametric tests can use the Mann Whitney test. The critical thinking ability data in the form of a questionnaire obtained was then analyzed using a descriptive analysis test using the IBM SPSS statistics 25 application, a normality test using the Kolmogorov-Smirnov test, a homogeneity test using the Levene Statiztic test, and a hypothesis test. The hypothesis test used is the Mann Whitney test. The critical thinking ability questionnaire uses a Likert scale. The Likert scale is a scale that uses ordinal measurements (Fikri, 2019). The Mann Whitney test can be applied to data measured on an ordinal scale and in certain cases, on a nominal scale (Birahi et al., 2022).

Result and Discussion

Learning in the Experimental Class

Learning activities in the experimental class were carried out four times using the discovery learning model. Learning activities generally begin with an opening greeting, prayer, checking attendance, apperception, motivation, group division, distributing students worksheet, and explaining the learning mechanism. The total number of experimental class students was 31 students, so the group was divided into 6 groups consisting of 5-6 students per group. Each group gets one student worksheet. The core learning activities are adapted to the syntax of the discovery learning learning model. The first step is stimulation, the teacher provides stimulation in the form of pictures and events contained in the student worksheet. This aims to foster students' curiosity, so that students are motivated to continue learning. The second step is problem identification. From the pictures or events contained in the student worksheet, students are then given the opportunity to formulate questions first.

After students get and record the questions, then students submit their questions. Next, the teacher directs students to carry out the third step, namely data collection with the aim of answering the questions that have been created. In collecting data, students are guided to find data and information in groups by viewing simple experimental videos, reading books, products or other sources regarding the material being studied. The fourth step is data processing, where students conduct group discussions to answer questions in the student worksheet based on the data and information that has been obtained in the data collection process. The teacher acts as a facilitator or guide who helps students develop their knowledge. Students discuss by carrying out their respective roles, including taking notes, looking for references, composing good sentences, representing presentations and other activities related to the discussion. At this stage, it really helps students to understand the material with their peers.

The fifth step is proof, each group representative makes a presentation of the results of the discussion and then questions and answers are held and provide responses or refute the results of the discussion that has been presented. This can motivate students to be mentally braver to learn to speak, argue, and not be shy about asking and answering. Finally, draw conclusions. The teacher guides students to conclude the results of the discussion by answering questions that students formulated at the problem identification stage. In the closing section, students are asked to note down important points from the learning outcomes they have studied. Teachers also remind students to repeat lessons at home and provide homework contained in the student worksheet with the aim of sharpening students' knowledge individually at home. Next, the teacher informs the learning activities at the next meeting. The teacher gives awards to the best groups and offers closing greetings.

Learning activities in the experimental class ran smoothly and were conducive. Many students actively ask questions, argue and interact, especially in core learning activities. Students always pay very good attention to guidance and direction from the teacher, meaning that students are interested in learning, so that

it can make it easier for students to understand the material and ongoing learning steps. In accordance with the statement in the research (Putri et al., 2019) that if students are interested and pay attention to the teacher in learning, students can get maximum results and learning is easily captured by students. When the results of presentations from other groups were not quite right, students had the courage to take the initiative to convey their arguments and in the end they got the right results. Such initiatives demonstrate students' courage, self-confidence and sharpness of thinking. However, learning in experimental classes is also not free from obstacles.

The obstacle is that there are still some students who are passive in the group and must be paid attention to individually so that these students can understand the material being discussed. If it is too passive, it will make the student's critical thinking abilities low. This is in accordance with research conducted by Dores et al. (2020) It was found that students' low critical thinking abilities were caused by several factors, including the lack of student participation in the learning process by just staying silent, sitting, listening, taking notes and memorizing. Another obstacle is that there are students who lack discipline and are late in participating in group discussions. However, this was resolved when the student immediately took part in the group discussion and was able to present the results of the discussion very well. In this class there are not too many passive students, so the discovery learning model still has a positive effect on student learning outcomes because it causes a significant increase in their achievement in the learning process. This is in accordance with research conducted by Suhada et al. (2019) which states that the discovery learning model can improve student learning outcomes.

Learning in the Control Class

Learning activities in the experimental class were carried out in four meetings using conventional learning models. Learning activities generally begin with an opening greeting, prayer, checking attendance, apperception, motivation, distributing student worksheet, and explaining the learning mechanism. Each student receives one student worksheet

The core learning activities are adapted to the syntax of the conventional learning model using the lecture method. The first step is exploration, in learning the teacher explains the material and examples while the students focus on paying attention to the explanation of the material and also the teacher's examples. The second step is elaboration, students are asked to work on the practice questions contained in the student worksheet individually, while the teacher goes around to guide and check the students' work. The final step is confirmation,

the teacher offers students to come forward to write the answers on the blackboard. However, in only one meeting there were two students who volunteered to write answers on the blackboard, in other meetings students had to be appointed first so that there were students who came forward to write answers on the blackboard. If there is an error in the answer, the teacher together with the students corrects the answer. In the closing section, the teacher concludes the material that has been studied. Students record important points from the learning outcomes they have learned. Next, the teacher reminds students to repeat the lesson at home. Finally, the teacher announces the learning activities at the next meeting and says closing greetings.

Learning activities in the control class ran smoothly and were conducive. However, there is an obstacle, namely that many students are passive. Many students look sleepy and are not interested in learning. Based on research conducted by Hasanah (2019) stated that the conventional learning model did not inspire students' enthusiasm for learning. As a result, many students get bored easily and don't understand the teacher's explanation, so they have to explain it one by one so that each individual understands. In accordance with the statement in the research (Syaparuddin et al., 2020) When students just passively listen to lectures from the teacher, they tend to feel bored and less motivated to participate in the learning process. This can be seen when teachers go around and check students' work and it turns out that many are still confused.

There are still many students who need to be approached to their seats first so they have the courage to ask questions. There are only a very few who dare to ask questions related to the material being studied. Some students also lack self-confidence because if they are appointed to advance, they throw it at other friends. Even though lectures and questions and answers are effective learning methods, teachers need to shift to using variations in the use of learning models that provide more student roles and involvement to improve critical thinking skills and student learning outcomes. In accordance with the statement in research conducted by (Ayuningsih et al., 2019) namely, to improve critical thinking and student learning outcomes, teachers need to use learning models that encourage students to play an active role in learning activities.

The Influence of the Discovery Learning Learning Model on Students' Critical Thinking Ability

Critical thinking ability is measured using a questionnaire. Questionnaires were given at the end of the meeting. The questionnaire data that was obtained was then tested for descriptive analysis using the help of the IBM SPSS Statistics 25 application. The results of the descriptive analysis test can be seen in Table 1.

Table 1. Descriptive Analysis Test Results of Students' Critical Thinking Ability Questionnaire

Experimental Class	N	Minimum	Maximum	Mean	Std. Deviation
Control Class	31	47	66	58.32	4.84
Valid N (listwise)	34	42	64	55.29	5.46
Experimental Class	31				

Based on Table 1, the average questionnaire score in the experimental class was 58.32 and in the control class it was 55.29. The average value of the experimental class is greater than the control class, so it can be concluded that the discovery learning model can improve critical thinking skills compared to using conventional learning models. This is in accordance with research conducted by Susanti et al. (2020) which states that students' critical thinking abilities using the discovery learning learning model are better than conventional learning models. Research data from questionnaires that had been filled in by experimental class and control class students were then analyzed for prerequisite tests, namely the normality test and homogeneity test using the IBM SPSS Statistics 25 application.

Table 2. Normality Test Results of Students' Critical Thinking Ability Questionnaire

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Critical Thinking Ability	Experimental Class	.122	31	.200*	.946	31	.125
	Control Class	.133	34	.132	.953	34	.146

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The normality test produced significance values in the experimental class and control class, respectively, namely 0.200 and 0.132. If in the Kolmogorov Smirnov test the significance value is > 0.05 then the data is declared normal (Jusmawati et al., 2020). This means that the experimental class and control class data are normally distributed because the significance value is > 0.05.

Data will be declared homogeneous if in Levene's test, the significance value is > 0.05. The homogeneity test shows a significance value based on mean, namely 0.188. This means that the data is declared homogeneous because the significance value is greater than 0.05. Next, a hypothesis test was carried out using the Mann Whitney test. The critical thinking ability questionnaire uses a Likert scale. The Likert scale is a scale that uses ordinal measurements (Fikri, 2019). For data with an ordinal scale and nominal scale, you can use the Mann Whitney hypothesis test (Birahi et al., 2022). Based on Table 4, the Asymp value is produced. Sig. (2-tailed) of 0.038 < 0.05. So the decision taken is that Ha is accepted and Ho is rejected. This means that there is an influence of the discovery learning model on critical thinking skills in buffer solution material for class XI MIPA at SMA Negeri 1 Kejobong.

Table 3. Homogeneity Test Results of Students' Critical Thinking Ability Questionnaire

		Levene Statistic	df1	df2	Sig.
Critical Thinking Ability	Based on Mean	1.77	1	63	.188
	Based on Median	1.54	1	63	.218
	Based on Median and with adjusted df	1.54	1	62.83	.218
	Based on trimmed mean	1.69	1	63	.197

Table 4. Mann Whitney Test Results of Students' Critical Thinking Ability Questionnaire

	Critical Thinking Ability
Mann-Whitney U	369.00
Wilcoxon W	964.00
Z	-2.08
Asymp. Sig. (2-tailed)	.038
a. Grouping Variable: Class	

During learning, many students in the experimental class were seen asking questions according to the material and during the presentation students were able to answer questions well. When there are presentation results that are not quite right, students are active in giving their opinions so that the results can be improved together. During the discussion, students also seemed active in working together to try to find out and solve existing problems so that they were able to decide on the conclusions of the discussion results together. Apart from that, the results of the discussion conclusions can also support students to discover the concepts of the material being studied. This is supported by research conducted by Hasnan et al. (2020) which states that the discovery learning model makes students think more critically because students are stimulated to find out answers to the problems they face, carry out investigations, learn independently, and can discover the concepts being studied.

In the control class there is very little interaction and involvement of students in finding the material,

because students are required to focus on listening and paying attention to the teacher who is explaining the material in front of the class. The teacher plays more of a role while the students become passive. This makes students' thinking and critical thinking abilities less developed. This is in accordance with the results of research conducted by (Rohaumah, 2018) that conventional learning models improve critical thinking skills less than discovery learning models. Based on the results of observations during learning, it can be concluded that there is an influence of the discovery learning model on critical thinking skills in buffer solution material for class XI MIPA at SMA Negeri 1 Kejobong.

The Influence of the Discovery Learning Learning Model on Student Learning Outcomes

The data used to measure student learning outcomes are pretest and posttest score data in the form of multiple choice questions on buffer solution material. The pretest is given to students at the first meeting and the posttest at the final meeting after treatment. Then a descriptive analysis test was carried out using the IBM SPSS Statistics 25 application. The results of the descriptive analysis test can be seen in Table 5.

Table 5. Descriptive Analysis Test Results of Multiple Choice Test Questions

	N	Mini-mum	Maximum	Mean	Std. Deviation
Pre-Test Experiment	31	17	50	32.16	8.34
Post-Test Experiment	31	61	100	84.77	9.22
Pre-Test control	34	6	44	25.47	11.15
Post-Test control	34	56	94	79.53	7.40
Valid N (listwise)	31				

Based on Table 3, the average scores for the experimental class pretest, experimental class posttest, control class pretest, control class posttest are 32.16, 84.77, 25.47, and 79.53 respectively. Judging from the average value of the experimental class being greater than the control class, it can be concluded that the discovery learning model can improve student learning outcomes compared to using conventional learning models. This is in accordance with research conducted by Amelia & Elfia Sukma (2021) that the discovery learning model has a more positive influence on student learning outcomes than conventional learning models. Also in line with research conducted by Suhada et al. (2019) which states that the discovery learning model can improve student learning outcomes. Before testing

the hypothesis, determine which statistical test is appropriate to use, between parametric or non-parametric statistical tests (Supardi, 2013). To find out which statistical test is appropriate, it is necessary to carry out analysis requirements tests, namely the normality test and homogeneity test (Usmadi, 2020).

Table 6. Normality Test Results for Multiple Choice Test Questions

	Kelas	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Student learning outcomes	Pre-Test Experiment	.143	31	.109	.947	31	.126
	Post-Test Experiment	.164	31	.033	.923	31	.028
	Pre-Test control	.207	34	.001	.904	34	.006
	Post-Test Kontrol	.242	34	.000	.893	34	.003
a. Lilliefors Significance Correction							

The results of the normality test stated that the significance value of the experimental class pretest was 0.109 > 0.05, meaning the data was normally distributed. Meanwhile, the significance values of the experimental class posttest, control class pretest, and control class posttest were respectively 0.033, 0.001, and 0.000. This means that the data is not normally distributed because the significance value is <0.05. Non-normal data occurs due to many causes, such as extreme data, ordered data, data following a distribution other than the normal distribution and other causes (Sari et al., 2017). In the homogeneity test, the resulting significance value based on mean is 0.055. This means that the data is declared homogeneous because the significance value is greater than 0.05.

Next, carry out a hypothesis test. In the normality test, it is known that there is data that is not normally distributed. If there is data that is not normal or does not come from a normally distributed population, then test the hypothesis using non-parametric statistical tests (Widana & Muliani, 2020). The non-parametric statistical test used is the Mann Whitney test. The Mann Whitney test is used to determine the comparison of two unpaired groups, independent of each other (Pujiati et al., 2019). Based on Table 8, the Asymp value is produced. Sig. (2-tailed) is 0.014 < 0.05, so Ha is accepted and Ho is rejected. This means that there is an influence of the discovery learning model on student learning outcomes in buffer solution material for class XI MIPA at SMA Negeri 1 Kejobong.

Table 7. Homogeneity Test Results for Multiple Choice Test Questions

		Levene Statistic	df1	df2	Sig.
Student learning outcomes	Based on Mean	3.837	1	63	.055
	Based on Median	3.428	1	63	.069
	Based on Median and with adjusted df	3.428	1	62.950	.069
	Based on trimmed mean	3.840	1	63	.054

Table 8. Mann Whitney Test Results for Multiple Choice Test Questions

	Student Learning Results
Mann-Whitney U	345.000
Wilcoxon W	940.000
Z	-2.448
Asymp. Sig. (2-tailed)	.014

Conclusion

The use of discovery learning models in learning buffer solution material can improve critical thinking skills in building their own knowledge, thereby improving student learning outcomes. This is evident from the average value of students' critical thinking abilities after using the discovery learning model, which is 58.32, while for those who do not use the discovery learning model, it is 55.29. Apart from that, the average value of student learning outcomes after using the discovery learning model was 84.77, while for those who did not use the discovery learning model it was 79.53. The conclusion from the results and discussion in this research is that there is an influence of the discovery learning learning model on critical thinking skills and student learning outcomes in class XI MIPA buffer solution material at SMA Negeri 1 Kejobong.

Author Contributions
Conceptualization. S. A. L. N. M.; methodology, S. A. ; validation. L. N. M. and S. A formal analysis, L. N. M; investigation, L. N. M and S. A.; resources, S. Aand.; data curation. L. N. M: writing—original draft preparation, L. N. M and S. A.; writing—review, S. A. And L. N. M editing. L. N. M: visualization S. A, .and L. N. M. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest
No Conflicts of interest.

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