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The Effect of Inquiry-Based Learning on Students' Critical Thinking Ability and Activeness in Reaction Rate Material

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Abstract
Critical thinking skills and student activity are essential in learning chemistry to obtain maximum learning results and can last a long time in their memories. However, most students only memorize concepts, think less critically, and refrain from actively participating in learning chemistry. One way to help students improve their critical thinking skills and make students active when learning is to apply inquiry-based learning. This research aims to determine the effect of inquiry-based learning on students' critical thinking skills and activeness in reaction rate material. The type of this research was quasi-experimental research. The research design used was a Pretest-Posttest, Non-Equivalent Control Group Design. The population of this research was class XI MIPA at public high school in Yogyakarta. The sampling technique used was the cluster random sampling technique. The sample for this research was class XI MIPA 1 students as the experimental group and class XI MIPA 4 students as the control group. Researchers used test instruments and observations as data collection techniques. The data analysis technique used was normality and homogeneity tests as prerequisite tests, followed by hypothesis testing using the Mann-Whitney U test. The results of the Mann-Whitney U test research showed differences in critical thinking between the experimental and control groups. The results of observations of student activity showed that the activity of the experimental group students was higher than the control group in each indicator. Thus, the inquiry-based learning model affects students' critical thinking skills and activeness in reaction rate material.

Keywords: inquiry-based learning, critical thinking, activeness, reaction rate material

INTRODUCTION

Learning chemistry is more than just acquiring knowledge. It is also about exploring new ideas and finding new ways to understand what we already know (Berlian et al., 2023). This is because chemistry is closely related to understanding natural phenomena systematically. In studying chemistry, students and teachers need an active role in managing learning activities to increase students' experience in understanding concepts and principles in chemistry. However, unfortunately, based on facts in the field, many chemistry teachers are not creative in implementing chemistry learning. Teachers only lecture and give assignments. Therefore, many students consider chemistry lessons difficult, so they become lazy and uninterested in learning chemistry. Chemistry is also considered difficult because the material taught is mostly abstract (Widiartini, 2017).

One chemical material that is considered difficult is the reaction rate. Reaction rates are difficult because some sub-concepts of this material are difficult to visualize (Pikoli et al., 2022) and require several mathematical calculations (Nurlaila, 2022). In studying reaction rates, students must explore concepts related to reaction rates using experiential techniques and practical activities that require process skills to make the teaching and learning system very popular, practical, and useful (Andromeda et al., 2018). In the reaction rate material, students are also required to think critically and participate actively when solving problems related to life phenomena related to chemical materials.

Critical thinking skills are needed to improve chemical abilities, especially in the 21st Century (Susilawati et al., 2020). Critical thinking skills are essential to training students to solve problems which is relevant not only to learning at school but also to real life problems (Ramadansur et al., 2023). The benefit of teaching critical thinking skills during learning is to increase students' enthusiasm for learning and enthusiasm for learning, and the learning process experienced by students will last a long time in their memories. Students who think critically are expected to have the ability to think scientifically and be competent in solving problems, both during learning activities in class (Hartati et al., 2019) and when they encounter concrete problems that they will encounter (Puspita et al., 2021). However in reality, implementing chemistry learning in schools tends to pay less attention to critical thinking skills. Students just listen to the teacher explaining the material and also sit quietly in their place. Students cannot participate in solving their problems, so the critical thinking process cannot be carried out. To overcome this problem, we can use the inquiry based learning method because this method is a this method is a series of activities that involve learning activities analytically, logically, critically, and neatly so that students can analyze their findings with confidence (Chususiyah et al., 2020). Apart from critical thinking, one of the elements for improving chemistry skills is students' active learning. Students who are actively involved in learning in class will achieve the cognitive component of learning and the emotional and social components (Mufidah & Tirtoni, 2023).

Classroom education is dominated by teachers as the primary source of knowledge, resulting in reduced student learning. This universally used teaching system can be improved again so that teachers are not only the only source of knowledge, but students can also try to improve themselves in seeking knowledge from various sources to achieve educational goals in the classroom (Rahmania et al., 2023).

Student activity can support the success of the teaching and learning process so that the knowledge and experience gained by students is maximized. During the learning process, teachers must create conditions that can give rise to motivation and interest in participating in learning so that students and teachers are both active in the transfer of

knowledge. The learning activities carried out sometimes need to accommodate activeness. Students have this problem caused by choosing an inappropriate learning model (Mahardika & Wiratama, 2020), so student activity needs to be facilitated (Langitasari et al., 2021) Choosing a learning model strategy is crucial for honing critical thinking skills and acting as an active student to achieve the expected learning outcomes.

The advantage of inquiry-based learning is that students can actively formulate hypotheses, investigate data, and communicate their findings with others (Kholili, 2022) to develop a clear and accurate understanding of the situation (Dewi et al., 2020). Another advantage of inquiry-based learning is that students can better understand basic concepts and ideas, use memory to remember information and transfer it to new learning situations, use their intelligence and creativity, and encourage students to take the initiative (Chususiyah et al., 2020). Inquiry-based learning emphasizes developing critical thinking skills, problem-solving, communication skills, and physical abilities in a balanced way (Gholam, 2019). This type of learning is seen as more useful (Novianti et al., 2022). With the advantages of the inquiry model, it is hoped that students will become more motivated when learning in the classroom and can stimulate students to improve their learning outcomes.

Inquiry-based learning can improve critical thinking skills in many subjects, such as science and technology-based (Duran & Dökme, 2016), biology (Destrilia et al., 2021), Islamic education subjects (Fadli et al., 2019) as well as chemistry (Sari & Muchlis, 2022). The inquiry learning model can influence high-level thinking in scientific literacy and student activity (Destrilia et al., 2021). There is a significant difference in learning activity between applying the inquiry learning method and the demonstration learning method in students' learning activity in chemistry learning (Sasongko & Haryanto, 2016). The video-based inquiry learning model can influence improving students' critical thinking skills and learning activity (Yuliyani et al., 2022).

Research on the impact of inquiry-based learning models on critical thinking skills and student involvement, especially on the reaction rate material, is still limited. Although the reaction rate material is related to practicum, which requires critical thinking and active participation in obtaining information, previous researchers have not studied this area in depth. This research is important because most students are still passive when taking chemistry lessons and only memorize, so they need help to think critically to understand and solve a problem. Thus, this research aims to determine the effect of inquiry-based learning on students' critical thinking abilities and activeness in reaction rate material.

METHOD

This research applied a Quasi Experiment using a pretest-posttest Non-Equivalent Control Group Design. Two groups: the experimental and control groups were used to seek the impact of inquiry-based learning model towards students' critical thinking and activeness. The experimental group is the group that is given treatment using the Inquiry-Based Learning model. In contrast, the control group is the control group that is treated with the Student Teams Achievement Division (STAD) learning model.

The population of this research was grade XI and using cluster random sampling technique, two classes were randomly selected as samples, with the condition that the population must be normally distributed, have the same average, and have the same homogeneity. Thus, the research sample consisted of 36 students from grade XI-4 as the control group and 36 from grade XI-1 as the experimental group. The data collection

instruments used in this research were 15-item pretest and posttest essay questions to measure students' critical thinking abilities and a 35-item observation sheet to seek students' activeness in learning activities based on five indicators, namely student involvement physically, mentally, emotionally, and intellectually; students learn directly in the form of cooperation and group interaction; students' desire to create a conducive learning atmosphere; students' involvement in searching for and utilizing learning resources; and students' involvement in asking and answering. The pretest and posttest were validated by asking the expert to review and assess. Then, a field test was carried out to test the validity, reliability, distinguishing power, and level of difficulty of the questions. The observation sheet is only tested for validity on the experts.

Based on validity testing results on 30 questions filled in by 33 students of grade XI, the r_{table} is 0.3338, corresponding to a significance of 0.05. An instrument is stated as valid if the r_{count} is greater than the r_{table} (Yusup, 2018). The results of the validity trial can be seen in Table 1.

Table 1 Question Validity

Statement	Item number	Total
Valid	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17	15
Tidak Valid	2, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30	15

Table 1 presents the validity test of the pretest and posttest critical thinking questions, which produced 15 valid and 15 invalid questions. Next, the researchers carried out a reliability test. Reliability is defined as how far the measurements' results can be trusted. This study used an approach to the consistency of intervals by calculating Cronbach's Alpha coefficient, which was calculated with the help of the SPSS 25 program. In this analysis, a method of consistency of intervals was used by computing Cronbach's Alpha coefficient, which was processed using the SPSS 25 program. Interpretation of the instrument reliability criteria can be seen in Table 2.

Table 2 Cronbach Alpha Coefficient Criteria

Cronbach Alpha	**N of Items**
0,899	15

Table 2 shows the Cronbach Alpha value obtained, which is 0.899 and is included in the very high-reliability category (Arikunto, 2012). Thus, it can be concluded that the question items are reliable and can be trusted as a tool for collecting data in research. The analysis technique for observing student activity is based on the average student score. Meanwhile, the pretest and posttest data to measure critical thinking skills were analyzed statistically using SPSS version 25. The pretest data was processed through the normality, homogeneity, and Wilcoxon tests, while the posttest data was processed through the Mann-Whitney (non-parametric) test.

FINDINGS DAN DISCUSSION

Findings

The data obtained for analyzing critical thinking tests consists of five indicators with a total of 15 essay questions. Indicators that serve as benchmarks in critical thinking

are defining terms and considering a definition, analyzing arguments, deciding on a course of action, creating and determining results, and identifying assumptions. The results of this research were obtained from data collection at a public high school in Yogyakarta. After conducting the research, the pretest and posttest results were analyzed using SPSS version 25. A descriptive analysis of the pretest and posttest scores for the experimental group and control group can be seen in Table 3.

Table 3 Descriptive Analysis Test Results

Data	**Pretest**		**Posttest**	
	Control	**Experimental**	**Control**	**Experimental**
The number of students	36	36	36	36
Lowest Value	9	4	46	50
The Highest Score	44	44	93	96
Mean	33	31	63	77

The highest score for the experimental group was the same as the control group (44). Meanwhile, the posttest result data in the experimental group was more significant than the control group, as seen from the experimental group's highest score of 96, while the control group was 93. The mean or average score of the experimental group in the posttest showed significant results compared to the control group. The average post-test score for the experimental group was 77, while the control group was 63. Next, a normality test was carried out on the pretest and posttest data for the control and experimental groups. The normality test helps test the results of data obtained, data from students' critical thinking before and after being treated with the inquiry learning model, so they can understand and know whether the data is normal or abnormal. The significant level used is 5% of the basis for decision-making that can be taken. If the significance value is higher than 0.05, the data has a normal distribution, and vice versa. The following normality test can be observed in Table 4.

Table 4 Normality Test Results

	Kolmogorov-Smirnova			Shapiro-Wilk		
Class	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test Experiment	.144	33	.080	.952	33	.150
Post-test Experiment	.125	33	.200*	.939	33	.062
Pre-test Control	.413	33	.000	.337	33	.000
Post-test Control	.127	33	.195	.946	33	.103

Based on Table 4, the significance value obtained in the control group posttest is 0.195, so the significance value is greater than 0.05. The data is not normally distributed, so the hypothesis test uses non-parametric statistics, namely the Wilcoxon and Mann-Whitney U tests. The results of the Wilcoxon test can be seen in Table 5.

Table 5 Wilcoxon Test Results

Statistic	Pretest-Posttest Experiment Class	Pretest-Posttest Control group
Z	-5.013	-4.424
Asymp. Sig. (2-tailed)	.000	.000

Based on Table 5, the Asymp value is obtained. Sig (2-tailed) < 0.05. Therefore, it can be deduced that the hypothesis is accepted. This indicates that there is a discrepancy in the results of the pretest and posttest, which means there is an influence of the application of the inquiry-based learning model on students' critical thinking abilities. Next, the Mann-Whitney U test was carried out. The Mann-Whitney U test was used to test differences in two independent samples. For the two sample groups to be equivalent in all respects, they must be selected randomly. The results of the Mann-Whitney U test can be seen in Table 6.

Table 6 Mann Whitney U Test Results

Statistic	Critical Thinking
Z	-3.232
Asymp. Sig. (2-tailed)	.001

Based on Table 6, it is known that the significance value or Sig (2-tailed) is obtained. The *assumed equal variance* is (0.001). If compared, the value will be smaller than *alpha* 0.05 (0.001 < 0.05). This shows that the hypothesis is accepted, and it can be concluded that there are differences in critical thinking between the experimental and control groups. If there is a significant difference, inquiry-based learning influences students' critical thinking abilities on reaction rate material.

Student activity was discovered after observing 33 students from the control group (XI MIPA 4) and 33 from the experimental group (XI MIPA 1). Two observers who used observation sheets to record their findings monitored the student activity closely. Student activity is seen based on five indicators. The first is the involvement of students physically, mentally, and intellectually. Second, namely cooperation and group interaction. Third, create a conducive learning atmosphere. The fourth indicator is the search for and utilization of learning resources. The fifth indicator is student involvement in ask and answer. The results of observations of student activity in the experimental group can be seen in Table 7.

Table 7 Results of Descriptive Analysis of Experimental group Student Activity

Indicator	**N**	**Mean**	**Std. Deviation**
Student involvement physically, mentally, emotional and intellectual	33	7.09	1,355
Group cooperation and interaction	33	9.21	1,364
Create a learning atmosphere conducive	33	5.70	,467
Search for and utilize resources Study	33	3.39	,659
Ask and answer	33	4.42	,708
Valid N (listwise)	33		

Based on Table 7 on the first indicator, student involvement in the physical, mental, intellectual, and emotional learning process, the average experimental group obtained a value of 7.09. In the second indicator, group cooperation and interaction were obtained on an average of 9.21. The third indicator, creating a conducive learning atmosphere, obtained an average of 5.70. In the fourth indicator, an average of 3.39 was obtained; in the fifth indicator, student involvement in asking and answering obtained an average of 4.42. The results of a descriptive analysis of the activity of control group students can be seen in Table 8.

Table 8 The Results of a Descriptive Analysis of the Control Group Students

Indicator	N	Mean	Std. Deviation
Student involvement physically, mentally, emotional and intellectual	33	6.00	2,250
Group cooperation and interaction	33	6.76	2,728
Creating a conducive learning atmosphere	33	4.91	1,208
Search for and utilize learning resources	33	2.30	1,287
Ask and answer	33	3.91	1,234
Valid N (listwise)	33		

Based on Table 8, the first indicator is student involvement physically, mentally, intellectually, and emotionally in each learning process. The control group obtained an average score of 6.00. In the second indicator, cooperation and group interaction obtained an average of 6.76. In the third indicator, creating a conducive learning atmosphere, the average was 4.91. In the fourth indicator, searching for and utilizing learning resources obtained an average of 2.30; in the fifth indicator, student involvement in asking and answering obtained an average of 3.91. Based on the analysis results described above, it can be concluded that the average value of each indicator of student activity in the experimental group is higher than that of the control group. Thus, the application of inquiry-based learning can improve student activity.

Discussion

In the experimental group that uses an inquiry-based learning approach, students will engage in various interactions and direct involvement to gain direct experience and explore knowledge independently, with only a teacher acting as a facilitator. This learning model trained students to be independent, looking for solutions to existing problems throughout the learning process. Implementing an inquiry-based learning model encourages students to actively search for information, analyze data, and draw conclusions based on existing evidence (Widiya & Radia, 2023). This allows them to understand new information and effectively solve existing problems. This process can improve students' critical thinking skills. As demonstrated by (Ramadhanti & Agustini, 2021), an inquiry-based learning model can enhance students' critical thinking skills by

cultivating an in-depth understanding of concepts gained through experiential learning. Similarly, Prasetiyo & Rosy (2020) also noted that the inquiry learning model could develop and enhance critical thinking skills. Unlike traditional teaching methods, where students passively receive information from the teacher, the inquiry learning model allows students to actively seek, discover, and draw conclusions from the knowledge obtained individually and in groups. This statement is also strengthened by research (Maryam et al., 2020), which stated that the inquiry learning model affected improving students' critical thinking skills. This is verified by the results of the Anacova test, which produces a significant value (p) of 0.00 ($p < 0.05$). The percentage of model influence inquiry learning on students' critical thinking skills is 27.4%. The influence provided is positive, which can be seen from the F calculation, which results in a positive value ($F = 28.328$).

Instilling and mastering students' critical thinking is crucial because it relates to solving problems rationally, logically, and systematically (Syifa et al., 2022). Through applying critical thinking, students can utilize various solutions to explain events and predict outcomes (Duran & Dökme, 2016). Apart from that, thinking ability and critical skills are critical skills in the world of education, especially in a science learning context. By cultivating students' critical thinking skills, it is hoped they will gain the ability to understand truth amidst the abundance of information they encounter, enabling them to act efficiently, argue, and make reasonable conclusions about the problem they find.

The inquiry-based learning model has the potential to significantly impact student activity due to the learning stages that can encourage active learning. By applying this model, students must take a more proactive approach to learning, as this stimulates their natural curiosity and motivates them to seek knowledge for themselves. Furthermore, the inquiry learning model fosters feelings of interest in a subject matter, thus encouraging students to deepen the material and dig into the ins and outs. As a result, students become more inclined to participate actively in class discussions, confidently express their opinions, and be eager to find answers to things they don't yet understand (Hariandi & Cahyani, 2018). The inquiry-based learning model can create many opportunities for students to increase their learning activities. These activities are designed to be interactive and interesting and provide deep understanding. As a result, this model has the potential to significantly increase students' interest in learning, which ultimately leads to greater involvement in their learning activities (Sundari et al., 2017). Liveliness Student learning will enable direct and encouraging learning experiences for students to participate actively in the learning process. Through this active involvement, students can better understand the subject matter and its meaning. Apart from that, liveliness Student learning is useful for cultivating active learning abilities in students and exploring the potential of teachers and students to expand together and share knowledge, skills, and experience. According to research conducted by (Destrilia et al., 2021), Inquiry-based learning is a learning model that motivates students to participate actively in learning activities. This model requires students to actively formulate questions, conduct research or exploration, test hypotheses, and draw conclusions. Inquiry-based learning encourages a deeper understanding of a subject by emphasizing student involvement. Other research conducted by (Muchindasari, 2016) showed similar findings regarding the effectiveness of the model inquiry learning in increasing student activity. In inquiry-based learning, students are encouraged to explore and discover their concepts through direct activities and investigations. As a result, students become actively involved in the process of learning and being able to obtain meaning and understanding from the material studied.

The same was also expressed in research conducted by Nisa' et al. (2020), which stated that applying the inquiry learning model results in increased learning activity of class students VII at Sawan 2 Public Middle School. In this model, the teacher acts as a guiding facilitator for students towards a problem or question to be explored. This approach forces students to take a more active role in teaching and learning activities and deepen their understanding of a subject matter.

CONCLUSION

Based on research that has been conducted, the inquiry-based learning model can affect students' critical thinking capabilities; this is confirmed by the Mann-Whitney U hypothesis test, which obtained a significance value of 0.001 (0.001 < 0.05), which means that there is a difference in critical thinking between the experimental class and the control class. Because there are significant differences, it can be said that there is an influence of inquiry-based learning on students' critical thinking abilities in the reaction rate material. The observation results show that the inquiry-based learning model can improve student activity; based on observations on the observation sheet, the average activity of each student indicator in the experimental group was higher than that of the control group. The inquiry-based learning model will make students actively involved in learning activities to gain direct experience and explore knowledge independently to find solutions to problems that arise throughout the learning process, with the teacher only acting as a facilitator. This process can improve students' critical thinking skills and student activity. Thus, the inquiry-based learning model can improve students' critical thinking skills and activities on reaction rate material. The weaknesses of this research is that the researcher only used worksheets in groups as a learning medium, so some students did not participate in the inquiry process and only relied on their friends. We suggest that future researchers to apply the inquiry-based learning model to different materials and subjects and expand the variables so that this method can develop and be useful for learning activities that can improve students' critical thinking abilities and activeness.

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