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BLENDED LEARNING WITH QUIZIZZ: IMPACT ON CRITICAL THINKING AND LEARNING OUTCOMES

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Abstract. The influence of the blended learning paradigm with Quizizz assistance on reaction rate material has been studied. The purpose of this research is to see (1) the effectiveness of blended learning assisted by quizizz in improving students' critical thinking (2) the effectiveness of blended learning assisted by quizizz in improving student learning outcomes (3) student responses after applying blended learning assisted by quizizz on reaction rate material. This research uses a quasi-experimental strategy based on a design with a non-equivalent control group. The research participants numbered 66 people, divided into two groups at MAN 2 Banjarmasin, namely XI MIPA 2 as the experimental group and XI MIPA 4 as the control group. Learning outcomes and critical thinking skills are dependent variables, while the learning model is the independent variable. Test and non-test techniques are used to obtain data. Descriptive and inferential analysis are used in data analysis techniques. The research results show that the average performance of each indicator in the experimental group increased by 82.35, compared to the control group, which was only 76.82. For the average achievement of students in the learning outcomes of each indicator in the experimental group jumped up to 84.41, compared to the control group of only 77.50. In addition, the blended learning approach assisted by Quizizz in terms of content has a response rate that has jumped up significantly, namely 67.65%, compared to the discovery learning approach of only 37.50%. Students in the experimental group have higher critical thinking skills and learning outcomes on the reaction rate material when using the blended learning approach assisted by Quizizz compared to the control group when using the discovery learning approach.

Keywords: blended learning, critical thinking, discovery learning, learning outcomes, quizizz media

INTRODUCTION

The 21st century is now centered on the development of Industry 4.0. In this century, education must prepare a generation to be able to compete in facing various global challenges with confidence and competence. Teachers in this century are expected to be able to provide learning facilities that support students' intellectual abilities so that they can develop their own understanding. With these abilities, they can train students' thinking skills (Wardani et al., 2018).

Higher-order thinking skills are particularly important in 21st-century learning, and critical thinking is one of those skills. Critical thinking is one of the most fundamental skills a person can acquire (Susanti et al., 2018). When making decisions about what to believe and what to do, critical thinking skills are absolutely crucial for all students to have (Dores et al., 2020; Wahyudi et al., 2020).

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According to Norris & Ennis (1989), there are five markers of critical thinking: (1) elementary clarification; (2) basic skills; (3) inferring; (4) advanced clarification; and (5) strategy. Critical thinking skills must be learned because they can help you understand concepts more easily and develop a better understanding of problem solving (Sarifah & Nurita, 2023).

The current goal of education is to train students to think critically about their studies. However, students' critical thinking skills are rarely developed in the classroom environment in general. As a result, students' critical thinking skills become stagnant and, in some cases, cannot develop (Wahyudi et al., 2020). Student learning outcomes will be impacted by their still weak critical thinking skills. Teachers can measure the growth of their students' knowledge and skills thanks to learning outcomes, namely observable changes in student behavior that result from teaching (Riinawati, 2021).

Some students found it difficult to understand concepts such as reaction rate when studying chemistry. Reaction rate is related to the speed of a reaction, which involves simple calculations in the form of fractions and decimals, theory, and practical work (Handayani et al., 2021; Syahdi et al., 2021). Based on an analysis of a survey of the needs of 12th-grade science students at SMAN 2 Kota Jambi, the response level shows that 88% of students stated that they did not understand the material on reaction rates, and 79% stated that the material on reaction rates was not relevant to their daily lives (Khalishah et al., 2024).

A thorough understanding of reaction rates is necessary in order to move on to more advanced chemistry concepts, so it is important for students to receive sufficient instruction in this area. One reason students have difficulty understanding reaction rate material is that they are unable to make the connections necessary to understand old concepts in conjunction with the introduction of new ones (Bain & Town, 2016; Munawarah et al., 2021) Understanding and applying concepts in the subject of low reaction rates is hampered by the fact that some teachers still use conventional teaching models, namely the expository method (lectures), which requires students to memorize theories and provides examples directly without involving students in actively discovering and constructing their own concepts of knowledge (Brown et al., 2017; Basit et al., 2023).

Consequently, learning outcomes are unsatisfactory due to the underdevelopment of students' critical thinking and analytical skills, resulting in a low level of conceptual understanding and application of concepts to real-world phenomena (Antara, 2022). In enabling students to fully comprehend or scrutinize the concepts discussed in chemistry lessons, it is important to encourage them to develop critical thinking skills, cultivate an interest in science, and feel ownership of their own learning (Idris et al., 2020).

Based on the researcher's interview with a chemistry teacher at one of the senior high schools in Banjarmasin, it was found that some students were still unable to answer the questions correctly, which had a negative impact on their performance in chemistry. This can also be seen from the results of the critical thinking pre-test, with an average score of only 16.42, and the learning outcome pre-test, with an average score of only 25.29 in the experimental class.

In line with research by Iriani et al. (2023), the average pre-test score for critical thinking skills through website-based live streaming learning using the blended learning model was only 24.19. Sugita & Muchlis (2022) conducted a pre-test of learning outcomes to determine the extent of students' understanding of the factors that influence the reaction rate process, with only 44.23% of students achieving an average score and 0% achieving the minimum passing grade of 78. This

inability on the part of students indicates a low level of critical thinking and learning outcomes. This indicates the need for a new approach to help develop students' critical thinking skills and learning success, which they desperately need.

The combination of face-to-face and online, known as blended learning, has proven to be a superior method that combines various learning methods, pedagogical approaches, and internet technology (Seage & Türegün, 2020). Blended learning can improve student engagement in teaching and learning (He & Zhao, 2020). Blended learning, according to Putra & Fitrayati (2021), has been proven to improve students' critical thinking skills. Similarly, the findings of Islami et al., (2021) showed that the use of the blended learning paradigm in students can improve learning success.

The growth of information and communication technology in the 21st century has the potential to influence every aspect of human activity. One option is to use methods that combine learning with technology, such as Quizizz as an educational medium. Salsabila et al., (2020) explained that Quizizz is an educational game application that can be used to provide information and as a fun and exciting learning assessment medium to motivate students to participate actively in the learning process. This can be seen from the research by Widyadarsana et al., (2024), which reveals that the use of Quizizz has a positive impact on students, as it can increase their focus and enthusiasm in the learning process with an increase in the average percentage of critical thinking skills from 35% in the pre-cycle to 58% in cycle 1 and increasing again to 79% in cycle 2. In addition, learning outcomes also improved, as seen from the increase in learning completeness from 30% on the pre-test to 83% on the post-test. Quizizz itself is an evaluation tool to measure students' understanding and success after participating in the learning process (Lestari et al., 2023). Based on the above explanation, it is known that the Quizizz-assisted blended learning approach to reaction rate material is suitable for use in improving students' critical thinking skills and learning outcomes.

METHOD

This study used a quasi-experimental strategy based on a non-equivalent control group design. The research steps were adapted from Hendri (2014), as shown in Figure 1.

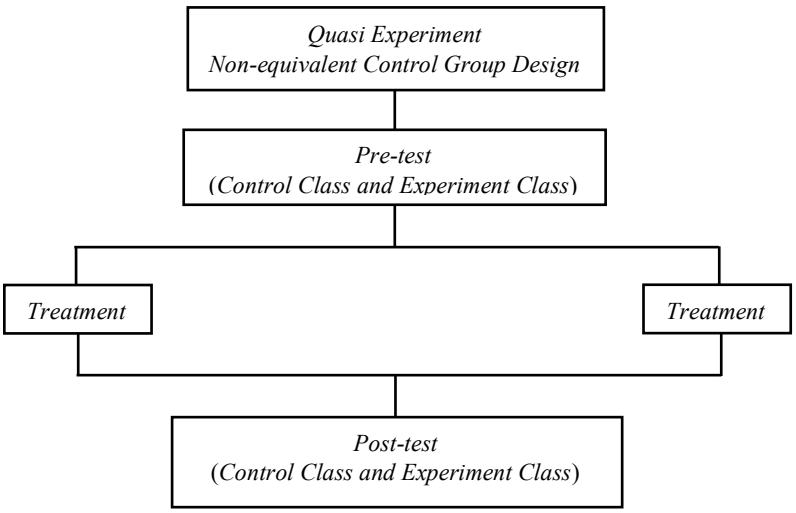

Figure 1. Quasi-experiment with non-equivalent control group design

All participants consisted of grade XI MIPA students covering five classrooms at MAN 2 Banjarmasin in the 2021/2022 academic year. The sample in this study was the XI MIPA 2 experimental group and the XI MIPA 4 control group, with 34 and 32 students, respectively, who had been recommended by their chemistry teachers. The independent variables in this study were the discovery learning model in the control group and the Quizizz-assisted blended learning model in the experimental group. On the other hand, the dependent variables in this study were the improvement in critical thinking skills and learning outcomes.

This research used test and non-test instruments in data collection techniques. Students could evaluate their critical thinking skills using a test instrument in the form of 7 essay questions. Meanwhile, to evaluate their learning outcomes, a test instrument in the form of 10 multiple-choice questions was used, one of which was correct and the others were distractors. The validity of these questions was tested by one chemistry teacher and four chemistry education lecturers before being used. One way to assess or evaluate learning outcomes is to use non-test instruments, such as distributing a questionnaire containing 10 positive questions.

Descriptive and inferential statistical techniques were used to analyze the data in this study. Data such as critical thinking skills, learning outcomes, and student responses were obtained from descriptive analysis in the field of educational research. The following formula can be used to determine the test scores before and after learning for each student in the areas of critical thinking skills and learning outcomes:

$$\text{Student score} = \frac{\sum \text{score obtained}}{\sum \text{maximum score}} \text{ x } 100$$

The hypothesized differences or deficiencies can be tested using inferential analysis. Before conducting the difference test (Wilcoxon and Mann-Whitney tests using IBM SPSS Statistics 25), normality and homogeneity tests were first conducted based on pre-test and post-test data (Sudjana, 2021).

RESULT AND DISCUSSION

Learning activities that guide students toward problem solving and collaboration can leave a positive impression on the development of critical thinking skills and the ability to acquire new information from students. The three steps taken in the Quizizz-assisted blended learning model are as follows: a) seeking of information (gathering information from various sources presented both online and through books supported by the validity of the information sources); b) acquisition of information (interpreting information individually and communally); c) synthesizing knowledge (reconstructing knowledge from the results of studies, analysis, and discussions and formulating conclusions).

Critical Thinking Ability

Wahyudi et al., (2020) identified five indicators of critical thinking according to Norris & Ennis (1989): (1) elementary clarification (providing simple explanations); (2) basic skills (developing basic abilities); (3) inferring (the ability to draw conclusions); (4) advanced clarification (providing more in-depth explanations); and (5) strategy (organizing tactics). In this study, measurements of students' critical thinking skills were taken before and after training for two groups, namely the experimental and control groups, and the data were analyzed using normality, homogeneity, Wilcoxon, and Mann-Whitney tests with IBM SPSS

Statistics 25 software. Figure 2 shows the test results for the experimental and control groups before and after learning.

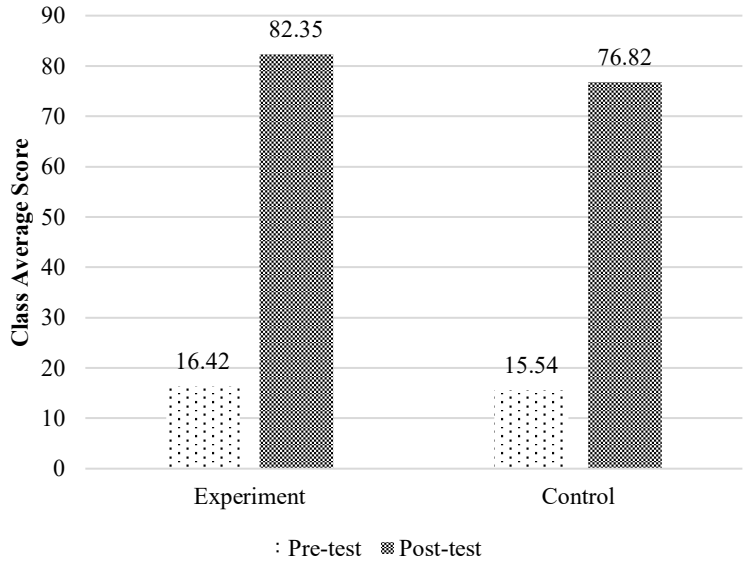

Figure 2. Average pre-test and post-test scores for critical thinking skills

The gap in post-test scores between the experimental and control groups is shown in Figure 2. Students in the experimental group obtained an average score of 82.35 on the critical thinking test, while students in the control group obtained an average score of 76.82. Students in the experimental group played a more prominent role in the learning process and may have found more solutions to the problems given than students in the control group. It can be said that students' critical thinking skills improved with the use of the blended learning paradigm with the help of Quizizz.

Fitria et al., (2023) stated that through blended learning, students can solve problems by expressing their thoughts and feelings based on their experiences, which helps them come up with innovative ideas. Table 1 shows how well students did in critical thinking for each part of the indicators based on the pre-test and post-test results for both the experimental and control groups.

Table 1. Average level of critical thinking skills achievement for each indicator

No.	Indicator	Experiment class		Control class	
		Pre-test	Post-test	Pre-test	Post-test
1	Elementary Clarification	37.25	79.41	47.40	88.02
2	Basic Skills	19.61	82.35	22.92	79.17
3	Inferring	10.78	90.69	4.69	78.13
4	Advanced Clarification	10.78	72.88	10.07	68.40
5	Strategy	12.25	86.76	7.29	76.30
	Average	**16.42**	**82.35**	**15.54**	**76.82**

Based on Table 1, the average value of the elementary clarification indicator, or the ability to provide simple explanations to students in the experimental group, increased from 37.25 to 79.41 by 42.16, while for students in the control group, it increased from 47.50 to 88.02 by 40.52. When comparing the conditions before and

after the test, the control group performed better on this indicator because its students started with a higher initial level of ability. However, when using the Quizizz-assisted blended learning model, the average score of the experimental group increased more than that of the control group. The elementary clarification skills of students in the experimental group were continuously developed at each meeting through the use of the Quizizz application, which contained sub-materials and quizzes provided by the teacher. At the end of the lesson, homework in the form of worksheets was given to reinforce the understanding that had been built previously. Quizizz as a learning aid can improve the quality of learning by reflecting students' understanding (Setiawati et al., 2024). These findings are consistent with those of Suciono et al., (2020), who reported that students obtained a percentage of 62.30%, which is classified as good for the elementary clarification indicator. Elementary clarification itself is related to a person's ability to focus on problems, examine arguments, ask questions, and respond to problems that require explanation in the face of challenges (Indriana & Hidayati, 2022). Not all students dare to express their opinions in class, even though some of them have many ideas. Conversely, blended learning can encourage students who tend to be reserved to become more active because the learning process provides many opportunities to ask questions or respond to issues (Pratiwi et al., 2022).

The basic skills indicator, or the ability to develop basic skills for students in the experimental group, experienced an increase in the average score from 19.61 to 82.35, an increase of 62.74, while for students in the control group, the average score increased from 22.92 to 79.17, an increase of 56.25. These findings show that the performance of students in the experimental group was better than that of students in the control group in terms of acquiring basic skills. When searching for and collecting important information as a step in completing or answering quizzes presented on the Quizizz application, students in the experimental group had to be able to assess whether a source was reliable, observe, and assess an observation report. The results of this study are consistent with the research by Suciono et al., (2020), which states that students obtained a percentage of 62.80% on a scale of good for the basic skills indicator. Basic skills themselves are related to a person's ability to evaluate the reliability of information and review observations based on their own observations (Puspita et al., 2020). The learning process through blended learning is not dominated by the transfer of theoretical knowledge but encourages students to learn collaboratively and independently through various evidence-based information-seeking activities. Students are guided to explore various issues that arise in their environment, thereby making learning more meaningful (Suriansyah et al., 2021).

The average score for the inferring ability, or conclusion-drawing ability, of students in the experimental group increased from 10.78 to 90.69, an increase of 79.91, while for students in the control group, it increased from 4.69 to 78.13, an increase of 73.44. This shows that the experimental group has the intellectual capacity to make the right decisions about which methods to use to support their findings. The results of this study reinforce the research by Suciono et al., (2020), which states that students obtained a percentage of 57.50% on a scale of fairly good for the inferring indicator in critical thinking skills. Andini & Warmi (2019) associated inferring with a person's capacity to form and review deductions, form and review inductions, and form and review the results. The reason for the increase in critical thinking is that blended learning allows students to obtain information extensively from various print and digital sources, thereby deepening their understanding to consider a concept needed to draw clear conclusions (Rachmawati & Subekti, 2022).

The advanced clarification ability indicator, or the ability to provide more in-depth explanations to students in the experimental group, increased from an average score of 10.78 to 72.88, an increase of 62.10, while for students in the control group, it increased from 10.07 to 68.40, an increase of 58.33. This shows that students in the experimental group were able to provide further explanations by presenting their thoughts, defending their reasoning based on evidence, and relating their explanations to the situation at hand. The results of this study are in line with the research by Suciono et al., (2020), which states that 53.70% of advanced clarification indicators are fulfilled with a fairly good category. Advanced clarification is related to a person's capacity to further clarify their ability to recognize terms, think about definitions, and find assumptions (Sinurat et al., 2020). The improvement in critical thinking skills occurred because blended learning created knowledge that was formed in the cognitive structure of each student. The students' ability to connect one concept with another helped provide further explanation (Rachmawati & Subekti, 2022).

The strategy ability indicator, or the ability to organize tactics, for students in the experimental group increased from an average score of 12.25 to 86.76, an increase of 74.51, while for students in the control group, it increased from 7.29 to 76.30, an increase of 69.01. This condition shows that students in the experimental group were able to organize tactics to uncover problems, decide on actions in determining the answer, and write down the reasons for their answers completely in accordance with the questions given. These findings are in line with those of Suciono et al., (2020), which state that students obtained a percentage of 57.10%, which is classified as fairly good for the strategy indicator. To have a good strategy, a person must be curious, open-minded, well-informed, smart in making decisions, and ready to reevaluate a situation based on new information (Zaini et al., 2018). Blended learning itself is divided into three phases, namely pre-planning, planning, and post-planning, which can help students have an open mind to better understand and explore new knowledge, help them solve problems, and determine the appropriate actions to solve problems, thereby positively influencing students' critical thinking (Syifa et al., 2022).

A teacher needs to have the ability to decide on a learning model and combine appropriate learning media to focus on fostering student-centered learning. This can provide students with relevant learning experiences and strengthen their critical thinking skills. Teachers must organize their teaching by producing learning tools such as syllabi, lesson plans, student worksheets, and assessment sheets. This can make learning more structured (Boleng et al., 2018).

Students' critical thinking skills were assessed before and after learning using tests, and the data were collected and evaluated using normality, homogeneity, Wilcoxon, and Mann-Whitney tests with IBM SPSS Statistics 25. The results of the pre-test and post-test normality tests showed that the experimental and control groups were normally distributed. The results of the pre-test homogeneity test showed that students in the experimental and control groups started with equivalent levels of ability. Meanwhile, the post-test homogeneity test found non-homogeneous variance between the experimental and control groups. Table 2 and Table 3 show the results of the Wilcoxon and Mann-Whitney tests conducted using IBM SPSS Statistics 25.

Table 2. Results of the Wilcoxon test of pre-test and post-test data on critical thinking skills

Class	Result	N	Sig	α	Conclusion
Experiment	Pre-test Post-test	34	0.000	0.05	There is a difference
Control	Pre-test Post-test	32	0.000	0.05	There is a difference

Based on Table 2, the Sig value reviewed from critical thinking skills was 0.000 with $\alpha = 0.05$, where Sig < α (0.000 < 0.05), which means H_0 was rejected. This means that a difference in the mean value was found in relation to students' critical thinking skills. This is shown by the use of the blended learning model assisted by Quizizz by the experimental group before and after the test, which showed an increase in critical thinking skills. Similarly, the use of the discovery learning model by the control group before and after the test also showed an increase in critical thinking skills.

Table 3. Mann-Whitney test results for post-test critical thinking ability data

Class	Result	N	Sig	α	Conclusion
Post-test	Experiment Control	34 32	0.010	0.05	There is a significant difference

The post-test Sig value reviewed from critical thinking skills based on Table 3 was obtained at 0.010 with $\alpha = 0.05$, where Sig < α (0.001 < 0.05), so it is known that H_0 is rejected and H_1 is accepted. As a result, it can be said that there is a difference in the average score referring to students' critical thinking skills. This is shown by the fact that after using the blended learning model assisted by Quizizz by the experimental group, there was an increase in critical thinking compared to after using the discovery learning model by the control group. In accordance with the research by Sari et al. (2023), which shows a significant increase in students' critical thinking skills before and after learning, where Sig < α (0.001 < 0.05) using a WhatsApp-assisted blended learning model on colloid system material. Furthermore, research by Suana et al., (2019) shows that the application of blended learning in a guided inquiry learning model has a significant effect on students' critical thinking skills in static electricity material, where Sig < α (0.00 < 0.05). In addition, research by Maunino & Tacoh (2023) showed that the use of Quizizz learning media has a positive impact on students' critical thinking skills, where r = 0.587 with a significance level of p = 0.000, resulting in (0.000 < 0.05).

Learning Outcomes

Behaviors such as engagement, perseverance, process skills, motivation, and student academic success can all be influenced by learning outcomes (Winkel, 1991). In this study, tests were administered to students in two groups, namely the experimental and control groups, before and after learning, and the data were analyzed using normality, homogeneity, Wilcoxon, and Mann-Whitney tests with IBM SPSS Statistics 25 to measure the impact of the intervention on learning. Figure 3 shows the test results of the experimental and control groups before and after learning.

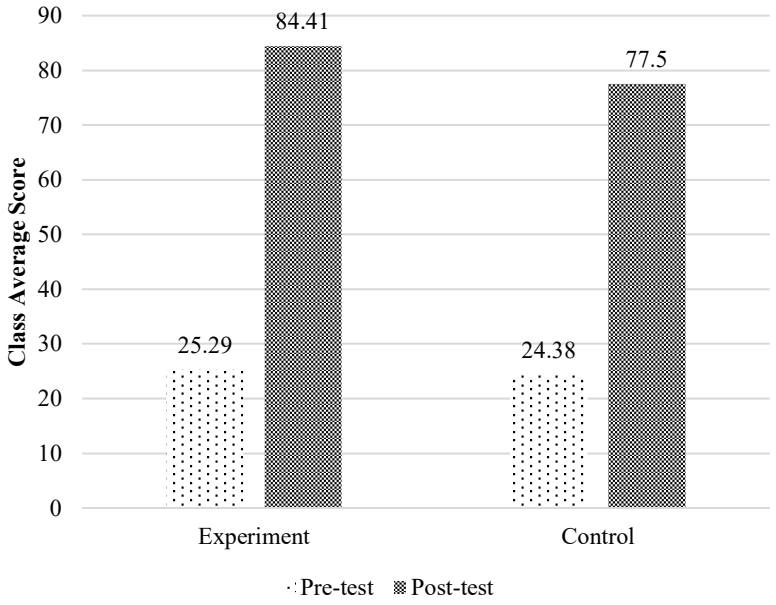

Figure 3. Average pre-test and post-test scores

The distribution of post-test results between the experimental and control groups is shown in Figure 3. Compared to the control group, which had an average learning score of 77.50, the experimental group had a significantly higher average learning score of 84.41. Blended learning exercises facilitated with the help of Quizizz showed how students' critical thinking skills improved in line with their academic progress. Students are taught to think critically to improve their academic performance. Students in blended learning are guided and encouraged to discover their own learning with the help of online technology (Fap & Hardini, 2021). Quizizz is one example of innovation in learning (Purbayatri, 2023). Research by Santoso et al. (2023) states that Quizizz, as an interactive medium, can improve learning outcomes by an average of 23.5%, from a pre-test average of 68.47 to a post-test average of 84.59. Table 4 shows the pre-test and post-test results along with the average degree of learning completeness for each indicator section, both for the experimental and control groups.

Table 4. Average achievement level for each indicator

No.	Indicator	Experiment class		Control class	
		Pre-test	Post-test	Pre-test	Post-test
1	Determining the concentration of a solution	52.94	91.18	68.75	81.25
2	Examining the concept of reaction rate	19.12	79.41	14.06	64.06
3	Explaining collision theory	14.71	70.59	28.13	75.00
4	Analyzing factors that affect reaction rate	2.94	88.24	15.63	81.25
5	Relating factors that affect reaction rate to collision theory	17.65	83.82	18.75	82.81

No.	Indicator	Experiment class		Control class	
		Pre-test	Post-test	Pre-test	Post-test
6	Analyzing the determination of reaction rate laws or reaction rate equations	29.41	88.24	12.50	84.38
7	Analyzing the determination of reaction order based on logical, comparative, and graphical methods	39.71	89.71	26.56	79.69
Average		**25.29**	**84.41**	**24.38**	**77,50**

The average achievement level for each indicator based on Table 4 shows that for indicator 1, the experimental group obtained a higher average score of 91.18, while the control group obtained 81.25. This shows that the experimental group was better at determining the concentration of a solution. For indicator 2, the experimental group obtained a higher average score of 79.41, while the control group obtained 64.06. For this indicator, the difference between the post-test averages of the control class and the experimental class was quite significant compared to other indicators, namely 15.35. This shows that the experimental group was better at analyzing the concept of reaction rate because students were good at combining various pieces of information to help solve problems and come up with the best alternatives that could be used as solutions. In this case, students were able to conclude a problem from various perspectives. Students were also accustomed to double-checking their answers to minimize errors. Indicator 3 showed a higher average score in the control group of 75, while the experimental group scored 70.59. In this indicator, the control group performed better than the experimental group, which may be due to the fact that the questions contained distractors with similar explanations, resulting in students not focusing on determining the correct answer. Indicator 4 showed a higher average score in the experimental group (88.24) than in the control group (81.25). This shows that the experimental group was better at analyzing the factors that influence the reaction rate.

The next indicator, indicator 5, obtained a higher average score in the experimental group of 83.85, while in the control group it was 82.81. This shows that the experimental group was better at connecting the factors that influence the reaction rate with collision theory. Indicator 6 showed a higher average score in the experimental group (88.24) than in the control group (84.38). This shows that the experimental group was better at analyzing the determination of reaction rate laws or reaction rate equations. Finally, indicator 7 obtained a higher average score in the experimental group of 89.71, while the control group scored 79.69. This indicates that the experimental group was better at analyzing reaction order determination based on logical, comparative, and graphical methods in learning outcome tests using the Quizizz-assisted blended learning model. Blended learning requires teachers to always ensure that the learning process runs effectively by building relationships with their students. Critical thinking skills are developed through guided exercises related to real-world problems and presented in accordance with students' cognitive development. Accuracy and the ability to solve problems are equivalent to solving problems, so learning success can be influenced by critical thinking. It is important to incorporate HOTS elements into questions by creating contextual questions and using aspects of understanding, application, and analysis to help students build on the knowledge they have previously acquired (Wahyunita & Subroto, 2021). Quizizz as an evaluation medium plays a role in supporting successful learning so that students'

critical thinking skills and learning outcomes can improve together (Maunino & Tacoh, 2023).

Students who are able to retain and apply what they have learned will become successful learners. Learning success is also supported by constructivism theory, which has two main implications: 1) individual constructivism, as proposed by Piaget, in which students construct knowledge by modifying, integrating, and reorganizing knowledge from previous information; and 2) social constructivism, as expressed by Vygotsky, in which students construct knowledge through their interactions with others (Baharuddin, 2008). This is in line with research (Wahyunita & Subroto, 2021) that reports that questions referring to critical thinking ability indices have increased rapidly and student classical mastery has reached 83.3%. This shows that blended learning strategies greatly improve students' learning success and critical thinking skills. The term "blended learning" refers to the practice of combining online and offline learning experiences. In the blended learning paradigm, students have access to a variety of learning materials through computers and other internet-based devices, which can broaden their perspectives and encourage independent learning. On the other hand, when students have difficulty understanding a learning topic, they can still ask questions directly to the teacher. The existence of teachers will still be needed in the classroom in order to encourage active student engagement with exposure to the real and dynamic changes in the world (Puspitarini, 2022).

According to research conducted by Mawaddah et al., (2021), Quizizz can encourage students to take an active role in their education by providing interesting learning content and interactive quizzes with a variety of themes at various levels or subjects. Quizizz itself can improve students' understanding, critical thinking skills, and accuracy in completing timed quizzes, which will have an impact on improving their learning outcomes. As an online evaluation tool, Quizizz is ideal for providing immediate feedback to teachers in the form of student scores (Zaeni, 2022). In line with Cholik's (2023) research, students become more focused and attentive to quizzes created by educators when using Quizizz. Quizizz, designed as a game-based educational medium, makes students serious and enthusiastic about learning. The level of enjoyment in playing quizzes has a positive effect on students' intelligence in learning.

Student learning outcomes were assessed before and after learning through tests, and the data were collected and evaluated using normality, homogeneity, Wilcoxon, and Mann-Whitney tests with IBM SPSS Statistics 25. The results of the pre-test and post-test normality tests obtained in the experimental and control groups did not follow a normal distribution, although the findings of the pre-test and post-test homogeneity tests for both groups indicated homogeneous variance. Table 5 and Table 6 show the results of the Wilcoxon test and Mann-Whitney test conducted using IBM SPSS Statistics 25.

Table 5. Results of the Wilcoxon test of pre-test and post-test data on student learning outcomes

Class	Result	N	Sig	α	Concluion
Experiment	Pre-test Post-test	34	0.000	0.05	There is a difference
Control	Pre-test Post-test	32	0.000	0.05	There is a difference

Based on Table 5, the Sig value reviewed from learning success was only 0.000 with $\alpha = 0.05$, where Sig < α (0.000 < 0.05), which means H_0 was rejected. This means that a difference in the average student scores was found in terms of learning outcomes. This is shown by the use of the blended learning model assisted by Quizizz by the experimental group before and after the test, which showed an increase in learning outcomes. Similarly, the use of the Discovery Learning Model by the control group before and after the test also showed an increase in learning outcomes.

Table 6. Mann-Whitney test results of post-test data on student learning outcomes

Class	Result	N	Sig	α	Conclusion
Post-test	Experiment	34	0.014	0.05	There is a difference
	Control	32			

The post-test Sig value reviewed from learning success based on Table 6 was obtained at 0.014 with $\alpha = 0.05$, where Sig < α (0.014 < 0.05), so it is known that H_0 is rejected and H_1 is accepted. As a result, it can be said that there is a difference in the average student scores referring to learning outcomes. This is shown by the fact that after using the blended learning model assisted by Quizizz by the experimental group, there was an increase in learning outcomes compared to after using the discovery learning model by the control group.

In line with the research by Puspitasari et al., (2022), which shows that there is an increase in learning outcomes where the Sig value is < α (0.000 < 0.05) using a blended learning model on the subject of My Nation's Cultural Diversity. Furthermore, research by Purwadi et al. (2022) shows that multimedia-based blended learning has an effect on student learning outcomes in human digestive system material at SMA Negeri 1 Praya Tengah, where Sig < α (0.035 < 0.05). Additionally, research by Billa et al. (2023) shows that the Quizizz educational game itself plays a role in student learning outcomes in civics education, where Sig < α (0.000 < 0.05).

Student Responses

Students in the experimental group were given a questionnaire at the end of the learning process to evaluate the effectiveness of the blended learning model supported by Quizizz, as were students in the control group who used the discovery learning model. Student responses were collected using a questionnaire containing 10 multiple-choice questions. Figure 4 provides a brief summary of the results of the test of students' understanding of response speed.

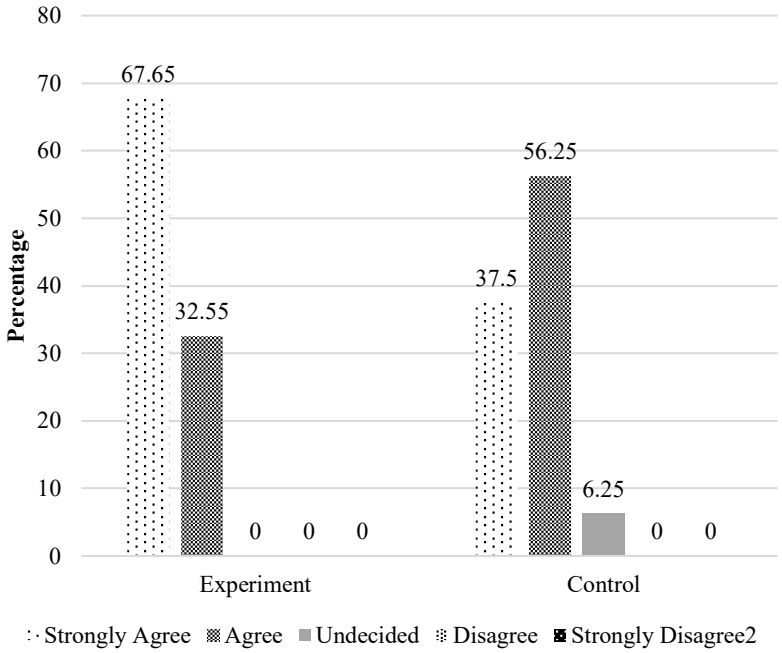

Figure 4. Students' responses to learning

Figure 4 shows that the proportion of students who answered “strongly agree” increased significantly in the experimental group to 67.65%, while in the control group it was only 37.50%. When viewed from the discovery learning paradigm used by the control group, the blended learning model assisted by Quizizz used by the experimental group received a more positive response from students. This is in line with the research by Putri et al., (2021) that students gave a positive response to the implementation of blended learning, with 76% responding “good.” Furthermore, research by Rahmawati et al., (2022) states that students' positive responses to the use of Quizizz on the interest indicator were 81.6% in the “very good” category. Meanwhile, on the concentration indicator, they were 80% in the “very good” category.

The improvement in critical thinking and student learning success is evidence of the success of the Quizizz-assisted blended learning approach. Implementing a blended learning model is the first step to increasing learning enthusiasm, reducing conceptual misunderstandings, improving students' capacity for long-term memory, and making learning materials easier to understand (Muis & Bahri, 2018). The results of this study are consistent with the results of Wardani et al., (2018), who argued that the blended learning approach can modernize and improve face-to-face educational experiences in line with the 21st century. Citra & Rosy (2020) mention that Quizizz as a learning medium has advantages, namely that the practice questions or quizzes presented in the Quizizz application have time limits, so that students are taught to think carefully, accurately, and quickly in working on these practice questions or quizzes.

The time limit helps train students' critical thinking skills so that they always stimulate their memory of the material previously presented by the teacher. Of course, this allows students to compete for the highest scores and motivates them to study harder so that their learning outcomes show improvement (Arif et al., 2021). The

positive response received by the Quizizz-assisted blended learning model from students is proof of its potential and usefulness as a means of improving students' analytical skills and the quality of their overall educational experience.

CONCLUSION

The research findings indicate that blended learning utilizing Quizizz in the experimental class was able to improve critical thinking skills and learning outcomes more significantly than discovery learning in the control class. In addition, students responded very positively to the application of blended learning in reaction rate material. This study recommends that the use of blended methods supported by Quizizz continue to be considered and developed to improve critical thinking skills and student learning outcomes in various teaching materials.

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