



Mathematical Communication and Critical Thinking Skills Through the Implementation of the Quizzizz Application

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Article Info

Article history:

Submitted: November 16, 2025

Accepted: December 07, 2025

Published: December 14, 2025

Keywords:

Quizzizz
Communication
Mathematical Critical
Thinking

Abstract

Background of study: Students playing with smartphones during class is a consequence of the increasing use of gadgets. This habit causes students to lose focus during the learning process. Consequently, students' communication and critical mathematical thinking skills decline.

Aims and scope of paper: Learning innovation is needed to support the development of students' mathematical communication and critical thinking skills. In the process, students are facilitated and encouraged to be more enthusiastic about learning through Quizzizz. The purpose of this research is to determine the influence of the Quizzizz application on students' mathematical communication and critical thinking skills.

Methods: This type of research is *quasi-experimental design*. The population was all eighth-grade students at MTs Muhammadiyah Sukarame Bandar Lampung. The sample selection used a simple random sampling technique. Data collection techniques used a communication ability test and mathematical critical thinking. The data analysis technique used in this study was the Multivariate Analysis of Variance test with a significance level of 5%.

Result: The results of this study obtained a value of 0.000, which indicates that there is an influence of Quizzizz on mathematical communication and critical thinking skills. *p – value*

Conclusion: Quizzizz has a positive impact on mathematical communication and critical thinking skills.

To cite this article: Widyawati, S., Maisaroh. (2025). Instruction / Mathematical Communication and Critical Thinking Skills Through the Implementation of the Quizzizz Application. De Partial Journal, 1(2), 73-81. <https://doi.org/10.22460/departial.v1i1.pxx-xx>

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INTRODUCTION

In early 2020, many schools began implementing online learning. This has led to students becoming increasingly attached to technology. This familiarity has led to students becoming more familiar with and accustomed to using smartphones. Many students, however, take advantage of this situation to engage in activities outside of class. One impact of this problem is that when learning takes place in class and students feel bored, they become preoccupied with their own smartphones. As a result, students lose focus, resulting in poor communication and critical thinking skills, as they lack understanding of the material being presented. Students' communication and critical thinking skills need to be developed, as these two abilities are part of the 21st-century learning competencies summarized in the 4Cs.

The importance of communication skills is stated in the Minister of National Education Regulation No. 22 of 2006 concerning the objectives of mathematics learning, namely so that students have the ability to communicate ideas with symbols, tables, diagrams or other media to solve a situation or problem (Shadiq, 2008). According to Umar, communicative ability is the ability of students to communicate their ideas in solving problems given by the teacher, participate in discussions, and be responsible for their answers to problems (Suyani & Wulandari, 2020). Simply put, mathematical communication skills are students' abilities to convey their ideas using mathematical language, both verbally and in writing. Ideas expressed can take the form of images, graphs, symbols, notations, equations, and so on, using mathematical language. Good communication skills are strongly influenced by analytical skills, drawing conclusions, and making sound decisions. Someone who lacks good analytical skills will have difficulty communicating the information they have obtained. In the process of planning solutions, stating and compiling steps to solve problems in the mathematical communication process, if the information obtained is still insufficient, other skills are needed, namely critical thinking (Kurniawati & Ekayanti, 2020).

Critical thinking skills, as part of higher-order thinking skills (HOTS), direct students to think not only by memorizing but also by understanding the essence of what is contained within. Critical thinking skills play a role in developing a person's moral and social mentality (Noor & Ranti, 2019). According to Ali Hamzah, critical thinking is a cognitive process and mental action to acquire knowledge. Critical thinking is the ability to analyze, identify, and evaluate a problem to make decisions that align with assessment standards (Asrori, 2020). This indicates that with critical thinking skills, a person is able to stimulate himself to think more logically and can filter information, choose things that are important or need to be prioritized, so that a person can solve various kinds of problems that are faced (Kurniawati & Ekayanti, 2020). In addition, critical thinking skills are important in helping students solve abstract mathematical problems (Mujib, 2019). Therefore, one of the critical thinking skills that students need to develop is the ability to think critically in mathematics. Mathematical thinking is the ability to reason about problems, develop strategies, and use methods to reason about a problem. The ability to develop and discover these methods and strategies is used to conduct experiments and arrive at conclusions or solve problems in mathematics learning (Astuti, Farida, & Pratiwi, 2022).

Students' mathematical communication and critical thinking skills can be developed through interactive learning. Community surveys show that learning media is a crucial aspect of the teaching and learning process, creating a more active learning environment (Supriadi, Ramadhona, Pratiwi, & Widyawati, 2020). Interactive learning media in the form of games can be used as a means of delivering material and assessing student understanding of the material presented. Several interactive learning media incorporate games into their features, one of which is Quizizz. Quizizz is a narrative and flexible application that can be used for delivering material and as a means of evaluating learning through engaging and fun games (Salsabila, Habiba, Amanah, & et al, 2020). Through this app, teachers can connect with each other and access free quizzes. Therefore, educators will never run out of ideas and can learn from each other to make learning interactive.

Quizizz has a positive impact on classroom learning, as evidenced by the findings of Zhao, Mei, Ju, and Adam, who found that students' grades and collaboration improved through Quizizz. The app can also be a solution to students' less-than-beneficial smartphone use in the classroom (Salsabila et al., 2020). Furthermore, research conducted by Agustina and Rusmana proves that Quizizz's features are suitable as a learning application that supports the 4.0 learning revolution due to its ease of use and assessment process. Other research indicates that the Quizizz application can increase student engagement in learning (Amany, 2020).

Changes in learning patterns that require students to understand the material independently, and sometimes teachers who don't provide material regularly, result in students experiencing difficulties and being reluctant to learn or explore information on their own. Consequently, if PBL learning is monotonous or without the aid of interactive media, students who were initially reluctant to learn will lose their enthusiasm. Therefore, implementing the Quizizz application is necessary to increase enthusiasm for learning and curiosity about the material presented. Through this curiosity, students can stimulate the development of communication skills and become more critical thinkers (Sianturi, Sipayung, & Simorangkir, 2018). This can happen because the use of these media can create a more interactive learning environment, and students will use their smartphones for learning.

Referring to previous research, Jira Rastal Arif, Aiman Faiz, and Lidiya Septiani stated that Quizizz media can shape students' critical thinking skills in online learning. In addition, research conducted by Fahriza Noor and Mayang Gadih Ranti showed a relationship between critical thinking skills and mathematical communication skills. However, these studies still examine these variables separately and have not specifically examined the simultaneous effect of using Quizizz media on mathematical communication and critical thinking skills. Therefore, this study was conducted to fill this gap by examining students' mathematical communication and critical thinking skills through the application of Quizizz.

METHOD

Research Design

This study uses a quasi-experimental design, namely a research design that involves administering treatment to the experimental group and comparing it with the control group without carrying out full randomization, so that it still allows researchers to test the effect of using Quizizz systematically in real classroom conditions.

Participant

Participants in this study included class VIII students of MTs Muhammadiyah Sukarame Bandar Lampung who participated in learning activities in mathematics, and were involved as subjects to observe the impact of implementing Quizizz in learning.

Population and Sampling

The population in this study was all eighth-grade students at MTs Muhammadiyah Sukarame Bandar Lampung in the 2024/2025 academic year. The sample was selected using a simple random sampling technique, so that each student in the population had an equal chance of being selected as a member of the experimental or control class.

Instrument

The instrument in this quantitative research uses a test of mathematical communication and critical thinking skills. The indicators used in this study are:

Table 1. Indicators of Mathematical Communication and Critical Thinking Skills

Ability	Indicator
Mathematical Communication(Corebima, Garak, & Samo, 2020)	<ol style="list-style-type: none"> 1. The ability to express mathematical ideas orally and in writing, as well as demonstrate and describe them visually (in writing). 2. The ability to understand, formulate and evaluate mathematical ideas orally, in writing or in other visual forms (drawing). 3. The ability to use mathematical language such as notation and terms in mathematics and its structures to show ideas and describe their relationship to situation models (mathematical expressions).
Mathematical Critical Thinking(A. Putri, 2018)	<ol style="list-style-type: none"> 1. Interpretation is a person's ability to understand problems that are shown through their answers in writing, whether known or asked in the question. 2. Analysis is a person's ability to identify the relationship between questions, statements and concepts presented in the problem, which is demonstrated by the way he or she provides explanations and creates mathematical models correctly and precisely. 3. Evaluation is a person's accuracy in choosing and using strategies to complete and solve problems in questions completely and accurately in their calculations.

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4. Inference is a person's ability to draw conclusions correctly and precisely.
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Procedures and Time Frame

The research procedure is carried out through four main stages as follows:

1. Research Preparation: Determining the experimental class and control class using simple random sampling techniques, and coordinating with teachers to determine the material and implementation schedule.
2. Learning Implementation: Providing treatment in the form of learning using the Quizizz application in the experimental class, while the control class received conventional learning without interactive media.
3. Post-test Administration: After all treatments were completed, both classes were given a post-test on mathematical communication and critical thinking skills using the same instrument.
4. Data Processing and Analysis: Collecting test results, scoring, and analyzing the data using prerequisite tests and MANOVA to determine the effect of Quizizz use. Each stage of the research was conducted in the 2024/2025 academic year.

Analysis plan

The test data were then analyzed using multivariate analysis of variance (MANOVA) with a 5% significance level. MANOVA was chosen because it allows the simultaneous testing of the treatment's effect on two dependent variables: communication skills and mathematical critical thinking skills. Through this analysis, researchers can determine whether the implementation of Quizizz significantly improves these two skills compared to learning without interactive media.

Scope and limitations

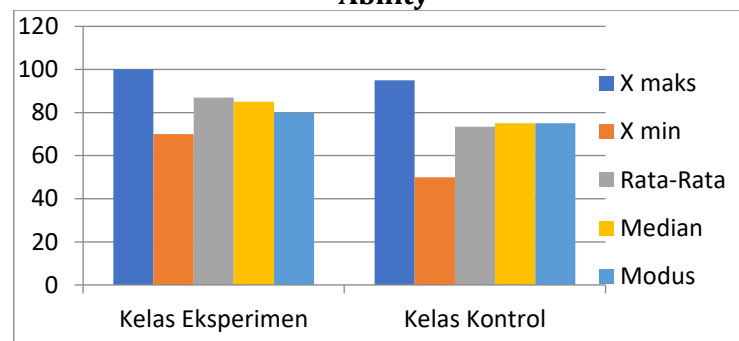
This research is limited to one school and one grade level so that the generalization of the results is limited and not widespread.

RESULTS AND DISCUSSION

Results

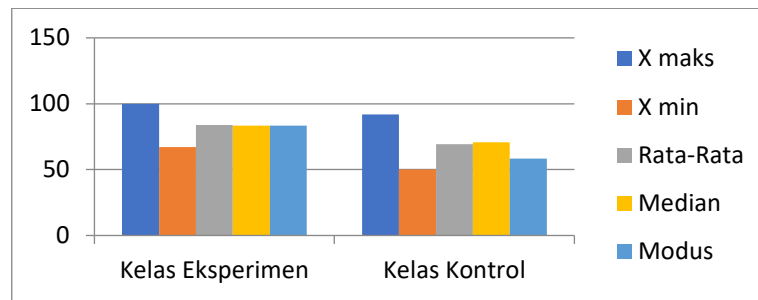
Based on the data obtained through the mathematical communication and critical thinking ability tests that have been conducted, it can be said that there is an influence of the Quizizz application on students' mathematical communication and critical thinking abilities. The description of the analysis of the test assessment results is:

Figure 1 Data Diagram Description of Post-test Scores of Mathematical Communication Ability



Based on Figure 1, it can be said that the mathematical communication skills of students in the experimental class are better than those in the control class. This can be seen from the maximum score in the experimental class which is higher than the control class, namely 100 for the experimental class and 95 for the control class. The minimum score in the experimental class is also greater than the control class, namely 70 for the experimental class and 50 for the control class. Based on the central tendency value, the experimental class has a higher score than the control class.

Figure 2 Data Diagram Description of Post-test Scores of Mathematical Critical Thinking Ability



Based on Figure 2, it can be said that the critical thinking skills of students in the experimental class are better than those in the control class. This can be seen from the maximum score in the experimental class which is higher than the control class, namely 100 for the experimental class and 92 for the control class. The minimum score in the experimental class is also greater than the control class, namely 67 for the experimental class and 50 for the control class. Based on the central tendency value, the experimental class has a higher score than the control class.

Based on the results *post-test* communication and critical thinking skills, to see their more significant influence, can be seen through hypothesis testing using the MANOVA test with the help of SPSS 26. However, before the test is carried out, prerequisite tests are first carried out, namely normality and homogeneity tests. The results of the normality test obtained a value of *p-value* of 0.051 in the experimental class, and 0.147 in the control class. Therefore, the value *p-value* > 0.05, so the data in all classes are normally distributed. Based on the results of the Box's M test, the value obtained indicates that the data obtained is homogeneous *p* > 0,05.

Once the prerequisite tests have been met, the next step is to conduct a MANOVA test. The MANOVA test is conducted to determine whether or not the application has an effect. *quizizz* on mathematical communication and critical thinking skills. The results of the MANOVA test are:

Table 2. SPSS Output Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Quizizz App	Pillai's Trace	,493	17,194	4,000	210,000	,000	,247
	Wilks' Lambda	,508	20,941b	4,000	208,000	,000	,287
	Hotelling's Trace	,964	24,833	4,000	206,000	,000	,325
	Roy's Largest Root	,961	50,453c	2,000	105,000	,000	,490

Table 2 shows that the mathematical communication and critical thinking skills using the four MANOVA tests obtained a Sig. 0.05 value, which is 0.00, and the F value in the test is significant. Therefore, the hypothesis is rejected. This indicates that there is an effect of the Quizizz application on students' mathematical communication and critical thinking skills. The effect of this media on each ability test tested can be determined through tests between subjects or variables. The following are the results of tests between subjects/variables (Tests of between-subject effects) using SPSS:<
 $H_{0AB} : \alpha\beta_{ij} = 0$

Table 3. SPSS Output Tests of Between-Subject Effects

Source	Dependent Variable	Type I Sum of Squares	Df	Mean Square	F	Sig.
Quizizz App	Mathematical Communication	3403,917	2	1701,959	25,780	,000
	Mathematical Critical Thinking	3830,754	2	1915,377	20,826	,000

Based on the test between subjects/variables (Tests of between-subject effects) using SPSS in Table 5, it can be concluded that:

- a. $H_{0A}: \alpha_1 = \alpha_2 = \alpha_3$ rejected because the sig. value is 0.00, so it can be said that there is an influence of the quizizz application on students' mathematical communication abilities. $< 0,05$ was rejected because the sig. value was 0.00, so it can be said that there is an influence of the Quizizz application on students' mathematical critical thinking abilities. $H_{0B}: \beta_1 = \beta_2 = \beta_3 < 0,05$

Discussion

Based on the conclusion of all the results obtained through the MANOVA test, and the measure of central tendency (mean, median and mode) on the post-test results of mathematical communication and critical thinking skills, it can be concluded that the Quizizz application has a better influence on students' mathematical communication and critical thinking skills compared to classes without the help of interactive media. This is because the Quizizz application is one of the fun learning application media, and can be accessed by students and teachers easily (VD Putri, 2021). In addition, Quizizz can also increase student learning motivation, which can influence students' mathematical communication skills. This is in line with research conducted by Hastri Rosiyanti, Ririn Widiyarsari, Ahmad Fikri Adriansyah, and Sarah Istiqomah, who stated that there was a difference in the influence on learning motivation between before and after Quizizz was implemented, where students were more enthusiastic about implementing Quizizz learning. (Rosiyanti, Widiyarsari, Ardiansyah, & Istiqomah, 2020). In addition, research conducted by Muhammad Abdi states that there is a significant role of learning motivation in mathematical communication skills, where the higher the student's learning motivation, the higher their mathematical communication skills will be (Abdi, 2018). Using Quizizz can also develop students' critical thinking skills. This aligns with research conducted by Jira Rastal Arif, Aiman Faiz, and Lidiya Septiani, which found that Quizizz can develop students' critical thinking skills in online learning. (Arif, Faiz, & Septiani, 2022). The results of the post-test calculation of mathematical critical thinking skills obtained in the experiment were better than those in the control class. Based on the results of calculations and observations during the learning process, it can be concluded that the Quizizz application has a better influence on communication skills and mathematical critical thinking, compared to the class without the Quizizz application.

Implications

The implementation of the Quizizz application has shown a significant positive impact on improving students' mathematical communication and critical thinking skills. This implies that:

1. Teachers should consider interactive learning innovations, especially game-based media such as Quizizz, to overcome the problem of students' lack of focus due to the habit of using smartphones.
2. Fun and easily accessible learning media can be an effective tool to increase learning motivation, which ultimately supports the development of students' mathematical communication and critical thinking skills.

Research contribution

This research contributes empirical evidence that the use of interactive learning media such as Quizizz can improve students' mathematical communication and critical thinking skills. Furthermore, this research enriches the literature on the effectiveness of game-based learning in the context of mathematics education and provides practical recommendations for teachers in selecting media that support the development of 21st-century competencies. This research also shows that

technology can serve as an effective and easily integrated evaluation tool in learning at the junior high school level.

Limitations

This research still has several limitations. The research was only conducted on MTs Muhammadiyah Sukarama Bandar Lampung in the 2024/2025 academic year. Therefore, the generalizability of the findings is still limited to specific contexts. The instrument used was only a written test, so it does not fully reflect communication skills in oral or face-to-face interactions. Furthermore, using Quizizz requires a stable internet connection, so less-than-optimal network conditions can impact student performance in answering questions. These limitations open up opportunities for improvement in future research.

Suggestions

Based on research findings obtained, the researcher suggests the following things:

1. Teachers are expected to use learning media that can more effectively activate the classroom atmosphere and help students develop their communication and critical mathematical thinking skills. For example, using more active media without the internet, such as GeoGebra.
2. For researchers, researchers hope to be able to use Quizizz media on other materials, and for other researchers it is recommended to be able to use media that is more interactive and able to make students focus on learning, for example GeoGebra.

CONCLUSION

Based on the analysis of research data and discussion of the research results obtained, the following conclusions can be drawn:

1. There is an influence of the Quizizz application on students' mathematical communication and critical thinking skills.
2. There is an influence of the Quizizz instruction application on students' mathematical communication skills.
3. There is an influence of the Quizizz application on students' mathematical critical thinking abilities.

ACKNOWLEDGMENT

The author expresses his sincere gratitude and appreciation to MTs Muhammadiyah Sukarama Bandar Lampung for the permission and cooperation granted, which made this research possible. Special appreciation is extended to all eighth-grade students who actively and cooperatively participated as research subjects. The author also thanks all parties, not mentioned individually, who assisted in various stages, particularly in the data collection and analysis process.

AUTHOR CONTRIBUTION STATEMENT

The authors' contributions to this article are divided into primary and supporting roles. SW, as P1, was responsible for the formulation of the idea, research concept, experimental design, implementation of data collection, initial data analysis, and drafting the main manuscript. Mh, as P2, made significant contributions by providing critical input on the research methodology, assisting in the interpretation of the results obtained, and conducting overall revisions to the manuscript to improve the academic and narrative quality of the article.

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