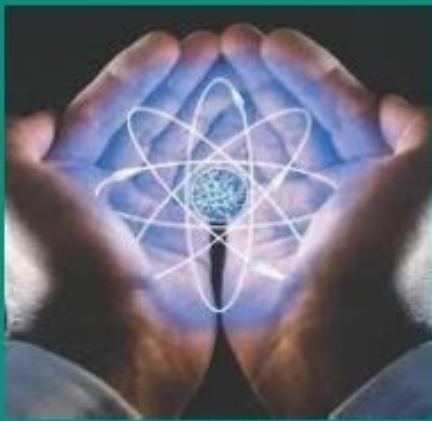

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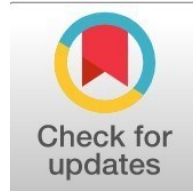
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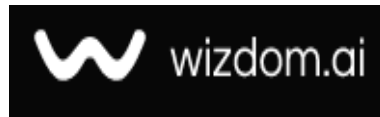
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Canva and Quizizz Foster Algebraic Thinking in Junior High Students

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Abstract

General Background: The rapid advancement of digital technology has transformed educational practices, requiring teachers to integrate innovative media that enhance learning quality. **Specific Background:** In mathematics education, particularly algebra, students often struggle to understand abstract concepts due to conventional teaching methods. **Knowledge Gap:** Few empirical studies have examined the combined use of interactive media such as Canva and Quizizz to improve algebraic thinking in junior high school students, especially within limited-resource contexts like Bireuen. **Aims:** This study investigates the effectiveness of Canva and Quizizz interactive media in enhancing students' algebraic thinking skills. **Results:** Employing a quasi-experimental design with pre-test and post-test control groups, findings show a significant improvement in the experimental group's performance (Asymp. Sig (2-tailed) = 0.000 < 0.05), with an N-Gain of 0.7968 (high category), compared to 0.1456 (low) in the control group. Students expressed positive responses, indicating increased motivation and engagement. **Novelty:** The integration of Canva's visual-based learning and Quizizz's gamified assessment creates a synergistic model that bridges conceptual understanding and learner motivation. **Implications:** The study demonstrates that digital interactive media can effectively enhance cognitive and affective learning outcomes, offering a replicable framework for innovative mathematics instruction in the digital era.

Highlights:

- Integration of Canva and Quizizz enhances students' algebraic thinking.
- Interactive media improve motivation and engagement in learning.
- Visual and gamified approaches make abstract math concepts concrete.

Keywords: Canva, Quizizz, Algebraic Thinking, Interactive Learning, Mathematics Education

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Introduction

The development of digital technology has had a major impact on the world of education, especially in terms of learning media innovation [1]. This digital transformation requires teachers to be able to adapt to various learning devices and applications that can support the improvement of the quality of the teaching and

learning process. One of the important competencies that needs to be developed in mathematics learning in this digital era is algebraic thinking. According to Sibgatullin et al. (2022), algebraic thinking is a mathematical thinking process that involves the ability to recognize patterns, make generalizations, and understand the relationships between variables through abstract symbols [2]. This ability is the foundation for mastering advanced mathematical concepts and applying mathematics in everyday life.

In the context of mathematics education, algebraic thinking has a very strategic position because it teaches students to think logically, systematically, and generally. Töman and Gökburun (2022) state that algebraic thinking is not only about operating mathematical symbols, but also about understanding the relationships between concepts and making generalizations from the patterns found [3]. In line with this, Aprildat and Hakim (2021) emphasize that algebraic thinking is a symbolic thinking process that trains students to use formal representations in solving complex problems [4]. Therefore, algebraic thinking skills are one of the main indicators of student success in mastering mathematics.

According to the NCTM (National Council of Teachers of Mathematics) (2020), the development of algebraic thinking skills needs to begin in junior high school, as this stage is an important transition period in the formation of mathematical thinking [5]. Students are introduced to the concepts of variables, algebraic expressions, and linear equations, which require abstract thinking skills. If algebraic thinking skills are not developed early on, students will have difficulty understanding more advanced mathematical concepts in later grades, such as functions, limits, and calculus [6].

However, research shows that the algebraic thinking skills of junior high school students in Indonesia are still relatively low. Faridah et al. (2025) found that most students have difficulty generalizing patterns and connecting symbols with their meanings [7]. Research by Pangaribuan (2018) and Nursyahidah et al. (2018) also reinforces these findings, showing that many students are unable to understand basic algebraic concepts, which impacts their mathematical problem-solving abilities [8], [9]. A similar condition was found among junior high school students in Bireuen Regency, where based on interviews with mathematics teachers, many students were still unable to identify algebraic relations and operate algebraic forms correctly.

Students' difficulties in understanding algebraic concepts are caused by various factors, one of which is conventional teaching methods. Teachers tend to use a lecture-based approach and practice questions without involving students in exploratory activities. As a result, mathematics learning feels boring and does not motivate students. Ismayanti et al. (2022) emphasize that monotonous teaching methods result in low algebraic thinking skills because students are not trained to reason and build concepts independently [10]. Therefore, a more interactive, contextual learning model that utilizes digital media is needed so that students can understand abstract concepts visually and enjoyably.

In this context, the use of interactive learning media based on digital technology is an innovative solution to improve students' algebraic thinking skills. According to Mayer (2005), the cognitive theory of multimedia learning (CTML) explains that the combination of text, images, and digital interaction can

strengthen concept understanding and long-term memory [11]. Technology-based learning allows students to learn actively through visual, auditory, and kinesthetic experiences, all of which support the creation of a deeper conceptual understanding.

One of the digital media widely used in mathematics learning is Canva. Canva is an online graphic design platform that allows teachers and students to create learning materials in the form of infographics, videos, or interactive presentations. Apreasta et al. (2024) showed that the use of Canva in mathematics learning increases students' interest in learning and creativity because of its visually appealing appearance [12]. The results of a study by Irkhamni et al. (2021) also mention that Canva-based e-modules can strengthen students' understanding of basic mathematical concepts because they make it easier for students to connect symbols with their visual representations [13].

Apart from Canva, another effective digital media for increasing student engagement is Quizizz. This application is an online quiz that combines game elements (gamification) such as points, rankings, and time. According to Rohmah et al. (2023), the use of Quizizz in mathematics learning can increase student motivation and engagement because it provides a competitive and enjoyable learning experience [14]. The gamification elements in Quizizz make learning not only focus on the end result but also on the interactive process that fosters enthusiasm for learning and collaboration among students.

The integration of Canva and Quizizz in mathematics learning provides a complementary approach. Canva is used as a medium to visualize abstract algebraic concepts, while Quizizz is used to evaluate students' understanding interactively. Jannah et al. (2023) state that the combination of these two media is effective in helping students understand algebraic concepts while improving their logical and reflective thinking skills [13]. The use of these two applications creates an active, collaborative, and challenging learning environment, which is in line with 21st-century learning principles.

Other studies by Wahyuni and Tranggono (2023) and Lestari et al. (2024) also support the effectiveness of using technology-based learning media, including Canva and Quizizz, in improving students' critical, creative, and mathematical thinking skills [15], [16]. Meanwhile, Ramadhani and Rais (2025) found that the systematic use of Canva in algebra learning can improve junior high school students' analytical thinking skills [17]. This shows that the integration of these two digital media can play an important role in modern mathematics learning.

In addition to improving cognitive abilities, the use of Canva and Quizizz also has an impact on students' affective aspects. Dadi (2023) explains that visual-based and game-based learning can reduce math anxiety and increase students' self-confidence [18]. Intrinsically motivated students will be more active in exploring mathematical concepts and dare to ask questions. This condition supports the creation of meaningful and enjoyable learning.

However, the use of digital media in learning also has obstacles, especially in areas such as Bireuen, which still face limitations in technology and internet networks. Fadillah et al. (2024) noted that some

students had difficulty accessing online-based media due to device limitations [19]. Therefore, teachers need to prepare adaptive strategies, such as using offline mode, giving group assignments, or project-based learning so that all students can be actively involved.

Field conditions in several junior high schools in Bireuen Regency show that some teachers have begun to utilize technology in learning, but have not yet optimally used interactive media such as Canva and Quizizz. Teachers still need training and assistance in integrating these two media so that mathematics learning becomes more effective. Thus, this study is relevant to provide empirical evidence on the effectiveness of using Canva and Quizizz in the context of mathematics learning in Bireuen.

Based on this background, this study aims to analyze the effectiveness of the interactive media Canva and Quizizz in improving the algebraic thinking skills of junior high school students in Bireuen Regency. Specifically, this study seeks to answer two main questions: (1) Is there a difference in algebraic thinking skills between students who learn using Canva and Quizizz media and students who learn conventionally? and (2) How do students respond to the application of these two media in algebraic learning? The results of this study are expected to make a real contribution to teachers and education practitioners in developing innovative mathematics learning that is relevant to the demands of the times.

Method

This study uses a quantitative approach with a quasi-experimental design because it involves two groups of subjects that are not fully randomized, but still receive comparable treatment and measurement. This approach was used because field conditions at the school did not allow researchers to completely randomize classes, as stated by Fraenkel et al. (1990) that quasi-experimental research is suitable for educational environments where researchers cannot fully control all external variables [20]. The quantitative approach was chosen because this study aims to objectively measure the effectiveness of Canva and Quizizz interactive media in improving students' algebraic thinking skills, through numerical data that can be analyzed statistically [21].

Table 1. Research Design.

Class	Pre-test	Treatment	Post-test
Experimental	Pre-test	With Treatment	Post-test
Control	Pre-test	Without Treatment	Post-test

The research design used was a pre-test post-test control group design, in which there were two groups, namely the experimental group and the control group. The experimental group received learning using interactive media Canva and Quizizz, while the control group learned using conventional methods without the help of these two media. Both groups were given a pre-test before the treatment and a post-test after the treatment to measure the increase in algebraic thinking skills. This design allowed researchers to

compare the differences in learning outcomes between the group that received innovative treatment and the group that did not receive treatment. This design model has been widely used in educational research, especially to assess the effectiveness of learning media [22].

This study was conducted at SMP Negeri 3 Bireuen, Aceh Province, which was selected purposively because the school had implemented the use of digital devices in teaching and learning activities. The research subjects were seventh-grade students in the odd semester of the 2025/2026 academic year. Two classes were selected based on academic ability equality, considering the previous semester's mathematics scores. Grade VII/A was designated as the experimental group, while grade VII/B was designated as the control group. The sampling technique used purposive sampling, which is the selection of samples based on certain considerations in accordance with the research objectives [23]. There were 29 students in each class, bringing the total number of research subjects to 58 students.

The material used in this study was algebraic operations, which included addition, subtraction, multiplication, and division of algebraic expressions. This material was chosen because it is included in the basic competencies for Grade VII of the Merdeka Curriculum and forms the basis for developing students' algebraic thinking skills. Learning in the experimental class used a combination of Canva and Quizizz media. Canva was used to create visual materials such as infographics, short videos, and interactive presentations that displayed concepts and steps for solving algebraic expressions. Meanwhile, Quizizz was used to provide interactive exercises in the form of quizzes that assessed students' understanding directly through a scoring system and automatic feedback. The control class received instruction using conventional lecture-based methods and written exercises without the aid of digital media.

The main data collection instruments in this study were algebraic thinking ability tests and learning observation sheets. The test used is in essay form with indicators compiled based on Kieran's (2004) theory of algebraic thinking, which includes the ability to recognize patterns, use symbols, and make generalizations [24]. Before being used in the study, the instrument was validated by three experts (expert judgment) consisting of mathematics education lecturers and senior teachers. The empirical validity of the instruments was tested using Pearson's product moment correlation, while reliability was calculated using Cronbach's Alpha formula. The test results showed that all items had a validity coefficient > 0.30 and reliability of 0.87, which means they are in the high category [25].

The data obtained were analyzed using descriptive and inferential statistical analysis. Descriptive analysis was used to describe the pre-test, post-test, and gain scores for students' algebraic thinking skills. Meanwhile, inferential analysis used an independent samples t-test to determine whether there was a significant difference between the experimental and control groups. Before conducting the t-test, assumption tests were first carried out, including normality (Kolmogorov-Smirnov) and homogeneity (Levene's Test) tests. If both data sets met the normal and homogeneous requirements, hypothesis testing was continued

with a t-test at a significance level of 0.05. This analysis procedure follows the recommendations of Santoso (2016) and Sugiyono (2009) in the processing of quantitative data in education [22], [26].

In addition to the t-test, improvements in students' algebraic thinking skills were also calculated using normalized gain developed by Hake in Meltzer (2002) with the formula [27]:

$$N-Gain = \frac{(Skor\ Post-test - Skor\ Pre-test)}{Skor(Skor\ Maksimum\ Ideal - Skor\ Pre-test)}$$

N-Gain values are categorized into three groups: high (≥ 0.7), moderate ($0.3 \leq g < 0.7$), and low ($g < 0.3$). These categories are used to measure the extent of improvement in algebraic thinking skills after using Canva and Quizizz. To support quantitative analysis, the researcher also collected qualitative data in the form of student responses to learning using a closed questionnaire. The questionnaire results were analyzed in percentages to determine the level of student acceptance of the interactive media used. Thus, the entire research procedure is expected to provide a comprehensive picture of the effectiveness of Canva and Quizizz interactive media in improving the algebraic thinking skills of junior high school students in Bireuen.

Result and Discussion

A. Results

1. Pre-Test and Post-Test Data

This study produced quantitative data on students' algebraic thinking skills before and after the application of Canva and Quizizz interactive learning media. Algebraic thinking skills were measured through an essay test developed based on indicators of algebraic thinking skills, including the ability to recognize patterns, make generalizations, use symbols, and solve contextual problems. This test was given to two groups: an experimental class that received Canva and Quizizz-based learning, and a control class that received conventional learning without digital media. The results of the analysis showed a significant difference in learning outcomes between the two groups.

Table 2. Average Pre-test and Post-test scores.

Class	Number of Students	Average Pre-test Score	Average Post-test Score	Average N-Gain	Category
Experimental	29	44.66	82.59	0.7968	High
Control	29	37.07	45.34	0.1456	Low

The average pre-test score for the experimental class was 44.66, while the post-test score increased to 82.59. The average N-Gain obtained was 0.7968, which is classified as high. In contrast, the average pre-test score for the control class was 37.07, with a post-test score of 45.34, resulting in an N-Gain of 0.1456, which is classified as low. These results indicate that interactive learning aided by Canva and Quizizz contributes significantly to improving students' algebraic thinking skills compared to conventional learning methods.

These findings indicate that the use of interactive media not only improves cognitive learning outcomes but also strengthens students' analytical and symbolic understanding of algebraic concepts.

The difference in learning outcomes between the experimental and control classes shows that interactive learning is able to provide a more in-depth learning experience. This is in line with Mayer's (2019) Cognitive Theory of Multimedia Learning, which explains that learning that involves text, images, and digital interaction can help students process information through visual and verbal channels simultaneously, thereby strengthening knowledge retention. Therefore, the test results show that students who learn using Canva and Quizizz have a significant improvement in associating symbolic and visual representations in understanding algebraic concepts.

2. Statistical Tests

Before conducting hypothesis testing, statistical assumption tests were first performed, including tests of normality, homogeneity, and linearity of the data. The results of the Kolmogorov-Smirnov normality test showed a significance value ($\text{sig.} > 0.05$) for the pre-test and post-test data in both groups, which means that the data are normally distributed. Furthermore, the homogeneity test results showed a sig. value ($0.646 > 0.05$), so it can be concluded that the variance of the two groups is homogeneous. The linearity test showed a sig. linearity value ($0.00 < 0.05$), which means that there is a significant linear relationship between the learning treatment and the improvement in students' algebraic thinking skills.

After the data met the basic assumptions, a t-test (paired samples test) was conducted to determine the difference in algebraic thinking skills between the experimental and control groups. The t-test results showed that the Asymp. Sig (2-tailed) value = $0.000 < \alpha = 0.05$, so H_0 was rejected and H_1 was accepted. Thus, there was a significant difference between the algebraic thinking skills of students who learned using Canva and Quizizz compared to students who learned conventionally. Empirically, these results prove that the application of interactive learning media has a positive effect on improving the algebraic thinking skills of junior high school students.

This improvement is also evident from the comparison of the average N-Gain between the two groups. The experimental class showed a much higher improvement than the control class, indicating that learning with Canva and Quizizz is more effective in developing symbolic, abstract, and logical thinking skills. These results are in line with the findings of Miftahul Jannah et al. (2023) and Ramadhani and Rais (2025), who stated that the use of Canva in mathematics learning improves students' critical thinking skills and learning motivation. Additionally, research by Devi, Kure, and Sumargiyani (2023) also shows that Canva is effective in increasing students' interest and understanding of algebraic concepts because the visualizations produced make it easier for students to understand symbolic structures and relationships between variables.

3. Student Response to Learning

Analysis of student response was conducted using a closed questionnaire consisting of indicators of interest, motivation, involvement, and perception of the effectiveness of interactive learning media. The results of the analysis show that of the 29 students in the experimental class, 34.48% gave a very positive response, 41.38% gave a positive response, 17.24% gave an adequate response, and only 6.90% gave a less positive response. The average class score reached 52.34 out of 75, or 69.79%, which was in the positive category.

These findings indicate that most students felt the real benefits of interactive learning using Canva and Quizizz. Students stated that learning became more interesting, easier to understand, and helped them participate more actively in the learning process. Quizizz, for example, provides a fun game-based learning experience with immediate feedback on students' answers. This encourages a healthy competitive atmosphere while increasing student engagement during the learning process. Meanwhile, Canva helps teachers visualize abstract concepts in a concrete way, such as displaying algebraic representations through colorful posters and infographics.

This study also found that Canva and Quizizz-based learning increased students' confidence in solving algebra problems because they felt they received sufficient visual support and interactive practice. These results are in line with the studies by Dadi (2023) and Rohmah, Sugandi, & Rosyana (2023), which found that interactive media not only improve cognitive learning outcomes but also strengthen students' mathematical communication skills. However, several obstacles were still found, such as limitations in devices and internet networks for some students. These obstacles affected the smooth running of the Quizizz quizzes, especially for students with unstable internet access. To overcome this, teachers are advised to use the homework mode feature or organize learning in small groups so that every student can still participate actively.

B. Discussion

The results of the study indicate that the use of interactive learning media such as Canva and Quizizz has a significant effect on improving the algebraic thinking skills of junior high school students in Bireuen. Empirically, the increase in the average post-test scores and high N-Gain scores in the experimental class prove that interactive digital media can facilitate mathematical thinking processes more effectively than conventional methods. This is in line with the view of Sibgatullin et al. (2022) that algebraic thinking is a complex cognitive ability that involves recognizing patterns, making generalizations, and understanding symbols and logical relationships [2]. Digital exploration-based learning provides opportunities for students to interpret algebraic concepts in a more meaningful way because they interact directly with visualizations and interactive exercises.

Canva plays an important role in building students' representational understanding of algebraic concepts. By utilizing infographic design features, animations, and attractive color combinations, teachers can present abstract concepts such as variables, algebraic expressions, and equations in a visual form that is easy for students to digest. According to the Cognitive Theory of Multimedia Learning by Mayer (2019) and

Sorden (2020), learning that involves text, images, and sound simultaneously allows students to process information through two complementary cognitive channels—verbal and visual [11]. Thus, Canva is an effective medium for converting abstract information into concrete forms, allowing students to more easily relate algebraic symbols to real-world contexts.

This visualization also helps reduce students' cognitive load, as presenting concepts in a structured visual form allows them to understand the relationship between variables and constants without having to rely entirely on the teacher's verbal explanations. Irkhamni et al. (2021) emphasize that graphic design-based visual learning media can improve students' concentration and information retention in mathematics [28]. In the context of this study, Canva helps students understand symbolic relationships in algebra, such as addition and subtraction of like terms, through communicative and aesthetically pleasing visual displays. As a result, students not only understand the procedures, but also internalize the meaning of the concepts they are learning.

In addition to Canva, Quizizz serves as a gamification medium that encourages active participation and motivation in learning among students. Game elements such as scoring, rankings, response times, and colorful displays create a fun and competitive learning environment. These findings support the results of Rohmah et al.'s (2023) study, which states that game-based learning can increase intrinsic motivation and mathematics learning outcomes because students receive immediate feedback on their answers [14]. In this study, students were more enthusiastic about solving algebra problems, not because they were forced to, but because they were interested in the challenging game system that also provided instant rewards in the form of scores and rankings.

The gamification applied in Quizizz has also been proven to strengthen students' self-regulated learning, which is the ability to manage their own learning strategies. When students receive real-time feedback, they can immediately correct their mistakes and identify weaknesses in their understanding of algebraic concepts. Dadi (2023) states that game elements in digital learning serve as motivational stimuli that reinforce positive attitudes toward learning mathematics [18]. In this context, students not only learn mechanically, but also gain reflective learning experiences that increase their confidence and critical thinking skills.

Furthermore, the use of Canva and Quizizz has a positive impact on the affective and social aspects of learning. Students show increased interest, activity, and ability to work together in group discussions during the learning process. Activities such as collaboratively designing Canva content or competing to answer questions on Quizizz create constructive social interactions in the classroom. These findings are in line with the principles of the Merdeka Curriculum, which emphasizes collaborative, creative, and technology-based learning [1]. Thus, the integration of these two media not only develops algebraic thinking skills but also fosters active and collaborative learning characteristics among students.

However, this study also revealed several obstacles encountered in the implementation of digital learning media, particularly related to technical aspects. Some students experienced difficulties due to limitations in personal devices such as laptops or smartphones, as well as internet network disruptions that hampered the smooth running of Quizizz activities. This condition is in line with the findings of Wahyuni & Tranggono (2023), who stated that the readiness of digital infrastructure is an important factor in the success of technology-based learning [16]. Therefore, teachers need to prepare alternative solutions, such as using the homework mode on Quizizz or conducting group learning so that all students can continue to participate actively.

Apart from technical obstacles, the readiness of teachers in managing digital media is also a challenge in itself. Not all teachers have the same ability to design interactive content or integrate Canva and Quizizz into a systematic learning strategy. Apreasta et al. (2024) emphasize that digital literacy training for teachers is very important to improve the effectiveness of interactive media implementation in schools [12]. In this study, creative and adaptive teacher support proved to be the key to the successful application of Canva and Quizizz media in improving student learning outcomes.

The application of these two media also has broad pedagogical implications. The use of Canva helps students develop visual and conceptual representation skills, while Quizizz trains reflective thinking and quick response to problems. The combination of the two forms a balanced learning ecosystem between conceptual understanding and practical skills. This supports the Blended Learning theory, which states that the integration of digital media in face-to-face learning can increase the efficiency, effectiveness, and flexibility of the learning process [10].

Overall, the results of this study reinforce the evidence that Canva and Quizizz interactive media are effective in improving junior high school students' algebraic thinking skills. These findings are consistent with the results of studies by Ramadhani & Rais (2025) and Jannah et al. (2023), which show that digital media not only has an impact on improving learning outcomes but also on strengthening motivation, digital literacy, and critical thinking skills [13], [17]. Therefore, the application of Canva and Quizizz is recommended as an integral part of mathematics learning innovation in the digital era, particularly in the context of implementing the Merdeka Curriculum, which is oriented toward developing 21st-century competencies.

Thus, the integration of Canva and Quizizz in mathematics learning not only serves as a teaching aid, but also as a means to build a digital learning culture in the school environment. Through this medium, students are not merely recipients of knowledge, but also creators in their own learning process. This study provides empirical evidence that when learning is designed based on interactivity, visualization, and reflection, students' algebraic thinking skills can improve significantly, both cognitively and affectively. In the future, the integration of technologies such as Canva and Quizizz needs to be further developed so that mathematics learning becomes more adaptive, inclusive, and relevant to the demands of modern education.

Conclusion

The results of research in class VII of SMP Negeri 3 Bireuen show that the use of interactive learning media Canva and Quizizz has a significant effect on improving students' algebraic thinking skills. The increase in the average post-test scores and N-Gain scores in the experimental class shows that these interactive media are able to help students understand algebraic concepts in a more concrete and enjoyable way compared to conventional learning. Canva makes it easier for teachers to visualize abstract concepts in an attractive form, while Quizizz provides game-based exercises that increase student motivation, participation, and knowledge retention. In addition, students' responses to learning using Canva and Quizizz were positive, indicating that these two media are effective not only in cognitive aspects but also in increasing interest and engagement in learning. These findings are in line with the objectives of the Merdeka Curriculum, which emphasizes active, creative, collaborative, and technology-based learning.

Based on these results, it is recommended that mathematics teachers continuously integrate Canva and Quizizz as innovative learning media, especially for abstract subjects such as algebra, functions, and linear equations. Schools and educational institutions are expected to provide support in the form of technological facilities and training in digital content creation so that teachers can become more skilled in managing technology-based learning. Future researchers are advised to expand their studies by examining the technical and non-technical factors that affect the effectiveness of interactive media, such as students' digital literacy, device limitations, and differences in school contexts. In addition, the government is expected to formulate policies to strengthen digital literacy and reward innovative teachers in an effort to encourage the digital transformation of education. With adequate policy support, infrastructure, and teacher competence, Canva and Quizizz interactive learning media can be effective strategies in improving the quality of mathematics learning and students' algebraic thinking skills in the digital age.

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