THE EFFECT OF DIGITAL MATHEMATICS LEARNING ON STUDENTS' PROBLEM-SOLVING AND CREATIVE THINKING ABILITIES IN STATISTICS LEARNING

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ABSTRACT Digital learning in mathematics has gained increasing attention as a way to support students' higher-order thinking skills, particularly problem-solving and creative thinking. This study aimed to investigate the effect of digital mathematics learning on students' problem-solving and creative thinking abilities in statistics. A quasi-experimental design was used involving 54 students who were divided equally into experimental and control groups. Data were collected through pretests and posttests and analyzed using descriptive statistics, paired-sample t-tests, and independent-sample t-tests. The results showed that the experimental group achieved higher posttest scores than the control group in problem-solving ability (72.41 vs. 63.78) and creative thinking ability (70.15 vs. 61.44). The experimental group also showed significant improvement from pretest to posttest in problem-solving ability (mean difference = 15.37, $t = 8.21$, $p < 0.001$) and creative thinking ability (mean difference = 14.81, $t = 7.56$, $p < 0.001$). In addition, students in the digital learning class performed better than those in the conventional class in fluency, flexibility, originality, and total creativity score. These findings indicate that digital mathematics learning can help students solve statistical problems more systematically and encourage creativity in exploring different solution strategies. This study highlights the importance of integrating digital media, such as interactive videos and Excel-based activities, into statistics learning to support more innovative mathematics instruction.

Keywords: creative thinking, digital learning, mathematics, problem-solving, statistics

ABSTRAK Pembelajaran digital dalam matematika semakin mendapat perhatian sebagai salah satu cara untuk mendukung keterampilan berpikir tingkat tinggi siswa, khususnya kemampuan pemecahan masalah dan berpikir kreatif. Penelitian ini bertujuan untuk menginvestigasi pengaruh pembelajaran matematika digital terhadap kemampuan pemecahan masalah dan berpikir kreatif siswa pada pembelajaran statistika. Penelitian ini menggunakan desain kuasi-eksperimen dengan melibatkan 54 siswa yang dibagi secara seimbang ke dalam kelompok eksperimen dan kelompok kontrol. Data dikumpulkan melalui pretest dan posttest, kemudian dianalisis menggunakan statistik deskriptif, uji-t berpasangan, dan uji-t independen. Hasil penelitian menunjukkan bahwa kelompok

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eksperimen memperoleh skor posttest yang lebih tinggi dibandingkan kelompok kontrol pada kemampuan pemecahan masalah (72,41 berbanding 63,78) dan kemampuan berpikir kreatif (70,15 berbanding 61,44). Kelompok eksperimen juga menunjukkan peningkatan yang signifikan dari pretest ke posttest pada kemampuan pemecahan masalah (selisih rata-rata = 15,37, $t = 8,21$, $p < 0,001$) dan kemampuan berpikir kreatif (selisih rata-rata = 14,81, $t = 7,56$, $p < 0,001$). Selain itu, siswa pada kelas pembelajaran digital menunjukkan capaian yang lebih baik dibandingkan kelas konvensional pada aspek kelancaran, keluwesan, orisinalitas, dan skor kreativitas total. Temuan ini menunjukkan bahwa pembelajaran matematika digital dapat membantu siswa menyelesaikan masalah statistika secara lebih sistematis dan mendorong kreativitas dalam mengeksplorasi berbagai strategi penyelesaian. Penelitian ini menegaskan pentingnya integrasi media digital, seperti video interaktif dan aktivitas berbasis Excel, dalam pembelajaran statistika untuk mendukung pembelajaran matematika yang lebih inovatif.

Kata-kata kunci: berpikir kreatif, pembelajaran digital, matematika, pemecahan masalah, statistika

INTRODUCTION

Mathematics education at the elementary level plays a fundamental role in developing students' higher-order thinking skills, including critical, analytical, and creative thinking (Siswono, 2018). Beyond supporting logical reasoning and problem-solving in everyday contexts, mathematics provides a conceptual foundation for knowledge construction and technological advancement in contemporary society (Yayuk, Purwanto, & As'ari, 2020; Marbun, 2023; Hadjerrouit, 2022). Through structured learning processes, students are expected to understand mathematical concepts, principles, and relationships, and apply them systematically, flexibly, and efficiently in solving both routine and non-routine problems. Furthermore, mathematics learning facilitates reasoning through analytical processes such as identifying patterns, constructing generalizations, and representing ideas symbolically, while simultaneously fostering essential learning dispositions, including accuracy, persistence, independence, and creativity (Bron & Prudente, 2024; Hwang & Chang, 2020; Utami, 2020). Consequently, mathematics education serves as a critical means of integrating logical analysis and creativity in students' problem-solving development.

In particular, fifth-grade students are expected to organize, compare, present, and analyze quantitative data in various visualizations and frequency tables to extract meaningful information (Yayuk, Purwanto, & As'ari, 2020). They should also determine events with higher probability in random experiments, demonstrating early statistical reasoning (Hadjerrouit, 2022). Mathematics education, therefore, not only develops cognitive skills but also shapes character, promoting creative thinking and problem-solving abilities (Marbun, 2023). These abilities must be systematically taught and nurtured from early schooling to ensure students can tackle complex challenges effectively (Sinclair & Baccaglini-Frank, 2016).

Thinking, especially creative thinking, involves generating diverse, original, and detailed ideas in response to problems or new situations (Utami, 2020). The creative process requires fluency, flexibility, originality, and elaboration

(Munandar, 1996). Problem-solving is a related process where students must understand problems, design mathematical models, execute solutions, and evaluate results (Pehkonen, 1997). Both skills are essential for enabling students to approach novel problems effectively and develop multiple solution strategies (Siswono, 2018; Marbun, 2023).

In the context of elementary mathematics education, students often face challenges in applying abstract concepts to real-life situations (Yayuk, Purwanto, & As'ari, 2020). Digital tools, particularly educational videos and spreadsheet software such as Excel, were selected in this study due to their complementary roles in supporting students' understanding of statistics and the development of higher-order thinking skills. Educational videos provide dynamic visualizations that help students grasp abstract statistical concepts such as data distribution, graphs, and comparisons by presenting them in concrete and contextualized forms (Hwang & Chang, 2020; Shabani, 2022). Through animations and step-by-step explanations, videos facilitate conceptual understanding and reduce cognitive load for elementary learners. Meanwhile, Excel enables students to actively engage in data manipulation, organization, and representation through tables, charts, and simple calculations, allowing them to explore patterns and relationships directly (Marbun, 2023; Hadjerrouit, 2022). This hands-on interaction supports the development of problem-solving skills by encouraging systematic procedures and logical reasoning. Furthermore, the combination of videos and Excel promotes creative thinking, as students are given opportunities to interpret data, test multiple solution strategies, and present their findings in varied formats. These tools also enhance student engagement and motivation by providing interactive and visually rich learning experiences, while supporting more personalized and exploratory learning processes (Godoy Jr., 2021; Christidamayani & Kristanto, 2020).

Despite the growing adoption of digital learning tools, empirical evidence on their effectiveness in improving problem-solving and creative thinking skills among fifth-grade students is still limited (Sinclair & Baccaglini-Frank, 2016; Godoy Jr., 2021). Most existing studies tend to examine creativity and problem-solving as separate constructs, with limited attention to how these skills interact within a digital learning environment (Bron & Prudente, 2024; Christidamayani & Kristanto, 2020). In addition, the integration of digital learning in statistics education at the elementary level remains underexplored, particularly in relation to simultaneously promoting content understanding and higher-order thinking skills (Yayuk, Purwanto, & As'ari, 2020; Siswono, 2018).

To address this gap, this study specifically employs educational videos and spreadsheet software (Excel) as complementary digital tools. Videos were selected

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for their ability to present abstract statistical concepts, such as data representation and interpretation, through dynamic visualizations and contextualized explanations, thereby supporting students' conceptual understanding. In contrast, Excel was chosen for its interactive features that allow students to organize, analyze, and visualize data באמצעות tables and charts, enabling hands-on exploration of statistical relationships. The integration of these tools is expected to support problem-solving by guiding students through systematic data analysis processes, while also fostering creative thinking through opportunities to explore multiple strategies, interpret results, and present findings in diverse ways. Thus, the combined use of videos and Excel provides a pedagogically grounded approach to simultaneously developing statistical understanding, problem-solving ability, and creative thinking in elementary mathematics learning.

Therefore, this study aims to investigate the impact of digital mathematics learning using videos and Excel applications on both problem-solving and creative thinking abilities of fifth-grade students in elementary school, specifically in the subject of statistics (Marbun, 2023; Hadjerrouit, 2022). By addressing this research gap, the study seeks to provide insights into effective strategies for integrating technology into mathematics instruction, ultimately enhancing students' engagement, creativity, and problem-solving competencies (Hwang & Chang, 2020; Shabani, 2022). The research focuses on whether digital learning significantly improves students' ability to solve statistical problems and generate creative solutions compared to conventional methods (Yayuk, Purwanto, & As'ari, 2020; Siswono, 2018).

METHODS

This study employed a quantitative approach with a quasi-experimental design to examine the effect of digital mathematics learning on fifth-grade students' problem-solving and creative thinking abilities. The research used a Pre-Test Two-Comparison Non-Equivalent Groups Design, in which two intact classroom groups were assigned as the experimental and control groups based on existing class structures, as random assignment was not feasible in the school setting. The experimental group received digital mathematics learning through videos and Microsoft Excel, while the control group followed conventional instruction. Pre-test results were used to ensure that both groups had comparable initial abilities before the intervention. Both groups underwent pre-test and post-test assessments to measure changes in problem-solving and creative thinking abilities, allowing for comparison of the intervention's effectiveness.

The population consisted of all fifth-grade students from seven elementary schools in the Sedati subdistrict, totaling approximately 420 students. Using purposive sampling, 54 students were selected from two schools with appropriate digital learning facilities. The experimental group included 27 students, while the control

group included 27 students, ensuring a representative sample while considering logistical constraints.

The instruments for data collection comprised observation sheets to monitor the implementation of digital mathematics learning and tests to measure problem-solving and creative thinking abilities. The observation sheets were designed to capture key aspects of the learning process, including teacher implementation of digital tools (videos and Microsoft Excel), clarity of instruction, classroom management, and student engagement such as participation, interaction, and responsiveness during activities. Each aspect was rated using a structured scale to ensure consistency across observations. The observation data were analyzed using descriptive statistics by calculating the mean scores for each aspect and categorizing the level of implementation (e.g., low, moderate, high). These results were used to evaluate the fidelity of the intervention and to ensure that the digital learning approach was implemented as intended throughout the study. Problem-solving tests included questions on basic statistics concepts, data collection, data processing (mean, median, mode, range), and data presentation (tables, charts, diagrams). Creative thinking tests required students to generate new ideas, establish connections between concepts, solve problems creatively, and present statistical analyses innovatively. Instructional materials included instructional videos, Microsoft Excel, Quizizz, textbooks, and worksheets.

Data analysis involved descriptive statistics to summarize frequency, mean, median, standard deviation, and score distributions, and inferential statistics using Before conducting the inferential analysis, prerequisite tests were performed to ensure that the data met the assumptions of parametric testing. Normality was assessed using the Shapiro–Wilk test, and homogeneity of variances was examined using Levene's test. The results indicated that the data were normally distributed and homogeneous ($p > 0.05$), thus meeting the assumptions for parametric analysis. Therefore, Paired-Sample t-tests were used to compare pre-test and post-test scores within the experimental group, while Independent Sample t-tests were applied to compare post-test scores between the experimental and control groups to compare post-test scores between the experimental and control groups. A significance level of $p < 0.05$ was used to determine statistically significant differences. This methodology ensures replicability and provides a valid and reliable framework to assess the impact of digital mathematics learning on students' problem-solving and creative thinking skills.

FINDING AND DISCUSSION

This study aimed to examine the effect of digital mathematics learning on fifth-grade students' problem-solving and creative thinking abilities in statistics. Data were collected from 54 students, divided equally into experimental and control groups. The data analysis involved descriptive statistics and inferential statistics,

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including Paired-Sample t-tests and Independent Sample t-tests, to evaluate differences in pre-test and post-test scores within and between groups. Prior to conducting the inferential tests, the assumptions of normality and homogeneity were examined using the Shapiro–Wilk test and Levene's test, respectively. The normality test results indicated that all data were normally distributed ($p > 0.05$), while the homogeneity test showed that the variances between groups were homogeneous ($p > 0.05$). These results confirmed that the data met the assumptions required for parametric testing, thereby justifying the use of paired-sample and independent sample t-tests.

Table 1. Comparison of Final Assessment Scores of Creativity between Digital Class and Conventional Class

No	Aspect	Digital Class	Conventional Class
1	Fluency	58.75	45.25
2	Flexibility	48.75	41.75
3	Originality	45.00	42.50
4	Creativity (Total)	151.00	131.25

The digital class showed higher scores than the conventional class across all aspects of creativity. In fluency, students in the digital class achieved 58.75 compared to 45.25 in the conventional class, showing their ability to generate more ideas. For flexibility, the digital class reached 48.75 while the conventional class scored 41.75, indicating that students in the digital class could use more varied approaches. In originality, the digital class obtained 45.00, slightly higher than the conventional class with 42.50, suggesting that digital learning helped students produce more unique ideas.

Overall, the total creativity score in the digital class was 151, clearly surpassing the 131.25 score of the conventional class. This difference highlights that digital-based learning gave students stronger opportunities to develop fluency, flexibility, and originality simultaneously. The results underline that the integration of digital learning has a positive impact on enhancing students' creative thinking compared to traditional classroom approaches.

Table 2. Descriptive Statistics of Problem-Solving Scores

Group	N	Minimum	Maximum	Mean	Std. Deviation
Experimental	27	50	92	72.41	11.32
Control	27	48	85	63.78	10.25

Table 2 shows that the experimental group, which received digital mathematics learning, had a higher mean problem-solving score (72.41) compared to the control

group (63.78). The standard deviation indicates moderate variability in students' performance in both groups. These results suggest that digital learning may enhance students' problem-solving skills in statistics.

Table 3. Paired-Sample t-test for Problem-Solving Scores (Experimental Group)

Test	Mean Difference	t	df	p-value
Pre-Test vs Post-Test	15.37	8.21	26	<0.001

Table 3 indicates a significant increase in problem-solving scores from pre-test to post-test in the experimental group ($p < 0.001$). This confirms that the digital learning intervention had a strong positive effect on students' problem-solving abilities.

Table 4. Results of Paired Sample t-Test Analysis

Statistic	Value
Number of pairs (n)	27
Sum of differences (Σd_1)	62,00
Mean difference ($\bar{d}$)	2,30
Sum of squared differences (Σd_1^2)	365,63
Standard deviation of differences (Sd)	3,75
Degrees of freedom (df)	26
t-statistic (t)	3,18
p-value	0,0038

Table 4 shows that the p-value (0.0038) is lower than the significance threshold ($\alpha = 0.05$), leading to the rejection of the null hypothesis (H_0). This result indicates that there is a statistically significant difference between the pre-test and post-test scores within the experimental group. In other words, students who received digital-based mathematics learning demonstrated a significant improvement in problem-solving skills after the intervention.

Table 5. Descriptive Statistics of Creative Thinking Scores

Group	N	Minimum	Maximum	Mean	Std. Deviation
Experimental	27	45	90	70.15	12.05
Control	27	42	82	61.44	11.47

Table 5 shows that the experimental group had a higher mean creative thinking score (70.15) than the control group (61.44). This suggests that digital mathematics

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learning through tools such as videos and Excel encouraged students to think more creatively in solving statistical problems.

Table 6. Paired-Sample t-test for Creative Thinking Scores (Experimental Group)

Test	Mean Difference	t	df	p-value
Pre-Test vs Post-Test	14.81	7.56	26	<0.001

Table 6 confirms that creative thinking significantly improved in the experimental group after digital learning intervention ($p < 0.001$). This shows that technology-based approaches effectively supported students in developing creative thinking.

Table 7. Independent Sample t-test for Post-Test Creative Thinking Scores

Group Comparison	Experimental Mean	Control Mean	Mean Difference	t	df	p-value
Experimental vs. Control	70.15	61.44	8.71	2.89	52	0.006

Table 7 shows that the experimental group significantly outperformed the control group in creative thinking ($p = 0.006$). This indicates the positive effect of digital mathematics learning in fostering creativity.

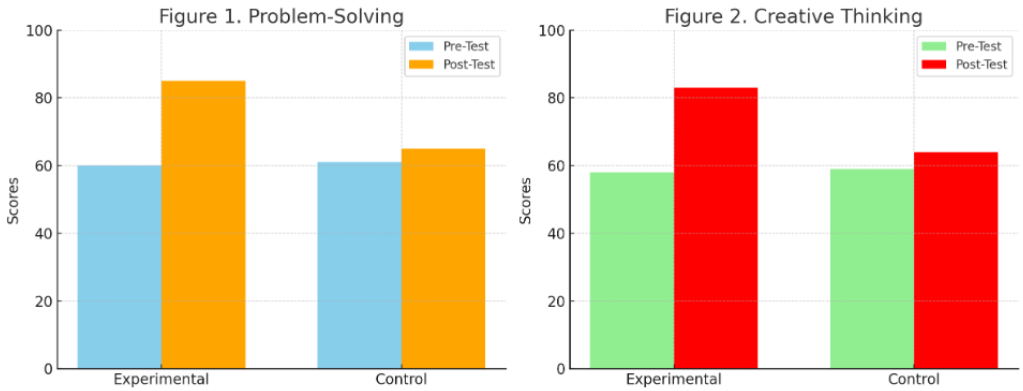

Figure 1. Problem-Solving and Creative Thinking side by side

In the experimental group, problem-solving scores increased substantially from 60 (pre-test) to 85 (post-test). In contrast, the control group showed only a slight improvement, rising from 61 to 65. This figure illustrates that the digital mathematics learning intervention had a significant positive effect on students' problem-solving ability. In the experimental group, creative thinking scores rose notably from 58 (pre-test) to 83 (post-test). Meanwhile, the control group experienced only a minimal increase, from 59 to 64. These results confirm that the use of digital media effectively encouraged students to think more creatively in understanding statistical concepts.

The present study revealed that digital mathematics learning significantly improved fifth-grade students' problem-solving and creative thinking abilities in statistics. The experimental group, which received digital-based interventions such as interactive videos and spreadsheet activities, outperformed the control group that followed conventional methods. The experimental group achieved a higher mean creative thinking score (70.15) than the control group (61.44), indicating that digital mathematics learning using videos and Excel enhanced students' creativity in solving statistical problems.

Creative thinking in the experimental group also improved significantly after the intervention ($t = 7.56$, $p < 0.001$), with a large effect size (Cohen's $d = 1.46$), while the comparison between groups showed a significant difference ($t = 2.89$, $p = 0.006$) with a moderate effect size (Cohen's $d = 0.79$). In terms of problem-solving, the experimental group demonstrated a substantial increase from 60 (pre-test) to 85 (post-test), whereas the control group showed only a slight improvement from 61 to 65. Similarly, creative thinking scores in the experimental group rose from 58 to 83, compared to a minimal increase from 59 to 64 in the control group. These results indicate that digital mathematics learning not only produced statistically significant improvements but also generated educationally meaningful gains, as reflected in the substantial effect sizes across both problem-solving and creative thinking domains. The results suggest that when students are engaged with digital resources, their ability to reason, analyze, and generate creative solutions increases more effectively than in traditional learning contexts (Gonzalez & Martinez, 2018).

The sharp increase in problem-solving ability in the experimental group reflects the capacity of digital interventions to provide scaffolding, visualization, and immediate feedback, particularly through Excel features such as automatic calculations and dynamic data representations that allow students to verify their answers in real time. Unlike conventional teaching, which often relies on rote methods, digital learning environments present problems in interactive ways, enabling learners to experiment with multiple strategies. This aligns with Kim and Park (2021), who found that blended learning enhances students' problem-solving by encouraging active exploration of mathematical ideas.

Similarly, the significant rise in creative thinking scores highlights the role of digital tools in fostering originality and flexible thinking. By using tools such as Excel, students could test hypotheses, visualize data, and generate alternative solutions, leading to more divergent and innovative approaches. This finding resonates with Shabani (2022) and Ahmed and Ali (2022), who emphasized that digital resources enrich creativity in mathematics classrooms by enabling learners to connect abstract concepts with real-world applications.

Interestingly, the control group also experienced minor improvements, but these were far less pronounced. This suggests that traditional teaching still contributes to skill development, but its impact is limited compared to digital integration. In other

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words, while both groups benefited from instruction, the presence of interactive media accelerated and deepened the learning outcomes (Utami, 2020).

Taken together, these findings provide compelling evidence that digital mathematics learning has transformative potential for primary education. It not only enhances technical problem-solving skills but also cultivates creativity, an essential competence in the 21st century learning framework (Sinclair & Baccaglini-Frank, 2016; Munandar, 2018).

One explanation for the improvements observed in the experimental group lies in Vygotsky's Zone of Proximal Development (ZPD) theory, which posits that learners achieve more with guidance and tools than independently. Digital learning materials served as "mediating artifacts," scaffolding students' understanding through visualizations, simulations, and feedback mechanisms. This allowed students to operate within their ZPD, thereby maximizing their problem-solving growth (Pehkonen, 2019).

Another theoretical framework that explains the results is constructivism, which emphasizes active engagement in constructing knowledge. Digital learning fosters an exploratory environment where students test ideas, analyze outcomes, and refine strategies. Yayuk et al. (2020) noted that creative mathematical thinking emerges more effectively when learners face open-ended challenges; digital resources amplify this by making abstract problems more concrete and manipulable.

The interactive and multimodal nature of digital tools also reduces cognitive overload, making complex statistical concepts more accessible. According to Hwang and Chang (2020), mobile and digital platforms facilitate learning by chunking abstract information into manageable units, which explains the stronger learning gains observed in this study.

Cultural and institutional contexts may also have influenced the results. In Indonesia, mathematics is often taught using procedural approaches (Utami, 2020). The novelty of digital learning provided students with fresh opportunities to engage actively, which might have amplified motivation and enthusiasm, thereby producing significant gains compared to traditional instruction.

Finally, the role of formative feedback must be acknowledged. Digital tools provide immediate feedback that helps students adjust their strategies quickly. Hadjerrouit (2022) highlighted the importance of formative feedback in mathematics education, and this mechanism may explain why students in the experimental group improved substantially in both problem-solving and creativity.

The findings are consistent with a broad body of literature emphasizing the benefits of digital tools in mathematics education. Ahmed and Ali (2022) reported that digital interventions foster creative thinking by encouraging students to visualize and manipulate mathematical objects. Similarly, Gonzalez and Martinez (2018) found that digital resources improved statistical reasoning skills, resonating strongly with the problem-solving gains reported in this study.

This study also aligns with Marbun (2023), who demonstrated that problem-based and technology-enhanced learning strategies significantly improved creative thinking and motivation among Indonesian students. Likewise, Yayuk et al. (2020) confirmed that primary students' creative thinking abilities improve when exposed to problem-solving tasks supported by structured interventions.

Wang and Hsu (2020) provided further support by showing that digital game-based learning enhances both problem-solving and creativity, aligning with the outcomes of this study. Their findings suggest that playful, interactive digital formats can make mathematics learning more engaging, which parallels the improvements observed in this research.

However, some differences emerge when compared with other contexts. For example, Zhang and Chen (2021) found that interactive tools enhanced learning outcomes in Chinese classrooms, but the effect sizes were smaller than those observed in this study. This may be attributed to cultural and curricular differences; Indonesian classrooms may have experienced stronger novelty effects from digital tools due to traditionally limited exposure.

Bron and Prudente (2024) conducted a meta-analysis on problem-based learning and mathematical creativity, showing consistent positive impacts but emphasizing that results varied depending on instructional design quality. This suggests that while digital tools are effective, their success depends heavily on thoughtful pedagogical integration, echoing the caution noted by Christidamayani and Kristanto (2020) in their case study on interactive software.

Theoretically, this study contributes to the growing body of literature linking digital learning with higher-order thinking skills. It demonstrates that creativity and problem-solving, traditionally studied separately, can be enhanced simultaneously through integrated digital approaches. This dual impact expands the scope of research on mathematics education, supporting the idea that cognitive and creative dimensions are interconnected (Siswono, 2018; Munandar, 2018).

From a practical perspective, the study provides insights for teachers and policymakers. Integrating digital tools such as videos, spreadsheets, and interactive software into the mathematics curriculum can improve learning outcomes. As Christidamayani and Kristanto (2020) noted, interactive software promotes student engagement, which is critical for sustained problem-solving practice.

For curriculum designers, the findings underscore the need to embed creativity-oriented digital activities within mathematics lessons. Fernandez and Torres (2017) argued that technology integration fosters innovative approaches to problem-solving, which this study empirically supports. The implications extend to teacher training, as educators must be equipped not only with digital literacy but also with pedagogical strategies to use technology meaningfully.

Policymakers can also benefit from this research by recognizing the importance of digital infrastructure in schools. As Godoy (2021) emphasized, student engagement

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rises significantly when digital learning environments are provided, which has long-term implications for academic performance and equity.

In terms of global knowledge, this study enriches discussions about digital pedagogy in developing countries, providing evidence that technological interventions can yield results comparable to those in more digitally advanced education systems (Li & Ma, 2019).

Despite its promising results, the study has several limitations. First, the sample size was relatively small (54 students), which limits the generalizability of the findings. Future studies should involve larger and more diverse populations across multiple schools or regions to strengthen external validity. Second, the duration of the intervention was relatively short. Longer-term studies are needed to determine whether the observed improvements in problem-solving and creativity are sustained over time or diminish once the novelty of digital tools wears off (Wang & Hsu, 2020).

Third, the study focused exclusively on fifth-grade students in one subject area (statistics). Future research could explore whether similar effects occur across different grade levels and mathematical domains, such as algebra, geometry, or calculus. This would provide a more comprehensive understanding of the role of digital tools in mathematics education (Pehkonen, 2019). Fourth, while this study demonstrated the effectiveness of digital interventions, it did not examine differential effects based on gender, prior achievement, or socio-economic background. These factors may influence how students engage with and benefit from digital learning (Yayuk et al., 2020).

Finally, the study did not incorporate qualitative data such as student interviews or classroom observations. Such data would provide richer insights into students' learning experiences, motivational factors, and perceptions of digital learning. Future research could adopt mixed-method approaches to capture both quantitative outcomes and qualitative processes (Fernandez & Torres, 2017).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results and discussion, it can be concluded that digital mathematics learning significantly enhances students' problem-solving and creative thinking abilities in statistics. The experimental group demonstrated substantial progress compared to the control group, indicating that the integration of digital tools fosters not only analytical skills but also creativity, which are essential for 21st-century learners. These findings contribute to the growing body of evidence that technology-supported pedagogy can be an effective means of improving mathematics education, particularly in contexts where traditional methods have often limited students' engagement and higher-order thinking.

Recommendations, Based on the findings, it is recommended that teachers integrate digital tools into mathematics instruction to foster both problem-solving and creative thinking skills. Schools should provide adequate infrastructure and

training to support this integration, while policymakers are encouraged to embed digital-based learning approaches into curriculum design to ensure equitable access for all learners. Future studies are suggested to involve larger samples and longer intervention periods to validate and expand the applicability of these results.

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