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Implementation of Khan Academy-Based Learning Media to Improve Numerical Literacy Skills

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ABSTRACT

Numeracy skills are fundamental competencies in primary education to prepare students for the demands of the digital era. However, numeracy achievement in several elementary schools still requires strengthening through innovative digital learning media. This study aims to (1) determine the effectiveness of Khan Academy–based learning media in improving numeracy skills among elementary school students in Pacitan Regency, and (2) analyze changes in numerical literacy following its implementation. A quantitative approach supported by descriptive data was employed. Data were collected through pre-tests, post-tests, and interviews with teachers and students regarding their perceptions of Khan Academy. Quantitative data were analyzed using the Paired Sample t-Test to compare pre-test and post-test results, while qualitative data were analyzed using Miles and Huberman's interactive model, including data reduction, data display, and conclusion drawing. The findings indicate a significant improvement in students' numeracy performance. The average score increased from 60.4 to 78.2, with an average gain of 17.8 points. Statistical analysis revealed a t-value of –60.603 with $p < 0.05$, indicating a significant difference between pre-test and post-test scores. Students also demonstrated high engagement in interactive exercises, along with increased independence and conceptual understanding. In conclusion, the use of Khan Academy as a digital learning medium effectively enhances numeracy skills in primary education and serves as an innovative solution to support technology-based learning in the digital era.

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1. INTRODUCTION

The numeracy literacy level among Indonesian primary school students remains a significant concern in the national education context. Results from the 2024 National Assessment (ANBK) indicate that the majority of students have not yet reached the minimum competency standards in numeracy. Likewise, Indonesia's performance in the Programme for International Assessment (PISA) continues to fall into the low category for mathematical literacy, reflecting weak foundational numerical understanding among learners. This situation highlights the urgent need for effective instructional strategies to strengthen numeracy competencies from early schooling.

Digital interactive learning platforms have emerged as promising tools to enhance students' engagement and conceptual mastery. Prior studies demonstrate that technology-enhanced learning can improve motivation and accelerate comprehension of complex numerical concepts ((Permansah & Murwaningsih, 2018); (Wiryanto et al., 2023); (Putri, 2022)). Khan Academy, as an online learning platform, has shown positive effects on mathematics achievement across different international settings ((Gray & Lindstrøm, 2019) and offers potential benefits for numeracy learning. However, empirical research on the application of Khan Academy in Indonesian elementary schools remains limited, especially in semi-rural settings with technological access challenges ((Zenteno Ruiz et al., 2022)).

Existing studies on the integration of digital learning platforms in Indonesia have generally concentrated on limited educational contexts and methodological approaches. A substantial body of prior research predominantly focuses on secondary school students, particularly those at the junior and senior high school levels, where learners are assumed to have higher levels of digital literacy, cognitive maturity, and independent learning skills. Moreover, many of these studies rely almost exclusively on quantitative research designs, emphasizing statistical measurements of learning outcomes such as test scores, achievement gains, or correlations between digital media use and academic performance (Badawi, 2023);(Putri, 2022);(Savitri et al., 2015);(Muh. Khaedar et al., 2023). While these approaches provide valuable empirical evidence regarding effectiveness, they often overlook the experiential, contextual, and pedagogical dimensions of technology implementation(Suparni, 2022);(L. Rahmawati, 2024);(Amilia, 2022) in real classroom settings.

In addition to the dominance of quantitative approaches, previous studies are largely situated in urban or metropolitan school environments(Yunarti & Almira, 2022);(Maharani & Hidayah Putri, 2023). Urban schools typically benefit from relatively stable internet connectivity, greater availability of digital devices, and higher levels of teacher readiness in adopting educational technology(Nasaruddin, 2018);(Batubara & Ariani, 2019);(Khoirin, 2023). As a result, findings from such studies may not adequately represent the realities faced by schools in semi-rural or rural areas, where infrastructure limitations, unequal access to devices, and varying levels of parental support continue to pose significant challenges(OECD, 2021)(Juniyanto et al., 2022);(Simorangkir & HS, 2021). Consequently, the generalizability of existing research remains constrained, particularly when applied to elementary school contexts outside urban centers(Siregar, 2022);(Rahayu et al., 2023);(Adillah et al., 2023).

Another limitation in prior research lies in the educational level under investigation. Research focusing on digital learning platforms, including Khan Academy(Nguyen & Le, 2020);(Rueda-Gómez et al., 2023);(Zenteno Ruiz et al., 2023);(Flaviano Armando Zenteno Ruiz et al., 2024), has more frequently examined junior secondary or higher education learners, assuming that younger students may struggle with self-paced or technology-mediated learning environments(N. K. Rahmawati et al., 2023);(Haluti et al., 2022). However, elementary school students represent a critical stage in the development of foundational numeracy skills, learning habits, and attitudes toward mathematics(Kurnia et al., 2021);(Wahyu et al., 2020);(Nurkholis et al., 2022);(S. Rahmawati et al., 2022). Early exposure to effective digital learning media may play a crucial role in shaping students' long-term numeracy competence and learning motivation(Abdul et al., 2020). Despite this importance, empirical studies exploring the implementation of digital platforms for numeracy development at the

elementary school level—particularly in Indonesian contexts—remain relatively scarce.(Winangsih & Harahap, 2023);(Hanannika & Sukartono, 2022);(Hakeu et al., 2023)

Based on the various limitations identified in previous studies, there is a need for research that can bridge gaps in context, educational level, and methodological approach in the implementation of digital learning platforms(Air Puji et al., 2023). Responding to this need, the present study positions itself differently by implementing Khan Academy in a semi-rural elementary school context(Aulia et al., 2023). This approach is intended to address the shortcomings of earlier research, which has generally emphasized quantitative measurements of learning outcomes without sufficiently exploring learning processes and user experiences in authentic classroom settings(Amali et al., 2023);(Marzuki et al., 2024).

The selection of a semi-rural elementary school is particularly relevant to the issue of digital education equity in Indonesia. Semi-rural educational environments represent transitional contexts in which digital learning initiatives are beginning to emerge but are still constrained by limited infrastructure, device availability, and resource support(Netri & Ramadan, 2023). By examining the implementation of Khan Academy under these conditions, this study provides insights into the feasibility, adaptability, and sustainability of digital learning media in schools that do not fully benefit from the facilities typically available in urban settings(- et al., 2015). This focus further underscores the importance of inclusive and equitable approaches to technology integration in education.

Beyond contextual and methodological considerations, the simultaneous inclusion of students' and teachers' perspectives constitutes a key strength of this study(Primasari & Supena, 2021);(RK & Watini, 2022). Students' experiences offer in-depth insights into motivation, engagement, and learning autonomy in digital numeracy learning, while teachers' perceptions reveal shifts in pedagogical roles from content delivery to learning facilitation, including adjustments in instructional strategies and classroom management practices when digital platforms are introduced(Jovanovic et al., 2022);(Kretschmer et al., 2022). Understanding both perspectives is essential for explaining not only whether Khan Academy is effective, but also how and why it can be optimally implemented (Arisanti, 2022);(Prianti, 2022);(Deri Hidayat Tullah, 2021);(Tabiin, 2021)within a semi-rural elementary school context.

In line with this framework, the study pursues two primary objectives(Ahmed et al., 2024). First, it seeks to analyze the effectiveness of Khan Academy–based learning media in improving elementary school students' numeracy literacy through systematic measurement of learning outcomes before and after the intervention(Nabilah et al., 2023). Second, it aims to explore students' and teachers' experiences and perceptions of Khan Academy implementation in classroom learning, with particular emphasis on motivation, engagement, instructional support, and contextual challenges that influence the success of technology-based learning(Oktaviani et al., 2023)(Feri, 2025).The contributions of this study are both theoretical and practical. Theoretically, it enriches the literature on technology-supported numeracy learning by providing empirical evidence from a semi-rural elementary school context that remains underrepresented in prior research. Moreover, the use of a mixed-methods approach offers a methodological contribution by demonstrating the value of integrating quantitative and qualitative data to capture the complexity of digital learning implementation(Lature et al., 2024);(Widiada et al., 2021);(Marbun, 2023). Practically, the findings propose an innovative, context-sensitive, and applicable model for implementing digital learning media in resource-limited elementary schools, serving as a reference for teachers, school leaders, and policymakers seeking to enhance numeracy literacy through accessible digital platforms such as Khan Academy.

Thus, by addressing methodological, contextual, and educational-level gaps in previous research, this study offers a more comprehensive understanding of the role of digital learning media in supporting numeracy development in elementary education, particularly within semi-rural school environments.

2. METHODS

This study employed a mixed-methods design with a sequential explanatory model, where quantitative analysis was conducted first and subsequently strengthened with qualitative findings(Yin, 2020);(Cohen et al., 2021);(Creswell & Plano Clark, 2023);(Miles et al., 2020). This approach was selected to objectively measure improvements in students' numeracy literacy and to explore their perceptions, experiences, and challenges during the implementation of Khan Academy-based learning media. This research design aligns with current educational technology studies emphasizing integrated quantitative and qualitative evidence to produce comprehensive insights (Poth, 2022);(Creswell & Plano Clark, 2021).

The study was conducted at Ngadirejan Public Elementary School, Pacitan Regency, during the second semester of the 2024–2025 academic year. The participants consisted of 28 fifth-grade students aged 10–11 as primary respondents, one homeroom teacher as the key informant for instructional practices, and five parents as supporting informants to provide information regarding learning habits at home. The school was selected purposively based on three criteria: its semi-rural context, availability of basic ICT facilities, and commitment to digital learning innovation(Nathaniel, 2023). These characteristics represent a transitional school environment with growing digital learning capacity, consistent with recommendations for inclusive digital transformation in education (Körtvési & Szendrei-Pál, 2023).

This study employed a comprehensive set of research instruments designed to capture both quantitative learning outcomes and qualitative learning experiences associated with the implementation of Khan Academy–based learning media(Creswell & Poth, 2021). The primary quantitative instrument was a numeracy literacy test developed in alignment with the numeracy indicators established by the Indonesian Ministry of Education and the learning objectives embedded within Khan Academy mathematics modules(Salmia, 2023)(N. Rahmawati & Widodo, 2021). This alignment ensured that the test measured competencies relevant to national curriculum standards while remaining consistent with the digital learning content used during the intervention(Ayanwale & Muraina, 2023)(Tan & Kusumawardhani, 2024). The numeracy test was administered as both a pre-test and a post-test to systematically measure changes in students' numeracy literacy before and after exposure to the Khan Academy platform(Megahed & Hassan, 2022)(Pratama & Hidayat, 2023);(D. Rahmawati & Suryadi, 2024).

In addition to the numeracy test, observation sheets were utilized to document students' learning activities during classroom implementation. These observation instruments focused on indicators such as student engagement, participation, independence in completing tasks, and interaction with digital content. The use of structured observation sheets enabled the researchers to capture real-time classroom dynamics and behavioral patterns that could not be fully explained by test scores alone. To further enrich the qualitative data, semi-structured interview guides were developed for teachers and students(Novitasari, 2023). These interviews were designed to explore participants' experiences, perceptions, and challenges related to the use of Khan Academy as a learning medium. Teachers were asked about instructional strategies, classroom management, and perceived changes in student learning, while students were encouraged to share their motivation, ease of use, and learning preferences(Andriana et al., 2023). Additionally, a student perception questionnaire was administered to systematically collect students' responses regarding their attitudes toward digital learning media, usability of the platform, and perceived benefits of Khan Academy in supporting numeracy learning(Adilla Kania et al., 2023).

To ensure the validity of the research instruments, content validity was assessed through expert judgment. This process involved two lecturers specializing in mathematics education and one certified numeracy teacher with practical classroom experience. The experts reviewed the instruments to evaluate the relevance, clarity, and alignment of each item with the intended learning indicators and research objectives. Feedback from the experts was used to revise and refine the instruments prior to data collection, following established validation standards in digital education research (Zhang & Hadi,

2024). This validation process strengthened the credibility and appropriateness of the instruments for use in an elementary school context.

Data collection was conducted using multiple techniques to obtain rich, comprehensive, and triangulated information. Quantitative data were collected through pre- and post-numeracy tests administered to all participating students(Brookhart, 2020);(Abylkassymova et al., 2024). Qualitative data were gathered through classroom observations conducted throughout the implementation of Khan Academy, semi-structured interviews with teachers, students, and parents, and documentation of student learning activities, including screenshots of digital progress and learning logs(Nuraini & Prabowo, 2022). The inclusion of parents as informants provided additional insights into students' learning habits and technology use outside the classroom. The combination of these data collection methods aligns with triangulation principles in educational research and enhances the depth and trustworthiness of the findings (Ardiansyah & Dewi, 2022);(Hein et al., 2020);(Setiani & Mangkurat, 2023).

Quantitative data analysis was performed systematically to determine whether the Khan Academy–based learning intervention led to statistically significant improvements in students' numeracy literacy. Prior to hypothesis testing, the data were subjected to a Kolmogorov–Smirnov normality test and a homogeneity test to examine the distribution and variance of the data. For normally distributed data, a paired-sample t-test was employed to compare pre-test and post-test scores. In cases where the data did not meet normality assumptions, the Wilcoxon Signed-Rank Test was used as a non-parametric alternative (Salmia, 2023). A significance level of $p < 0.05$ was applied as the criterion for determining whether observed differences were statistically meaningful.

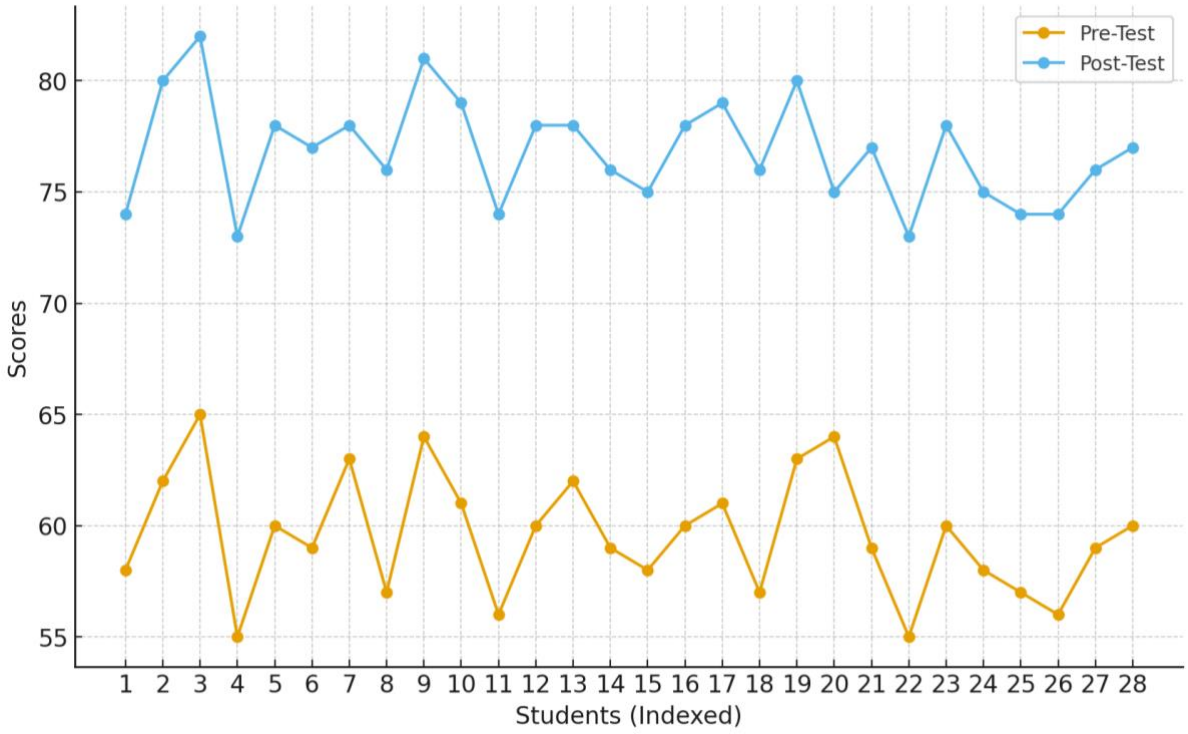
Qualitative data analysis followed the Miles and Huberman(Miles et al., 2020) interactive model, which consists of three interrelated stages: data reduction, data display, and conclusion drawing. During data reduction, interview transcripts, observation notes, and documentation were systematically coded and categorized to identify recurring themes and patterns related to student engagement, instructional practices, and implementation challenges(Habibzadeh, 2024). Data display involved organizing the reduced data into matrices and narrative descriptions to facilitate interpretation. Finally, conclusions were drawn by interpreting the patterns and relationships emerging from the data. To enhance data credibility, both source triangulation (students, teachers, and parents) and method triangulation (tests, interviews, observations, and documentation) were applied, ensuring the reliability, validity, and depth of qualitative interpretation(Pallant, 2020).

3. FINDINGS AND DISCUSSION

The quantitative results indicate a significant improvement in students' numeracy literacy skills after participating in learning activities using the Khan Academy platform for four weeks. At the beginning of the study, students were given a pretest to measure their initial abilities. The average pretest score obtained was 59.57, suggesting that most students were still at a basic numeracy level and required improvement in understanding elementary mathematical concepts.

Following the Khan Academy–based learning intervention, students were administered a posttest to assess their numeracy development. The posttest results demonstrated a substantial increase, with an average score of 76.82, representing a 17.25–point improvement from the pretest. This improvement was observed across all students, although the degree of improvement varied among individuals. These results indicate that learning through Khan Academy provided equitable benefits for all participants.

Figure 1.Pre Tes vs Post Tes Score of Students Using Khan Academy



To ensure that the improvement did not occur by chance, a series of statistical tests was conducted. First, normality tests using the Kolmogorov–Smirnov and Shapiro–Wilk methods were performed. The results confirmed that both pretest and posttest data were normally distributed, allowing further analysis using parametric tests. A paired sample t-test was then administered to examine differences between the pretest and posttest means. The results showed a t-value of −60.603 with a p-value of 0.000 ($p < 0.05$). This extremely small p-value indicates a statistically significant difference between scores before and after the intervention.

A paired sample t-test was conducted using SPSS to determine whether the difference between pretest and posttest scores was statistically significant. Prior to the analysis, normality tests using Kolmogorov–Smirnov and Shapiro–Wilk confirmed that the data were normally distributed, allowing the use of parametric tests. The results of the paired sample t-test showed a t-value of –60.603 with a p-value of 0.000 ($p < 0.05$). Therefore, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted.

According to the testing criteria, when t-count > t-table or –t-count < –t-table, H_0 must be rejected. In this study, because –60.603 < –2.052, it can be concluded that there was a statistically significant difference between the pretest and posttest mean scores. The mean paired difference of –17.250 indicates an average improvement of 17.25 points after the intervention, with a 95% confidence interval ranging from –17.834 to –16.667. The standard deviation (1.506) and standard error (0.285) further support the consistency and reliability of the data.

In addition, the effect size was calculated using Cohen's d, resulting in d = 11.45, which falls into the category of a very large effect size. This indicates that the use of Khan Academy had not only a statistically significant effect but also a highly substantial practical impact on students' numeracy improvement. In other words, the observed gains were not due to random variation or chance, but rather a meaningful outcome of the digital learning intervention

The qualitative data in this study were obtained through in-depth interviews, classroom observations, and teacher field notes throughout the learning process. The analysis revealed consistent learning experience patterns that illustrate changes in student behavior, the shifting role of the teacher, and the role of the learning environment in implementing the Khan Academy platform.

One of the most prominent findings was the noticeable increase in students' motivation and enthusiasm while using the digital platform. Students appeared more focused, active, and engaged during technology-supported learning sessions. They demonstrated strong interest in short instructional videos and interactive practice exercises that provided immediate feedback. The platform's points, badges, and visual progress indicators effectively fostered intrinsic motivation, encouraging students to learn independently and complete tasks consistently. Many students reported feeling more confident because they could revisit materials as needed until they fully understood the concepts. The instant feedback feature helped them identify and correct errors quickly, fostering a sense of achievement while reducing mathematics anxiety that commonly arises in traditional learning settings.

In addition, the findings revealed a significant shift in the teacher's role from a transmitter of knowledge to a learning facilitator. The teacher not only provided initial explanations but also supported students in accessing materials, selecting appropriate content, and monitoring learning progress through the platform's dashboard. Personalized assistance was offered when students encountered technical difficulties or struggled with mathematical concepts. Real-time learning data enabled the teacher to identify students who required additional support, resulting in a more targeted, adaptive, and individualized learning process.

Despite the effective implementation of digital learning, several challenges emerged, particularly regarding limited access to digital devices and internet connectivity at home. Some students could only use Khan Academy when their parents returned home with mobile phones, limiting learning time outside school hours. Nevertheless, parents provided meaningful support by assisting their children in accessing the platform, supervising learning activities, and encouraging consistent study habits. These findings suggest that the success of digital learning depends not only on the quality of the platform but also on technological readiness and parental involvement—particularly in semi-rural areas where digital infrastructure remains limited.

Overall, the qualitative findings indicate that the use of Khan Academy promotes improved student motivation, strengthens the teacher's role as a facilitator, and requires family support and adequate digital resources to ensure sustainable and effective implementation of digital learning.

The research implies that integrating digital media such as Khan Academy into the elementary classroom can enhance both student engagement and learning outcomes. Teachers play a crucial role as facilitators, ensuring that digital learning complements—not replaces—traditional teaching. Schools with limited resources can adopt similar approaches by gradually incorporating online media to strengthen numeracy and other cognitive skills.

In summary, the study demonstrates that the implementation of Khan Academy learning media at Ngadirejan State Elementary School was effective and impactful. Students showed measurable improvement in numeracy skills, while teachers and parents reported positive changes in learning attitudes and motivation. Despite technical challenges, the overall results indicate that technology-assisted learning can substantially support numeracy development at the elementary school level.

The results of the analysis indicate that Khan Academy possesses a fundamental advantage that clearly distinguishes it from other interactive media platforms in the context of numeracy learning at the elementary school level. This advantage lies primarily in its implementation of a *mastery learning* approach that is designed to be gradual, systematic, and adaptive to individual students' abilities. This approach places conceptual mastery as the central objective of learning, rather than merely emphasizing scores or the rapid completion of tasks. In the context of numeracy literacy, such an approach is critically important, as mathematical understanding cannot be developed instantaneously but must be constructed through repeated processes that allow students to grasp the meaning underlying each concept, procedure, and numerical representation.

In contrast to Kahoot and Quizizz, which emphasize quiz-based evaluation with a competitive atmosphere, Khan Academy offers a learning experience that is deeper and more reflective. Kahoot and Quizizz are indeed effective in increasing short-term learning motivation through gamification, speed,

and competition among students. However, the primary focus of these platforms is the rapid measurement of learning outcomes rather than the development of sustained conceptual understanding. As a result, students may become more oriented toward answering quickly and accumulating points than toward engaging in genuine mathematical reasoning. In numeracy learning, this condition risks producing superficial understanding that is unlikely to endure over time.

By contrast, Khan Academy provides a comprehensive and structured learning sequence, beginning with conceptual explanations delivered through simple and accessible instructional videos, followed by tiered practice activities that adapt to students' ability levels, and immediate feedback that is diagnostic in nature. This feedback does not merely indicate whether an answer is right or wrong but guides students to identify errors and correct them independently. In this way, mistakes are not positioned as failures but as an integral part of the learning process. This approach aligns with constructivist learning principles that position students as active agents in constructing their own knowledge.

When compared to Photomath, the fundamental differences of Khan Academy become even more apparent. Photomath offers instant convenience by displaying step-by-step solutions simply by scanning a mathematical problem. Although this feature may help students understand procedural steps, reliance on instant solutions can potentially inhibit the development of mathematical thinking and numeracy literacy. Students may become trapped in a result-oriented learning pattern without understanding the underlying concepts. In the long term, this condition may weaken students' ability to solve contextual problems that require numerical reasoning.

Khan Academy, by contrast, deliberately encourages active mathematical thinking processes. The exercises provided are designed to assess conceptual understanding rather than mere procedural execution. Students are encouraged to try, make mistakes, reflect on feedback, and repeat until they truly master the material. This approach is highly relevant to the goals of numeracy literacy, which emphasize the ability to use mathematical knowledge meaningfully across diverse real-life contexts. Thus, Khan Academy not only helps students solve problems but also shapes a more mature and sustainable way of numerical thinking.

Meanwhile, GeoGebra is widely recognized for its strength in visualizing mathematical concepts, particularly in geometry, algebra, and functions. The interactive visualizations offered by GeoGebra can help students understand relationships between variables and mathematical representations more concretely. However, this strength also becomes a limitation when applied at the elementary school level. The use of GeoGebra requires a certain level of cognitive readiness, independent exploration skills, and adequate pedagogical guidance from teachers. Without proper scaffolding, students may interact with visual representations without fully understanding the underlying concepts.

In this context, Khan Academy offers a more balanced combination of accessibility and depth of content. Its simple interface, communicative language, and clearly structured learning pathways make it more accessible for elementary school students to use independently. The materials are organized hierarchically, preventing students from jumping to more complex topics before mastering prerequisite concepts. This structure is particularly important in numeracy learning, as mathematical concepts are cumulative and interconnected. Consequently, Khan Academy helps prevent learning gaps, which are often a major challenge in elementary mathematics education.

Another significant advantage of Khan Academy lies in its pedagogical flexibility and learning sustainability. The platform enables consistent integration between school-based and home-based learning. Students can continue learning beyond school hours using the same materials, while teachers can monitor students' learning progress through available performance data. This data provides a more comprehensive picture of each student's level of conceptual mastery, allowing teachers to implement differentiated instruction more precisely. In the context of Indonesia's Merdeka Curriculum, which emphasizes differentiated learning, this feature represents a highly relevant added value.

When compared to Ruangguru, the pedagogical orientation of Khan Academy becomes even clearer. As a commercial platform, Ruangguru tends to focus on providing ready-to-consume content,

such as instructional videos and question packages designed to help students prepare for examinations. Although effective for improving short-term understanding, this approach may position students as passive consumers of learning materials. In contrast, Khan Academy, which is open-access and free, emphasizes independent learning, learner autonomy, and student responsibility for the learning process. These values are essential for fostering a sustainable learning culture beginning at the elementary school level.

These findings indicate that Khan Academy should not be viewed merely as an additional interactive learning medium but rather as a comprehensive numeracy learning ecosystem. This ecosystem encompasses instructional content, adaptive practice systems, data-driven feedback, and the role of teachers as facilitators and pedagogical decision-makers. Through this approach, numeracy learning is no longer fragmented into separate learning and assessment activities but becomes an integrated, continuous process oriented toward conceptual mastery.

Furthermore, the superiority of Khan Academy over other interactive media platforms reinforces the novelty of this study at both conceptual and pedagogical levels. This novelty does not lie in the mere use of digital technology in learning, as such applications have been extensively examined in previous research, but rather in positioning Khan Academy as a strategic pedagogical instrument for strengthening numeracy literacy. This study demonstrates that the integrated use of Khan Academy is capable of shifting the paradigm of mathematics learning from an outcome- and speed-oriented approach toward one that emphasizes process, understanding, and learner autonomy.

By positioning Khan Academy as a comprehensive numeracy learning ecosystem, this study offers significant theoretical and practical contributions. Theoretically, the findings enrich the discourse on digital learning by highlighting the importance of mastery learning and data-driven differentiation in the development of numeracy literacy. Practically, this study proposes a model for utilizing digital platforms that aligns with the characteristics of elementary school students and the demands of the national curriculum. Thus, Khan Academy emerges not merely as an alternative learning medium, but as a strategic solution for sustainably improving the quality of numeracy learning.

4. CONCLUSION

Based on a four-week mixed-method study (exploratory sequential design) conducted at Ngadirejan Elementary School in Pacitan Regency, the implementation of Khan Academy–based learning media was proven effective in enhancing students' numeracy skills, interest, and engagement. The combination of interactive instructional videos, adaptive practice exercises, and real-time progress monitoring created a learning atmosphere that was more personalized and motivating for students. Teachers effectively integrated face-to-face instruction with digital exercises, strengthening student interaction and instructional quality. Statistical analysis using a paired sample t-test confirmed a significant improvement in learning outcomes, with the average score increasing by approximately 17.8 points (from 60.4 to 78.2), demonstrating the substantial positive effect of digital-supported learning on numeracy development at the elementary school level.

The findings further suggest that digital platforms like Khan Academy can strengthen students' autonomy and motivation as active learners while supporting teachers in facilitating differentiated instruction. To maximize these benefits, schools are encouraged to gradually integrate digital-based learning strategies and provide continuous professional development for teachers, while families are encouraged to foster digital literacy and support learning at home. However, this study also acknowledges limitations, including a relatively short intervention period, challenges related to limited internet connectivity and device availability, and the focus on a single school setting, which restricts broader generalization. Therefore, future research involving a larger sample, longer intervention duration, and diverse school contexts is recommended to further validate and expand understanding of the long-term impact of technology-supported learning on numeracy achievement.

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