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INTEGRATING DIGITAL TECHNOLOGY IN EDUCATION: THE EFFECTIVENESS OF MOBILE GAMES IN NUMERACY LEARNING

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ABSTRACT

The numeracy skills of elementary school students in Indonesia remain low, as reflected in national and international assessments. Conventional teaching methods are ineffective in improving numeracy skills, necessitating a more interactive and engaging approach. This study aims to analyze the effectiveness of mobile game-based learning in facilitating numeracy education. Using a quasi-experimental design, the study involved two groups of third-grade students: an experimental group using mobile games and a control group using PowerPoint. Data were collected through numeracy tests covering number relations, arithmetic operations, and counting. The results showed that the experimental group experienced a significant improvement in numeracy skills compared to the control group, with a p-value of 0.043. These findings suggest that mobile game-based learning is more effective, interactive, and flexible in enhancing students' numeracy skills. The study recommends mobile games as an innovative alternative learning medium in elementary education.

Keywords: *mobile game, numeracy, elementary school*

1. INTRODUCTION

Developing numeracy skills from an early age is crucial for subsequent mathematics learning in school and is crucial for a successful future career (Aunio, 2019). This is because numeracy skills are a strong predictor of academic success and are even better predictors than early reading skills and early attention skills (Butterworth, 2005; Claessens et al., 2009; Duncan et al., 2007). The term numeracy describes the ability to understand, apply, and utilize mathematical ideas and techniques in a variety of situations (King & Purpura, 2021; Litkowski et al., 2020; Trickett et al., 2022). This includes basic arithmetic operations, numerical reasoning, problem solving, and the competence to explain and communicate mathematical facts well (Ajmal & Hussain, 2022; Barham et al.,

2019; Piper et al., 2018; Rajagopal et al., 2022). Based on research results, only 19.3% of students are able to solve numeracy literacy problems (Lamada et al., 2019). The low PISA 2018 mathematics score shows that Indonesian students' numeracy literacy skills are still far from ideal, with an average score of 379 compared to the OECD average of 487. (Andri Nurcahyono, 2023; Ayuningtyas & Sukriyah, 2020; Feriyanto, 2022).

Efforts to improve students' numeracy skills have been widely reported by researchers through publications. Many efforts are made through the application of learning models that can support the development of numeracy skills (Andri Nurcahyono, 2023). Conversely, the application of inappropriate learning models will result in underdeveloped numeracy skills. Based on the literature, several models that can be used to improve students' numeracy skills include problem-based learning models (Awami et al., 2022; Mawarsari & Wardani, 2022; Rachman & Nuriadin, 2022; Simamora et al., 2022; Wibowo et al., 2022), project-based learning models (Baharuddin et al., 2021; Faridah et al., 2022), cooperative learning models using teams games tournament techniques (Offirstson & Muhammad Zaenal, 2021), inquiry-based learning models (Alvionita et al., 2022), and realistic mathematics education learning models (Agustina et al., 2022; Mubarokah et al., 2024). The use of learning models is an effective way to improve numeracy skills. However, from a number of these reports, these models are mostly applied at the secondary school level, and there are still few that study the subject of elementary school students. Where elementary school students still prefer to learn through play.

Learning through play is an effective and enjoyable approach to support children's learning (Andri Nurcahyono, 2023). Students acquire mathematical language and conceptual understanding when given ample opportunities to participate in language-rich interactions and to practice mathematical thinking in a fun way (Cohrssen et al., 2014). Mobile games have become an integral part of children's lives today. Mobile games offer a variety of engaging features, such as dynamic visual and audio interactions, engaging stories, and motivating reward systems. These engaging characteristics of mobile games have the potential to be utilized in numeracy learning. By integrating numeracy concepts into mobile games, numeracy learning can become more engaging, interactive, and enjoyable for students.

2. RESEARCH METHOD

This study uses a quantitative approach with a *quasi-experimental design* to analyze the effectiveness of using *mobile games* in improving elementary school students' numeracy skills. This design was chosen because it allows comparisons between two groups: the experimental group receiving learning with *mobile*

games and the control group using conventional learning media in the form of PowerPoint. Data were collected through numeracy tests conducted before and after treatment, namely *pre-test* and *post-test* . The test instruments used cover three main aspects of numeracy, namely numeracy relations, counting, and arithmetic operations. The *pre-test* was conducted to measure students' initial numeracy skills, while *the post-test* was conducted after treatment to see changes in numeracy skills after the learning process. The use of this test allows researchers to compare student learning outcomes between the two groups to determine the effect of the learning method used.

The data source for this study was third-grade elementary school students who were divided into two groups. The experimental group learned using *mobile games*, while the control group learned using PowerPoint media. Data collection from these two groups provides a clear picture of the differences in numeracy learning outcomes caused by different learning methods. Data analysis was carried out in several stages. First, a prerequisite test was conducted to ensure whether the data were normally distributed. This normality test was carried out using the Shapiro-Wilk and Kolmogorov-Smirnov tests. If the data were normally distributed, a parametric statistical test was conducted using *the Independent Samples T-Test* to compare the average *pre-test* and *post-test results* of the two groups. However, if the data were not normally distributed, the non-parametric Mann-Whitney test was used as an alternative. This test aims to determine whether there is a significant difference between the numeracy abilities of students who used *mobile games* and students who learned with PowerPoint.

3. RESULT AND ANALYSIS

RESULT

The results are the main part of a scientific article, containing: net results without data analysis processes, hypothesis testing results. Results can be presented in tables or graphs, to clarify the results verbally . The discussion is the most important part of the entire content of a scientific article. The purpose of the discussion is: Answering research problems, interpreting findings, integrating research findings into existing knowledge and developing new theories or modifying existing theories. Hypothesis testing is carried out to determine whether there are differences in numeracy abilities between the control and experimental groups, both before (pre-test) and after (post-test) treatment. The testing stages are carried out through several steps, namely normality tests and t-tests. Before conducting a t-test on the pre-test data, a normality test is first conducted to ensure that the data is normally distributed. The normality test is carried out using Shapiro-Wilk and Kolmogorov-Smirnov. Based on the results of the normality test as in Table 1. the Shapiro-Wilk statistical value for the pre-test

data is 0.983 with a p-value of 0.587. Meanwhile, the Kolmogorov-Smirnov statistic was 0.0744 with a p-value of 0.894. Both test results indicated a p-value > 0.05, indicating that the pre-test data from both groups were normally distributed. Therefore, the pre-test data met the assumption of normality, and testing was continued with a t-test.

1. Table 1Tests of Normality

		statistics	p
Pretest	Shapiro-Wilk	0.983	0.587
	Kolmogorov-Smirnov	0.0744	0.894
Posttest	Shapiro-Wilk	0.951	0.017
	Kolmogorov-Smirnov	0.1258	0.298

Note. Additional results provided by *moretests*

After the normality assumption was met, a t-test was conducted to determine whether there was a difference in numeracy ability between the control and experimental groups before treatment. Based on the results of the Independent Samples T-Test as shown in Table 2, the t-value was 0.1 with 58 degrees of freedom (df) and a p-value of 0.921. Since the p-value > 0.05, it can be concluded that there was no significant difference between the numeracy ability of the control and experimental groups at the pre-test stage. Thus, both groups had equivalent numeracy ability before being given treatment.

2. Table 2Independent Samples T-Test

		Statistics	df	p
Pretest	Student's t	0.1	58	0.921

Note. $H_a\ \mu_{Control} \neq \mu_{Experimental}$

[a] Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances

Next, testing was conducted on the post-test data after treatment. As with the pre-test data, a normality test was first conducted on the post-test data. The results of the normality test as shown in Table 1show that for the post-test data, the Shapiro-Wilk statistic value is 0.951 with a p-value of 0.017, and the Kolmogorov-Smirnov value is 0.1258 with a p-value of 0.298. Based on these results, the

Kolmogorov-Smirnov test shows p > 0.05, so the post-test data can be considered to meet the assumption of normality. Therefore, testing can be continued with a t-test.

After the normality assumption for the post-test data was met, a t-test was conducted to determine whether there was a significant difference between the numeracy abilities of the control and experimental groups after treatment. Based on the results of the Independent Samples T-Test as shown in **Table 3**, the t-value obtained was -2.069 with a degree of freedom (df) of 58 and a p-value of 0.043. Since the p-value <0.05, it can be concluded that there is a significant difference between the numeracy abilities of the control and experimental groups in the post-test data.

3. Table 3Independent Samples T-Test

		Statistics	df	p
Posttest	Student's t	-2,069	58	0.043

Note. H_a $\mu_{Control} \neq \mu_{Experimental}$

[a] Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances

ANALYSIS

Based on the research results presented previously, it can be seen that there is a significant difference between the numeracy skills of the experimental group and the control group after treatment. The experimental group, which used mobile games as a learning medium, showed a higher increase in numeracy skills compared to the control group that used PowerPoint media as a means of delivering material and practicing questions. This increase is supported by the results of the t-test on the post-test data, which showed a significant difference with a p-value of 0.043 (p < 0.05), which indicates that the mobile game-based learning method has a significant effect on students' numeracy skills.

Mobile game-based learning facilitates students in a more interactive and engaging way compared to traditional methods such as PowerPoint (Arif et al., 2022; Nadeem et al., 2023). Mobile games offer a fun learning experience, which can increase learning motivation and active student engagement in the learning process (Cho & Castañeda, 2019; Ramli et al., 2020). In the context of numeracy, mobile games allow students to develop their numeracy skills through interactive simulations, game-based challenges, and direct feedback provided in real time (Nuraini et al., 2022; Srisawasdi et al., 2021). This is in line with learning theory which emphasizes that learning that involves active student involvement will be more effective in building conceptual understanding and skills (EL Machtani EL Idrissi et al., 2022).

The superiority of mobile games compared to PowerPoint is also evident in the difference in standard deviations in the post-test data. The experimental group had a lower standard deviation compared to the control group, indicating that numeracy skills in the experimental group were more evenly distributed after using mobile games as a learning medium. This suggests that the use of mobile games is not only effective in improving students' average numeracy skills but also helps minimize the ability gap between students within a group (Nadeem et al., 2023; Panjaburee et al., 2019).

Furthermore, the use of mobile games allows students to learn independently and flexibly at their own pace and needs (Srisawasdi et al., 2021; Yadav & Oyelere, 2021). Mobile games provide an environment that supports repetitive learning, where students can repeat material and exercises as many times as they need without time pressure (Bennis & Amali, 2019; Troussas et al., 2020). This feature is very helpful in strengthening understanding and numeracy skills, especially for students who may need more time to grasp certain concepts (Eichler et al., 2019).

In contrast, the PowerPoint presentation used in the control group was more passive, with students receiving the material in a one-way format (Godoy, 2020). Although PowerPoint provided materials and practice problems, the lack of interactivity and immediate feedback that could motivate students made this method less effective in developing deeper numeracy skills (Zeng et al., 2020).

In contrast, the PowerPoint presentation used in the control group was more passive, with students receiving the material in a one-way format. Although PowerPoint provided materials and practice problems, the lack of interactivity and immediate feedback that could motivate students made this method less effective in developing deeper numeracy skills.

This research supports previous findings showing that digital technology, particularly mobile games, can be an effective learning tool, particularly in areas requiring practical skills such as numeracy. With the right design, mobile games can stimulate students' cognitive abilities, increase active participation, and provide an adaptive learning tool tailored to individual needs.

Overall, the results of this study provide evidence that mobile game-based learning is effective in facilitating numeracy learning. Mobile games as a learning medium offer a more interactive, flexible, and adaptive approach, which has been proven to improve students' numeracy skills better than the more conventional use of PowerPoint. Therefore, the application of mobile games in numeracy learning can be an innovative solution to improve the quality of education, particularly in developing numeracy skills among students.

4. CONCLUSION

Based on the research results, it can be concluded that numeracy learning using mobile games has proven effective in improving students' numeracy skills. This is demonstrated by the post-test results, where the experimental group using mobile games as a learning medium experienced significant improvement compared to the control group using PowerPoint. Statistical test results showed a significant difference between the two groups in the post-test measurement, with a higher average score in the experimental group.

Mobile games provide an interactive, fun, and flexible learning experience that can help students better understand numeracy concepts. Furthermore, the use of mobile games allows students to learn independently in an adaptive manner tailored to their individual needs. Mobile game-based learning also has the potential to increase student motivation and active engagement in the learning process, ultimately positively impacting learning outcomes .

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