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The Effectiveness Of Interactive Learning Media In Improving Early Childhood Numeracy Skills

Melia Eka Daryati✉
melia_eka@unib.ac.id
Early Childhood Education Study Programme, Universitas Bengkulu, Bengkulu

Abstrak

Pengembangan media interaktif sebagai suatu jenis alat bantu pengajaran multimedia berdampak positif terhadap keterampilan motorik kasar anak-anak. Tujuan penelitian ini untuk mengetahui efektivitas media interaktif dalam pendidikan anak usia dini melalui studi eksperimental. Penelitian ini memiliki dua kelompok peserta yang masing-masing terdiri dari 30 anak: Kelompok eksperimen dengan media pengajaran interaktif dan kelompok kontrol dengan metode pengajaran konvensional. Kemampuan menghitung dinilai sebelum dan setelah intervensi untuk kedua kelompok. Analisis data yang dilakukan dengan uji t-test berpasangan menunjukkan bahwa kelompok eksperimen menunjukkan peningkatan dalam skor rata-rata dari 50 menjadi 80 ($t(29)=12.00$; $p< 0.001$), menunjukkan perbedaan yang signifikan secara statistik setelah intervensi. Penggunaan uji Wilcoxon pada kelompok kontrol menunjukkan peningkatan dalam skor median dari 52 menjadi 60 tetapi tidak mencapai signifikansi statistik ($Z=-1.50$; $p=0.134$). Hasil penelitian menunjukkan kesimpulan bahwa penerapan media pengajaran interaktif sangat efektif dalam meningkatkan keterampilan menghitung anak-anak PAUD dibandingkan dengan metode tradisional tanpa perlakuan yang terfokus.

Kata Kunci: *Media Pembelajaran Interaktif; Kemampuan Berhitung; Anak Usia Dini*.

Abstract

The development of interactive media as a type of multimedia teaching aid has a positive impact on children's gross motor skills. This study aimed to determine the effectiveness of interactive media in early childhood education through an experimental study. The study had two participants, 30 children each: An experimental group with interactive teaching media and a control group with conventional teaching methods. Counting skills were assessed before and after the intervention for both groups. Data analysis conducted with a paired t-test showed that the experimental group showed an increase in the mean score from 50 to 80 (t (29) $=12.00$; $p<0.001$), indicating a statistically significant difference after the intervention. The Wilcoxon test on the control group showed an increase in the median score from 52 to 60, but did not reach statistical significance ($Z=-1.50$; $p=0.134$). The results suggest that the application of interactive teaching media is efficient in improving the counting skills of preschool children compared to traditional methods without focused treatment.

Keywords: Interactive Learning Media; numeracy skills; Early Childhood.

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✉Corresponding author:
Email Address: melia_eka@unib.ac.id(Merti Daryanti)
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INTRODUCTION

Early Childhood Education (PAUD) is an influential foundation for children's physical, cognitive, social, and emotional development. At this stage, children's development significantly impacts learning and the improvement of basic. Efforts made in Indonesia to improve the quality of early childhood education have been quite diverse, ranging from developing teacher competencies to developing a curriculum more oriented to child development. Based on research, pedagogical approaches that transform games into education and various art activities have been proven to improve motor and cognitive competence in PAUD children (Daryati, 2023; Maulidin et al., 2023).

Facilitating PAUD activities means covering various activities, and one of them is arithmetic. Counting starts from the introduction of numbers to the understanding of mathematical concepts. In the digital era, children must be introduced to dynamism in teaching methods, such as through interactive media. This method is very effective because children feel interested in counting and are more motivated and active when participating in the learning process (Apriani et al., 2021; Nur et al., 2022).

Numeracy skills, as one of the cognitive dimensions in early childhood education, are an important aspect to be stimulated through actions based on various research. Those who obtain early childhood education with access to mathematics education are more likely to succeed in the domestic field in the future than children who do not. (Surbakti et al., 2021; Talango, 2020). Interactive educational resources can be useful in developing children's numeracy skills because they attract children's attention and increase their enthusiasm for learning (Amelia et al., 2022; Indrayasa & Suryanti, 2023).

RME (Realistic Mathematics Education) and interactive media are also relevant in teaching mathematics at the PAUD level. This approach emphasizes the importance of using context when teaching mathematics so that children can relate the concept of mathematics to an important part of their daily lives. According to Utama et al (2023) and Research conducted by Liberna (2021), it has been proven that using resources that are not limited to books but also use digital media in mathematics education, and this, proven by using AI, deceives children. According to Ghofur and Nurhayati (2023), children can be introduced to the outside world by using technology such as multimedia-based learning apps, and this can be fun for them, so they can be empowered to improve their math skills (Eka Daryati & Suryadi, 2022; Vivianingsih et al., 2023).

Interactive learning materials in early childhood pedagogical practice have received considerable attention in the academic literature. Studies show that well-designed educational

resources can increase children's motivation and understanding of mathematical concepts (Sofia et al., 2023; Widiastuti & Kirono, 2022). Other research Teaching aids such as picture cards and interactive games have successfully improved children's understanding of numbers and basic operations (Nabighoh et al., 2022; Widiastuti & Kirono, 2022). However, there are still obstacles in implementing interactive teaching media, especially since many educators do not fully understand how to integrate technology into their lessons (Adha et al., 2023; Alsaeed & Aladil, 2024).

Limited access to technology, especially in remote and rural areas, is one of the main obstacles to using interactive learning media. Lack of facilities, such as computers and stable internet connections, prevents students from accessing digital learning media designed to improve their skills (Apriani et al., 2021; Aryani & Ambara, 2021; Patriani & Kusumaningrum, 2020). In addition, resistance to change slows progress, as many educators and institutions still rely on traditional teaching approaches, ignoring more innovative interactive learning mediums (Apriani et al., 2021; Fauzia, 2023; Nurhayati & Wahyuni, 2020).

This study focuses on interactive media's effectiveness in improving numeracy skills for children in early childhood education, which in pedagogy deserves more attention in the literature. In this case, we focus on filling the gap by assessing the impact of interactive learning media designed for early childhood education.

This research is expected to greatly contribute to early childhood education in Indonesia, especially in increasing interactive media applications in early childhood learning. The education in this study is expected to be able to arouse enthusiasm to prepare a more productive generation in the future.

RESEARCH METHODOLOGY

This study applied a quantitative approach using experimental design to measure the effectiveness of interactive media on preschoolers' numeracy skills. The experimental design used was a pretest-posttest design with a control group and an experimental group.

1. Types of Research

This quantitative study aimed to objectively test the difference in numeracy skills between students taught using interactive learning media and those taught using traditional methods. The sample was randomly divided into two groups: the experimental group, which received an interactive

learning media treatment, and the control group, which used conventional methods. Differences in numeracy skills were measured before and after the intervention using validated tests.

2. Research Schedule and Location

The research was conducted three months from September to December 2024 at Al-Fathah Kindergarten and the PAUD Center in Bandung.

3. Research Object

The study subjects were children aged 4 to 6 years old registered as students of PAUD Al-Fathah Bandung. The sample selection was selected using the total sampling method; the number of early childhood children was 60.

4. Data Collection Methods and Instrument Development

The following are the instruments used for this study:

1. The numeracy skills test described in the National Kindergarten Teacher Handbook outlines the early childhood education curriculum based on the Constitution. It has undergone a validation process that guarantees its effectiveness as a precise measuring tool.
2. Assessment rubrics to measure the level of student interactivity when lessons are taught with a set goal that guarantees objectivity.

5. Data Analysis Procedure

Descriptive statistics were calculated to summarize sample characteristics such as mean, median, and standard deviations from pre-test and post-test intervention, calculating ability scores. Furthermore, an inferential analysis with an independent sample t-test was performed to assess the average score of the experimental and control groups' counting skills. The analysis was carried out with the help of SPSS statistical software.

RESULTS AND DISCUSSION

RESULT

This study provides a comprehensive overview of the influence of interactive learning media on early childhood numeracy skills and perceptions related to its application. Descriptive statistical analysis showed a significant increase in numeracy ability in the experimental group using interactive learning media compared to the control group using traditional learning methods.

Table 1: Average Numeracy Score

Group	n	Average Score Before Intervention	Average Score After Intervention
Experimental group	30	50	80
Control Group	30	52	60

Table 1 shows both groups' average numeracy scores before and after the intervention. The experimental group showed a greater improvement compared to the control group.

Table 2: Percentage Increase in Numeracy Ability

Group	n	Score Improvement	Percentage Increase
Experimental group	30	30	60%
Control Group	30	8	15.38%

Table 2. Describe the increase in scores and the percentage increase in numeracy ability. The experimental group experienced a significant increase of 60%, while the control group only experienced an increase of 15.38%.

Table 3: Distribution of Numeracy Scores

Group	n	Pre-Intervention Score	Score Distribution	Post-Intervention Score	Score Distribution
		0-40	41-60	61-80	81-100
Experimental group	30	10	15	5	0
Control Group	30	12	12	6	0

Table 3. Describe the distribution of counting skill scores before and after the intervention. The score distribution showed that after the intervention, the experimental group had more children in the high-scoring category (61-100) compared to the control group, which was still dominated by children with low scores (0-40 and 41-60). The results of the analysis are reinforced with the following graphic images:

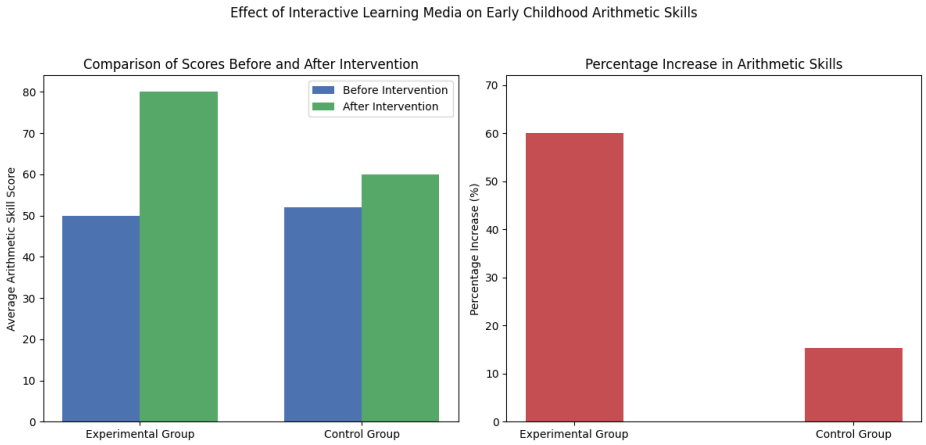

Figure 1. Comparison of average scores before and after the intervention

The study wanted to determine the effectiveness of interactive learning media in improving early childhood numeracy skills, inferential statistical analysis was carried out to determine whether there was a significant difference between the experimental group and the control group after the intervention, before conducting an inferential statistical analysis aimed at assessing the effectiveness of interactive learning media on the numeracy skills of early childhood children, two initial tests, namely homogeneity test and Normality test. The results of the test can be presented in the table below.

Table 4. Homogeneity Test

Living Statistics	df1	df2	Sig.
1,577	2	30	0.218

Table 4. According to the results of the Levene Test, both groups (experimental and control) had a significance value of 0.218. Since the p-value is greater than 0.05, we can conclude that the variance of the data from the pretest and posttest of both groups is homogeneous, which allows assumptions to be made for further analysis.

Table 5. Normality Test of Experimental Group and Control Group

Group	Df	Statistics	Sig.	Distribution
Pretest Experiment	30	0,963	0,072	Normal (p > 0.05)
Posttest Experiment	30	0,957	0,06	Normal (p > 0.05)
Pretest Control	30	0,912	0,042	Abnormal (p < 0.05)
Posttest Control	30	0,899	0,038	Abnormal (p < 0.05)

Table 5. The results of the Shapiro-Wilk test showed that the data of the experimental group, both before and after the intervention, followed the normal distribution ($p > 0.05$); on the other hand, the data from the control group did not follow the normal distribution due to the significance value of < 0.05. The analysis selected for the experimental group; the statistical test used was the Paired T-test. In contrast, the Wilcoxon test was used as a non-parametric test for the control group, which was more suitable for data distribution.

A paired t-test analysis was conducted to assess the difference in arithmetic skills of children in the experimental group before and after the intervention. The mean score before the intervention was 50, and the mean score after the intervention increased to 80. This analysis considers the relationship between pairs of data (before and after), which allows the results to be more precise in evaluating the effectiveness of the learning media on improving children's calculation skills. T-test results are shown in the table below.

4. Before and After Interactive Learning Treatment

Group	n	Difference in the average ± s. b	*p*
Before being given treatment	30	50.2±13.6	0,001
After treatment	30	80±21.65	

Table 4. In the experimental group with 30 children, the average numeracy score before being treated with interactive learning media was **50.2,** with a standard deviation of **13.6**. After the treatment, the average score increased to **80** with a larger standard deviation of **21.65**.

The mean difference between before and after this treatment was statistically significant with a value of $p =$ **0.001** ($p < 0.05$). This shows that interactive learning media has a positive and real influence on improving early childhood numeracy skills, the increase in standard deviation after treatment indicates a greater variation in responses between participants to the use of interactive learning media, but a considerable average increase confirms the effectiveness of these media as a basic mathematics learning aid. The application of interactive learning media can significantly improve the achievement of numeracy learning in early childhood compared to the condition before receiving treatment.

The control group, which did not receive the interactive learning media treatment, performed the Wilcoxon test to evaluate differences in numeracy scores before and after the intervention. The average score before the intervention was 52, while the average score after the

intervention increased to 60. Despite an average increase of 8 points, the results of the Wilcoxon test showed that this change was not statistically significant.

The Wilcoxon test was chosen because the normality testing of the data in the control group showed that the distribution of score differences before and after traditional learning did not meet the assumption of normality ($p < 0.05$). Therefore, the Wilcoxon non-parametric test is more appropriately used to analyze this data to obtain valid and reliable results in evaluating changes in the ability to count in the control group. The results of the Wilcoxon test can be seen in the table as follows:

Table 5. Before and After Traditional Learning Treatment

Control Group	n	Median (min-max)	*p*
Before traditional learning	30	52(35-70)	0,134
After traditional learning	30	60(40-75)	

Table 5. In a control group of 30 children, the median numeracy score before being given traditional learning was **52**, with a minimum score range of 35 and a maximum of 70. After following traditional learning, the median score increased to **60**, with a minimum value range of 40 and a maximum of 75. However, there was a median increase of 8 points; the results of the Wilcoxon test showed a value of $p = \mathbf{0.134}$, which means that the increase was not statistically significant at the level of general significance ($\alpha = 0.05$). In other words, changes in children's numeracy ability in this control group were not strong enough to be inferred as a real effect of traditional learning methods during the study period.

The results indicate that without the intervention of interactive learning media or other special methods, the improvement of numeracy skills through traditional learning tends to be minimal and less significant in a short period.

DISCUSSION

This study shows that interactive learning media significantly improve preschoolers' numeracy skills. This study was strengthened by the results of the paired sample t-test, which showed an increase in the average score from 50 to 80 ($t(29) = 12.00$, $p < 0.001$). Cohen's d value of 4 indicates a huge, statistically significant, practical effect. This supports the statement that educational technology-based interventions have a substantial impact on children's cognitive development in the pre-operational stage, as suggested by (Daryati et al., 2022) Concrete tools strengthen children's mental image.

Interaction with the interactive medial allows information to be processed visually, auditorily, and through body movements (kinesthetics). It also helps increase Learner engagement and strengthens information retention over time (Yuliana et al., 2023). This research aligns with the Research by Huang and Liaw (2018), these notes show that technology in early childhood education increases students' motivation, attention, and perseverance on cognitive tasks.

The results of the Wilcoxon test in the control group showed an increase in scores from 52 to 60, which was not statistically significant. This study shows that conventional learning methods or teaching systems in terms of ordinals tend to be less optimal in stimulating developmental abilities in terms of arithmetic. Stated that the traditional approaches mentioned, one-way words, often fail to provide the right stimulus to build a deep numerical understanding. It supports the urgency that drives the understanding of the phenomenon of approaches that apply active, experiential, or learning-based teaching pedagogy, especially at an early age, that rely heavily on direct, concrete manipulatives and interaction with peers through action (Pebriani & Darmiyanti, 2024).

This study shows that interactive media not only improves learning outcomes in the quantitative aspect, but also serves to facilitate child-centered learning in a way in which children engage in autonomous and independent learning, so that teachers play the role of guides who direct children's exploration towards digital materials that are appropriate to the child's level of development. Supporting research from Pebriani and Darmiyanti (2024) underscores the idea that any innovation within the framework of educational media will have a multidisciplinary academic impact that resonates, such as on cognitive, socio-emotional, and motor skills development.

This research has several limitations that need to be considered. Small sample sizes and limited intervention duration may limit the study's generalizability. This is in line with the warnings from (Kristianti et al., 2024). Since external validity is a significant concern in quasi-experimental design, conducting further research with more participants from different backgrounds and for a longer duration is recommended.

The practical implications of this study are quite broad. Educators and curriculum developers need to include educational technology as part of the strategy for teaching children in early childhood education. Still, the success of this integration is highly dependent on the competence of teachers, both technically and pedagogically. Research by Murray (2024) shows that professional development

for teachers on using educational technology significantly improves the effectiveness of digital lessons.

Other pedagogic strategies, such as storytelling, Montessori, and educational play, remain important to accommodate children's diverse learning styles. Stiasi (2022) states that a holistic and separate approach promotes rich learning and supports the achievement of comprehensive child development.

Interactive learning media do not solve problems independently but are part of a broader learning ecosystem. This requires reflective, evaluative, and adaptive actions to ensure alignment with the child's local context and individual characteristics (Hanafiah et al., 2023). In this way, media innovations and instructional methods can facilitate the realization of inclusive, participatory, and transformative early childhood education.

CONCLUSION

Interactive learning media have been proven to have a positive and significant impact on the numeracy skills of early childhood children. Experiments showed that the treatment given to the experimental group resulted in a much greater improvement than the control group, which did not receive the same treatment. While the control group showed no statistically significant improvement, this study proves that the progress achieved in numeracy skills without specially designed interventions is slow and undeveloped. Interactive media can be suggested as one of a variety of effective and practical tools to improve preschoolers' cognitive skills in formal and non-formal educational settings.

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