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Effectiveness of Educational Game Method in Improving The Concept of Mathematical Operations

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***Abstract*:**
The low emphasis on mathematical operation concepts in elementary school students is a problem that is often encountered. The educational game method in learning can improve the idea of mathematical operations. The quantitative study was conducted by collecting Pretest-Posttest answers in offline worksheets in the classroom. The research subjects were 5th-grade students of SD Negeri 4 Mataram. We analyzed the data by paired sample t-test to see whether the initial hypothesis was accepted or rejected. Based on the results, it is observed that the use of educational game methods can significantly improve the concept of mathematical operations for 5th-grade students. The obtained grades increase from a minimum of 25% to a maximum of 100%, with an average increase of 57.22%. Based on these findings the researcher provides the following recommendations: (1) Teachers should present variations of math learning so that students are not bored and interested during the learning process (2) Schools should support learning by providing the necessary learning materials so that learning objectives can be achieved. (3) Researchers should study methods other than educational game methods so that they can provide recommendations to teachers regarding effective learning methods to be applied in learning.

Keywords: educational games; learning process; mathematical operations, mathematics, concept.

Introduction

Childhood is a period characterized by a child's enjoyment of playful activities. The relationship between children and play is intrinsic, spanning from birth until the onset of pre-adolescence. During this stage, children often channel their vivid imaginations through various play activities and tools. Presently, numerous toy manufacturers offer a wide range of games. Among these, some toys not only serve as

a source of entertainment but also possess educational value (Aprilianto & Mariana, 2018).

The learning methods used should be oriented to the developmental needs and characteristics of students. The chosen learning method can serve as a strategy to improve learning outcomes (Yogica et al., 2020). For students at lower levels or grades, incorporating games or play methods into the learning process is very effective. Play activities offer many benefits, from building basic learning concepts to supporting student development (Hurlock, 1978). Implementing game-based learning activities in a results-oriented classroom can make the learning experience interesting and fun, thus preventing boredom (Anggraini & Pujiastuti, 2020). The development of learning media such as game-based learning media can improve students' mathematical understanding in terms of validity, practicality, and effectiveness (Rahmawati & Jamaluddin, 2024). The utilization of learning media aims to assist students in detailing mathematical objects that have abstract properties(Febriyanti & Boediono, 2021). Therefore, teachers should incorporate this preference into their learning methods. Using play methods not only facilitates the presentation of the material but also enhances the individual skills of each student. Teachers should choose learning methods that are appropriate for the students' developmental stages (Sopiandi & Andina Sopandi, 2021). One effective approach is the educational play method, which provides a structured and designed environment for students to engage in relaxed, fun, and liberating activities (Haryati, 2019). This method facilitates active participation, which leads to direct knowledge acquisition and a more effective and memorable learning experience. For younger students, especially those in lower grades, the educational game method is particularly beneficial, as it supports their development through engaging and non-monotonous activities that can be adapted to focus on learning outcomes while creating a fun learning atmosphere (Pratiwi, 2017; Fatonah & Naemah, 2022).

Translated with DeepL.com (free version) The game method, an educational approach designed to achieve cognitive, psychomotor, and affective instructional objectives in Mathematics, significantly enhances student engagement and motivation by organizing activities in a fun, interactive, and dynamic manner (Ningrum, 2015; Sari, 2023). Incorporating gamification elements into math education fosters deeper understanding and retention of concepts, as well as critical thinking and problem-solving skills, thereby improving students' overall performance and confidence (Apriyantini, 2024; Tokac et al., 2019; Sinaga et al., 2023). By creating a stimulating and enjoyable learning environment, educational games solve the common issue of low student motivation, making math lessons more appealing and effective (Nanda Pramudya et al., 2018). According to Rini (2015), educational games can increase effectiveness and interest, judging from the results of limited trials on the applicability of the attractiveness and effectiveness of the Little Detective educational game method in learning activities. Data analysis of the limited trial results showed that the

percentage of method applicability was 74%, the percentage of method attractiveness was 91% and the effectiveness of the method was 78%.

Research indicates that educational games significantly enhance learning effectiveness and student interest. For instance, Rini, (2015) demonstrated that the "little detective" game method yielded a 74% applicability rate, 91% attractiveness, and 78% effectiveness in learning activities. Similarly, Dwirahayu & Nursida, (2016) found that game techniques improved 1st-grade students' engagement and performance in basic arithmetic at MIS Tarbiyatul Islam 01, transforming previously uninterested students into motivated learners. (Oktaviani et al., 2019) showed that combining bingo games with active learning enhances math outcomes by fostering a cooperative and enjoyable learning environment. Ardani, (2021) observed that role-playing methods increased student involvement and improved performance in learning simple fractions among third-grade students, with the class average rising from 67.70 to 80.42 through two learning cycles. Finally, Nursafitri et al. (2023) confirmed the effectiveness of educational games in improving the understanding of mathematical operations, highlighting their focused examination of this specific concept. Collectively, these studies affirm the effectiveness of incorporating play methods in math education.

Based on previous studies, researchers re-examined how the effectiveness of the educational game method in improving math learning outcomes. However, this issue remains excessively broad and requires further specification from a particular perspective concerning mathematical skills. In this study, we focus on a more specific investigation into the effectiveness of specialized educational game methods for enhancing the understanding of mathematical operations, in contrast to previous studies that have remained relatively general.

Research Methods

This quantitative study conducts a mathematical analysis of the data collected through tests. The data are obtained by Pretest-Posttest, which was conducted offline in the classroom. The participants were 40 5th-grade students of SD Negeri 4 Mataram. They initially worked on 10 Math problems within 45 minutes. After the Pretest, educational games were introduced, starting with the game "congklak" to teach the concept of division. This was followed by a "snakes and ladders" game consisting of addition, subtraction, and multiplication questions, and finally, a dice-based quiz where each surface of the dice corresponded to a question of varying difficulty. Each educational game session lasts between 15 to 20 minutes. This process was conducted three times a week for two weeks. Then, a post-test with the same number of questions and duration as the Pretest was administered. Students who achieved a perfect score were rewarded. Students' answers were manually checked against the answer key, and the Pretest and Posttest results were documented. The effectiveness of the learning method was assessed using the N-Gain score test, and further statistical analysis was

conducted with paired samples t-test to evaluate significant differences between the means of paired samples. Figure 1 is a flowchart of the research procedure.

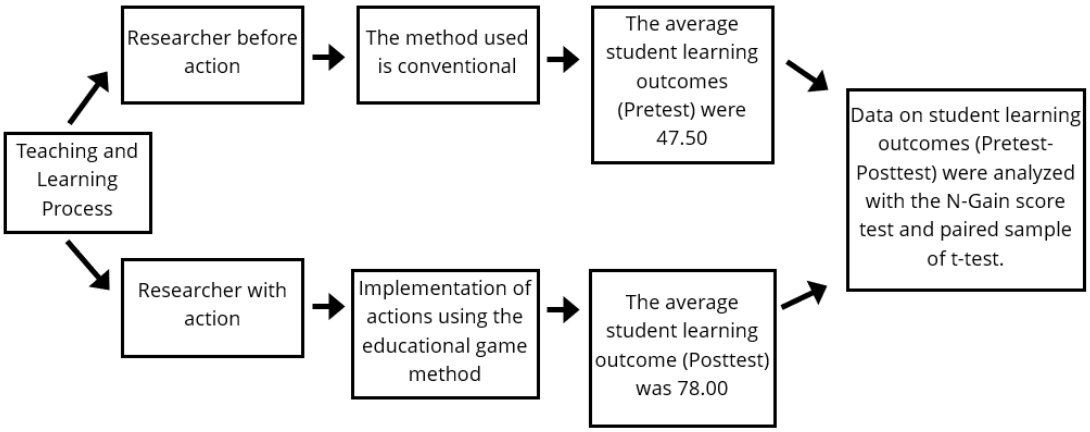

Figure 1. Flowchart of the research procedure

Results and Discussions

This study analyses the effectiveness of learning outcomes by applying educational games in improving the concept of mathematical operations in students. The results of the research data are described using quantitative methods so that the following results in **Figure 2** are obtained.

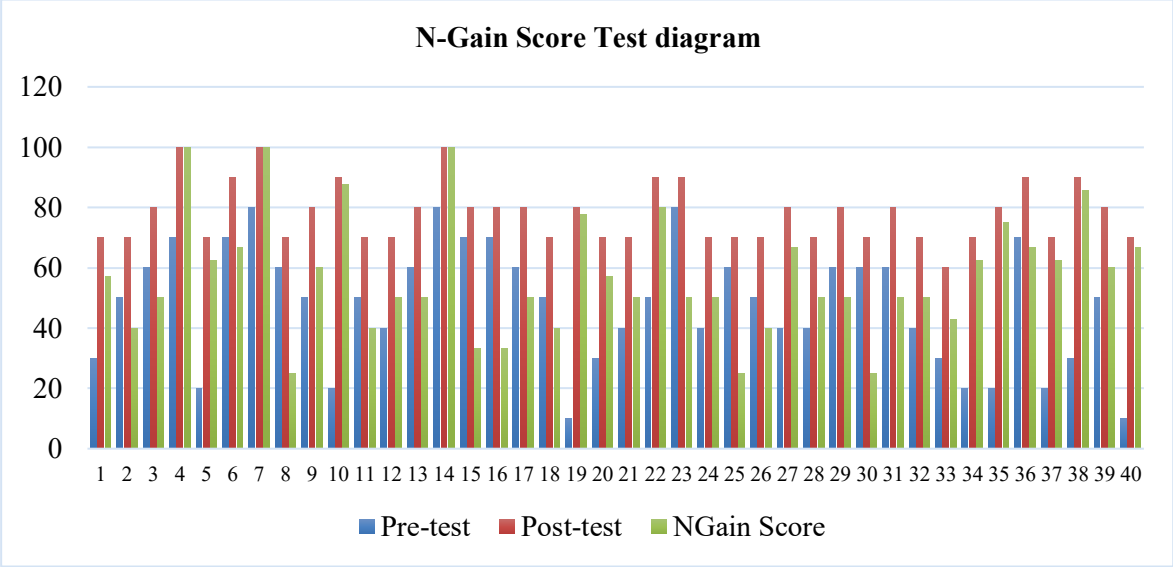

Figure 2. Result of the research data

Tabel 1. NGain Score Test

	Pretest	Posttest	NGain Score	NGain (%)
Mean	47,50	78,00	0,57	57,22

Based on data from 40 respondents who have been collected, there is a comparison of the increase in learning outcomes by applying educational games in improving the concept of mathematical operationsin 5th grade students of SD Negeri 4 Mataram. The increase in the effectiveness of the educational gamemethod on learning outcomes can be seen from the lowest starting at 25.00% to the highest at 100%.

In **Table 1** there is NGain test results in the form of scores (NGain Score) and percentages (NGain (%)). The effectiveness of math learning before and after ivolving the educational game method has an average increase of 57.22%.

Table 2. Tests of Normality

	Class	Statistic	df	Sig.	Statistic	df	Sig.
Exam Scores	**Pretest**	.137	40	.056	.951	40	.081
	Posttest	.265	40	.000	.845	40	.000

Lilliefors Significance Correction

Table 2 is a normality test which is a prerequisite test for conducting hypothesis testing. Based on Table 2, it can be seen that the data from the pretest and posttest results are normally distributed because the sig value. (0.081) > the significance level (0.05) so that the data can be tested. Furthermore, to find out the standard deviation of the pretest and posttest data, Paired Sample Statics is carried out as follows.

Table 3. Paired Sample Statics

		Mean	N	Std.Devition	Std.Error Mean
Pair 1	Pretest	47.50	40	19.70943	3.11633
	Posttest	78.00	40	9.92278	1.56893

Based on **Table 3**, it can be seen that if the application of educational games in learning activities is able to improve the concept of mathematical operations, judging from the increase in learning outcomes in 5th grade students of SD Negeri 4 Mataram with an average score of 47.50 to increase with an average score of 78.00. This proves that students are interested in the use of educational game methods in planting learning concepts. So not only using learning methods that involve the physical presence of teachers and students in the classroom where the teacher is the main instructor who provides material explanations, students actually need learning activities that seem fun during the learning process.

Table 4. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	**Pretest & Posttest**	40	.511	.001

Based on **Table 4**, it shows that there is a correlation or relationship in the use of educational game methods in instilling the concept of mathematical operations that can be observed from learning outcomes. From Table 4 above there is 0.511 the magnitude of the relationship between the use of educational gamemethods in the effectiveness of increasing the concept of mathematical operations in the learning process. From the data above, it proves that the use of educational game methods has a significant relationship to increasing the concept of mathematical operations of 5th grade students of SD Negeri 4 Mataram. The conclusion is obtained by Paired Sample Test based on the following table.

Table 5. Paired Sample Test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig (2-tailed)
				Lower	Upper			
Pair1 Pretest-Posttest	-30,50000	16,93880	2,67826	-35,91729	-25,08271	-11,388	39	,000

Based on the results of **Table 5** it is clear that H0 is not supported. H0 is not supported because the Sig (2-tailed) value (0.000) < (0.05) and the Sig (2-tailed) value (0.000) < (0.05). This means that there is a difference between the mean scores of pretest and posttest students using the educational gamemethod in improving the concept of mathematical operations.

The educational game approach to improve the concept of mathematical operations as a whole has a range of difference values from 25.00% to 100%, with an average of 57.22%. these results indicate that the use of the educational game approach has an impact on increasing the concept of mathematical operations in 5th grade students of SD Negeri 4 Mataram.

The learning method with educational games has techniques in learning activities. Material delivery is carried out using various physical media, namely congklak, snakes and ladders and dice quiz. It is intended that during the learning process there is interaction and communication so that learning can be said to be effective. Learning activities are considered effective if they can stimulate the attention, feelings, interests and thoughts of students towards the learning process being carried out.

The abstract concepts in mathematics make it difficult for students to understand if the teacher only explains with sentences and students are directed to imagine it. Therefore, a visual aid is needed to make it easier for students to understand learning and get optimal results.

Conclusions and Suggestions

Based on the results of data analysis conducted on the results of pretests and posttests on the use of educational game methods in improving the concept of mathematical operations, it can be said that the use of educational game methods can improve the concept of mathematical operations of 5th grade students of SD Negeri 4 Mataram. The resulting increase ranged from a minimum (25.00%), to a maximum (100%), with an average increase of 57.22%. based on these findings, researchers can provide recommendations as follows: (1) Teachers should present variations of mathematics learning so that students do not feel bored and feel interested during the learning process; (2) Schools should support learning activities by providing all the necessary learning materials so that learning objectives can be achieved. (3) For researchers, they should study methods other than educational game methods, so that they can provide recommendations to teachers regarding effective learning methods to be applied in learning.

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