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THE EFFECT OF RANGKU ALU TRADITIONAL GAMES BASED ON MATHEMATICAL GENERALIZATION ON ELEMENTARY SCHOOL STUDENTS LEARNING OUTCOMES IN NUMBER PATTERNS

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ABSTRACT

This study aimed to determine the effect of the Rangku Alu traditional game based on mathematical generalization on elementary school students learning outcomes in number pattern material. The study used a quantitative approach with a pre-experimental one group pretest-posttest design. The subjects were 35 fifth-grade students from two elementary schools. Data were collected through pre-test and post-test instruments consisting of four essay questions based on indicators of mathematical generalization ability. The results showed that the average score increased from 42,86 on the pre-test to 82,86 on the post-test. The Wilcoxon Signed Rank Test showed a significance value of less than 0,05, indicating a significant difference before and after treatment. The N-Gain value of 0,70 indicated that the learning improvement was in the good category.

Keywords: Rangku Alu, mathematical generalization, number patterns

INTRODUCTION

Mathematics education in elementary school plays a crucial role as the foundation for understanding mathematical concepts at higher levels. A lack of conceptual understanding at an early stage can lead to difficulties in learning more complex material (Ruqoyyah, 2021). Through education, students can learn various subjects, one of which is mathematics. Learning mathematics is closely related to learning activities, processes, and thinking. Mathematics plays a vital role in enhancing thinking skills. In the world of mathematics, reasoning is emphasized more than experimental results or observations. This aligns with the unique characteristics of mathematics—distinct from other sciences—which demonstrate that mathematics is a discipline built upon agreed-upon symbols, demands conceptual precision, and relies on logical thinking and deductive reasoning (Aprilia et al., 2023).

These characteristics necessitate learning objectives that focus on developing students' reasoning and conceptual understanding, as outlined in Ministry of Education Regulation No. 22 of 2006 page 148 (Permendiknas No. 22 Tahun 2006 halaman 148), regarding content standards: the objective of

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mathematics education is for students to develop the following competencies: (1) Mathematical concepts; (2) Critical thinking; (3) Problem-solving; and (4) Communicating ideas. (Ariani et al., 2021) also states that mathematics learning objectives are divided into two categories: (1) Students are proficient in problem-solving; and (2) Students are proficient in calculation.

The National Council of Teachers of Mathematics (NCTM) divides mathematics learning standards into content standards and process standards. One of the content standards outlined by the NCTM is algebra, which is relevant to and aligns with the focus of this article. In (Agus & Lusyana, 2023), it is stated that students in grades 3–5 are introduced to algebraic concepts as a foundation for strengthening their algebraic skills in grade 6. At this stage, students in grades 3–5 need to build and construct algebraic ideas, particularly in understanding the meaning of mathematical symbols such as x, y, and z and their relevance to solving math problems. They are expected to describe, extend, and make generalizations. Furthermore, they should represent and analyze patterns using words, tables, and graphs.

The success of learning objectives depends on an effective learning process. Learning outcomes represent the final result of that process and are the primary focus of teaching and learning activities. Therefore, in the context of mathematics education in elementary school, learning outcomes are used to measure students' understanding of basic mathematical concepts (Suciati & Amran Hapsan, 2022).

The topic of number patterns not only emphasizes computational skills but also requires the ability to recognize patterns and make generalizations. This material serves as a crucial foundation in mathematics education, particularly as a basis for mastering algebraic concepts and functions in subsequent grade levels. However, in elementary school classrooms, many students still struggle to systematically identify and extend number patterns. Students tend to provide random answers without relying on the correct pattern structure, leading to low achievement in number patterns (Fatikhah & Kusno, 2025). Based on research findings published in a journal (Suna et al., 2022), student learning outcomes in number patterns for the 2021/2022 academic year did not meet the Minimum Passing Criteria (KKM), with completion rates ranging from 69.35% to 73.50%. This indicates that students still struggle to understand and analyze mathematical problem-solving.

Based on previous research, students' difficulties in solving number pattern problems include conceptual difficulties (20.8%), principle-based difficulties (37.5%), and skill-based difficulties (41.7%), with skill-based difficulties being the most prevalent. These findings indicate that low mathematics achievement in number patterns is caused by inaccuracies in problem-solving steps, which are influenced by a lack of conceptual understanding, low interest in learning, carelessness, and students' inability to apply the order of operations correctly (Sartika et al., 2022). Furthermore, another previous study in (Saputro, 2024) identified the causes of low student learning outcomes in number patterns as teaching methods that do not align with students' learning styles, a lack of variety in teaching

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methods, and insufficient provision of adequate practice problems. The researcher is aware of numerous studies that utilize games in mathematics instruction. One such study cited in (Wijayanti & Yanto, 2023) indicates that implementing mathematics instruction through a game-based approach can address conceptual understanding and student learning activities, resulting in excellent mathematics learning outcomes.

Based on these findings, it can be concluded that students' low achievement in number patterns is due to difficulties in understanding concepts, applying principles, and developing the skills needed to solve problems systematically (Chrisnawati & Pratama, 2023a). Furthermore, the lack of variety in teaching methods and the suboptimal use of approaches tailored to the characteristics of elementary school students also contribute to this problem (Indriani et al., 2025).

Various studies have shown that traditional games incorporate a variety of mathematical concepts, such as patterns, numerical operations, and geometry, which can be utilized in mathematics education (Naibaho et al., 2025). Traditional games such as hopscotch, congklak, and hide-and-seek have been shown to be linked to mathematical concepts and to help students understand the material in a more contextual and meaningful way (Rahmadhani, 2022). This suggests that an ethnomathematics approach using traditional games has the potential to improve students' conceptual understanding and learning activities (Nur, 2025).

However, research integrating traditional games with mathematical generalization skills—particularly regarding number patterns in elementary school—remains limited. Yet mathematical generalization skills are a crucial aspect of mathematics learning, especially in understanding and developing number patterns (Halimah et al., 2024).

One traditional game that can be utilized in learning is the Rangku Alu game. Research indicates that the Rangku Alu game contains various number patterns that can be analyzed through the movements and interactions within the game, making it a potential tool for contextual mathematics instruction (Pangestuti et al., 2024). By integrating the Rangku Alu game with mathematical generalization, students are expected to more easily recognize patterns, identify regularities, and perform generalizations independently.

Based on the above discussion, this study aims to determine the effect of using the traditional game Rangku Alu, based on mathematical generalization, on elementary school students' learning outcomes in number patterns.

METHODS

This study employs a quantitative approach because the data collected consists of test scores on number pattern learning among students, which are then analyzed statistically. The method used is an

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experimental design aimed at determining the effect of the traditional game Rangku Alu on students' ability to generalize number patterns (Zashinta, 2021).

The chosen experimental design is a pre-experimental design based on the size and composition of the population, in which students were already assigned to fixed classes with limited numbers, making it impossible to randomize them or assign them to a control group. Therefore, this study involved only one group without a comparison or control group. The design used was a one-group pretest-posttest design (Efendi & Surya, 2023). The research design is as follows:

Figure 1. One-Group Pretest-Posttest Research Design

The variables in this study consist of the traditional Rangku Alu game based on mathematical generalization as the independent variable and elementary school students' learning outcomes regarding number patterns as the dependent variable (Darmawan & Gunamantha, 2021).

The study was conducted among students in the second semester of the 2024/2025 academic year at Balonggabus Public Elementary School and Putat Public Elementary School. The population consisted of all fifth-grade students, numbering 18 and 17 students, respectively. Because the population size was relatively small, total sampling—or saturation sampling—was used, meaning that all members of the population were included in the study sample (Nisa & Darmawan, 2025).

The instrument used in this study was a learning achievement test, specifically a written essay-type test designed to measure students' proficiency in number patterns. This written test consisted of four items developed based on indicators of mathematical generalization skills. The indicators for the number patterns learning achievement test are presented in the following table:

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Table 1. Indicators for the Number Patterns Learning Achievement Test

Task	Indicator
Task #1. Listen to the lyrics of the song "Rasa Sayange"! In the game Rangku Alu, each round is accompanied by one full song. Determine the number of lines in one round of the game! **Rasa Sayange** Rasa sayange Rasa sayang sayange Lihat ambon dari jauh Rasa sayang sayange Kalau ada sumur di ladang Boleh kita menumpang mandi Kalau ada umurku panjang Boleh kita berjumpa lagi	*Perception of generality*: recognizing and identifying patterns from a given situation.
Task #2. If the game is played for 2, 3, and 4 rounds, determine the total number of lines sung!	*Expression of generality*: stating patterns in numerical form.
Task #3. Write down the number pattern formed by the sum of those lines!	*Symbolic expression of generality*: expressing patterns systematically.
Task #4. Determine the general formula for the sum of the lines in the 10th round and explain your answer!	*Manipulation of generality*: formulating and using patterns in symbolic form.

Before being used in the study, the instrument was first tested for validity and reliability to ensure that each item was suitable for use and demonstrated good consistency in measuring student learning outcomes. The validity test was conducted to determine the validity of the items, while the reliability test was used to assess the instrument's consistency (Azis, 2020).

Data were collected through written tests administered twice: (1) a pre-test, before instruction to assess students' initial abilities; and (2) a post-test, after instruction to assess students' final abilities (Saifuddin & Tika, 2024). The written tests were administered based on the objectives to be achieved from the generalization ability indicators, namely: (1) Perception of generality; (2) Expression of generality; (3) Symbolic expression of generality; and (4) Manipulation of generality (Naraswari et al., 2023). The research procedure was carried out through the following stages:

Figure 2. Research Procedure

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Based on Figure 2, the researcher first administered a pre-test to determine the students' initial generalization ability, then provided a treatment consisting of instruction using the traditional game Rangku Alu. Afterward, the researcher administered a post-test to assess the students' final generalization ability. The results of the pre-test and post-test were analyzed to obtain the research findings (Ayuningtyas et al., 2022).

Data analysis in this study was conducted in several stages, including: (1) Descriptive statistics, used to determine the mean, minimum, maximum, and standard deviation of students' learning outcomes; (2) Prerequisite tests, specifically the Shapiro-Wilk test for normality to determine whether the data are normally distributed or not; (3) Hypothesis testing, performed using a paired-sample t-test if the data are normally distributed, and the Wilcoxon Signed-Rank Test if the data are not normally distributed, to determine differences in students' learning outcomes before and after the intervention; and (4) N-Gain test, used to determine the improvement in students' learning outcomes after the intervention (Saldaha et al., 2025). The following table presents the indicators of student learning achievement (Widyasari et al., 2024):

Table 2. Indicators of Student Learning Achievement

Value Conservation (0-100)	Category
81 – 100	Excellent
61 – 80	Good
41 – 60	Fair
21 – 40	Poor
0 – 20	Very Poor

FINDINGS

The results of this study were obtained by analyzing student achievement test data on number patterns. The collected data were then used to describe student learning outcomes following the implementation of instruction using the traditional game Rangku Alu, based on mathematical generalization. The following are the results of the data analysis, processed using SPSS version 31.

Descriptive Statistical Analysis

Descriptive statistical analysis was conducted to provide an overview of the students' learning outcomes. This analysis includes the minimum, maximum, mean, and standard deviation, which aim to identify trends and the distribution of student scores. Based on the results of the descriptive statistical analysis, the following data were obtained:

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Table 3. Descriptive Statistics of Student Learning Outcomes

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	35	25	75	42.86	14.965
Post-test	35	75	100	82.86	6.335
Valid N (listwise)	35				

Table 3. shows that the students' pre-test mean score was 42.86, with a minimum score of 25 and a maximum score of 75. After the intervention, the post-test mean score increased to 82.86, with a minimum score of 75 and a maximum score of 100.

Additionally, the standard deviation of 14.965 in the pre-test indicates that the distribution of student scores remains quite varied. In contrast, the standard deviation decreased to 6.335 in the post-test, indicating that student scores became more evenly distributed following the instruction. Thus, descriptively, there is a clear improvement in student learning outcomes after implementing instruction using the traditional Rangku Alu game based on mathematical generalization.

Normality Test

Next, the student learning outcome data were analyzed using a normality test to determine whether the data were normally distributed or not. The normality test in this study used the Shapiro-Wilk test. Based on the results of the normality test, the following data were obtained:

Table 4. Results of the Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test	.148	35	.051	.916	35	.011
Post-test	.188	35	.003	.905	35	.005

a. Lilliefors Significance Correction

The significance value (Sig.) for the pre-test data was 0.011 and for the post-test data was 0.005, with the latter being less than 0.05. This indicates that the pre-test and post-test data are not normally distributed.

Hypothesis Testing

Next, based on the results of the normality test, which indicate that the data are not normally distributed, the paired-sample t-test cannot be used for hypothesis testing. Therefore, the Wilcoxon

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Signed-Rank Test was used to determine differences in student learning outcomes. This test was used to assess differences in student learning outcomes before and after instruction. The results of the Wilcoxon test are presented in the following table:

Table 5. Wilcoxon Rank Test Results

Ranks

		N	Mean Rank	Sum of Ranks
Post-test - Pre-test	Negative Ranks	0[a]	.00	.00
	Positive Ranks	35[b]	18.00	630.00
	Ties	0[c]		
	Total	35		

a. Post-test < Pre-test

b. Post-test > Pre-test

c. Post-test = Pre-test

The table above shows that all students experienced an improvement in learning outcomes, as indicated by 35 positive ranks and no negative ranks or ties. The results of the significance test are presented in the following table:

Table 6. Statistical Results of the Wilcoxon Test

Test Statistics[a]

	Post-test - Pre-test
Z	-5.171[b]
Asymp. Sig. (2-tailed)	<.001

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

A significance value (Asymp. Sig.) of <0.05 indicates that there is a significant difference between students' learning outcomes before and after instruction.

N-Gain Calculation

The N-Gain calculation was performed to determine the level of improvement in students' learning outcomes after the instruction. The results of the descriptive analysis of students' N-Gain scores are presented in the following table:

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Table 7. Descriptive Statistics of N-Gain

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain	35	.38	1.00	.7002	.10583
Valid N (listwise)	35				

The mean N-Gain score obtained was 0.70, with a minimum of 0.38 and a maximum of 1.00. Furthermore, the standard deviation of 0.10583 indicates that the distribution of students' N-Gain scores is relatively homogeneous. The mean N-Gain score of 0.70 indicates that the improvement in students' learning outcomes falls into the "good" category.

DISCUSSION

The research results show that the use of the traditional Rangku Alu game based on mathematical generalization has a positive effect on elementary school students' learning outcomes regarding number patterns. This is evident from the increase in students' average scores, from 42.86 on the pre-test to 82.86 on the post-test. This increase indicates that after receiving the intervention, students were able to understand the concept of number patterns better than before the learning activity was conducted.

This improvement in learning outcomes occurred because the traditional Rangku Alu game provides concrete, active, and enjoyable learning. At the elementary school level, students tend to understand mathematical concepts more easily when they are linked to real-world activities (GAMES, n.d.). The repetitive movements, rhythm, and step patterns in the traditional Rangku Alu game help students directly observe regularity, sequence, and relationships between numbers, thereby fostering the ability to recognize and generalize patterns. Thus, students do not merely memorize patterns but build understanding through learning experiences (Firdaus & Akib, 2022).

The results of the Wilcoxon Signed Rank Test showed a significance value of <0.05, indicating a significant difference between learning outcomes before and after the intervention (instruction). Additionally, all students demonstrated an increase in scores, as evidenced by 35 positive ranks, with no negative ranks or ties. These findings indicate that the implementation of the traditional Rangku Alu game has a consistent impact on improving students' abilities in number pattern material.

The average N-Gain score of 0.70 falls into the "good" category. This indicates that the improvement in student learning outcomes is not only statistically significant but also practically effective in the learning process. The "good" category indicates that the majority of students experienced optimal improvement in understanding after participating in lessons that incorporated traditional games.

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Theoretically, the results of this study align with the view that mathematics learning becomes more meaningful when students are actively engaged in discovering concepts through direct experience. Traditional games combined with mathematical generalizations provide students with the opportunity to recognize patterns, predict the next sequence, and formulate general rules from a pattern (Chrisnawati & Pratama, 2023b). These skills form the core of number pattern material and serve as a foundation for understanding algebra at the next educational level.

The findings of this study also support previous research indicating that the use of games in mathematics learning can enhance student motivation, engagement, and learning outcomes (Bilangan, 2023). The novelty of this study lies in the utilization of the traditional Rangku Alu game integrated with mathematical generalization indicators, thereby not only preserving local culture but also improving the quality of mathematics learning.

Thus, the traditional Rangku Alu game based on mathematical generalization can serve as an effective alternative learning medium for elementary school teachers, particularly for number patterns. In addition to improving learning outcomes, this learning model is also capable of creating an interactive, contextual, and enjoyable learning atmosphere for students.

CONCLUSION AND SUGGESTION

The use of the traditional Rangku Alu game based on mathematical generalization has a positive effect on elementary school students' learning outcomes regarding number patterns. This is demonstrated by an increase in students' average scores from 42.86 on the pre-test to 82.86 on the post-test. The results of the Wilcoxon Signed Rank Test also indicate a significant difference between learning outcomes before and after the intervention (instruction). Additionally, the N-Gain value of 0.70 falls into the high category, indicating that the implementation of this game is effective in enhancing students' understanding.

Thus, it can be concluded that the traditional Rangku Alu game based on mathematical generalization can serve as an innovative, enjoyable, and meaningful alternative for mathematics instruction. The implementation of this game is capable of improving learning outcomes, fostering student engagement, and introducing local cultural values into the learning process.

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