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Megoak-goakan game with vak model improves elementary students' mathematical concept understanding

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concept understanding; lks; mathematics learning; megoak-goakan game; vak model

Abstract

This study investigated the effectiveness of a traditional megoak-goakan game, integrated with the Visual, Auditory, Kinesthetic (VAK) learning model and supplemented with student worksheets (LKS), in enhancing Phase A elementary school students' understanding of mathematical concepts. Using a quasi-experimental approach with a time-series design, the research was conducted with first-grade students at SDN Kranji VI and SDN Kayuringin Jaya VI in Bekasi City. The findings showed a significant improvement in students' understanding of mathematical concepts. Post-test scores and N-Gain scores increased by 35% at SDN Kranji VI and 51% at SDN Kayuringin Jaya VI. These results suggest that integrating traditional games with the VAK model and LKS provides an interactive and enjoyable learning experience, effectively improving mathematical concept understanding as well as students' social and emotional skills.

INTRODUCTION

Background of the Study

Education is the main foundation in nation building, because through quality education a generation that is smart, competent, and ready to compete in the era of globalisation can be born. However, in Indonesia, one of the challenges that continues to be faced is the low numeracy literacy of students. Based on data from the Program for International Student Assessment (PISA) in 2022, only 18% of Indonesian students reached level 2 or above in the mathematical ability category, far below the OECD country average of 69% (OECD, 2023). This

indicates that there are still many students who have difficulty in understanding basic mathematical concepts and applying them in everyday life.

Mathematics is known as a subject that is abstract, full of symbols, and requires deductive reasoning skills (Muhammad & Gunawan, 2025, Hariyono, *et al.,* 2023). This challenge becomes even greater for elementary school students, especially in Phase A (grades I and II), who are at the concrete operational cognitive development stage according to Piaget's theory (Jupriyanto, *et al.,* 2024; Sutanto, *et al.,* 2024). Students at this stage more easily understand concepts through direct, concrete experience. Therefore, a mathematics learning approach that is too theoretical and lacks contextualization can actually hinder understanding and reduce student motivation to learn.

On the other hand, the characteristics of elementary school students, especially in the lower grades, tend to like to play, move, work in groups, and demonstrate things directly (Nurhairani, *et al.,* 2026; Sutanto, *et al.,* 2024; Kusmaryono, 2023). Therefore, learning that integrates play activities is not only in accordance with their developmental needs, but is also able to create a fun and meaningful learning atmosphere.

The Problem of The Study

This study was motivated by the results of observations and interviews with first grade teachers at SDN Kayuringin Jaya VI and SDN Kranji VI, Bekasi City. The teachers stated that students still have difficulty in solving story-shaped math problems. They tend to understand addition or subtraction in the form of numbers only but fail to relate it to the context of everyday life. In fact, some students are not able to read well, which affects their understanding of the problem.

Furthermore, the mathematics learning that is applied still tends to be conventional, with the dominance of lectures and written problem exercises. The lack of variety in learning models and the lack of use of learning media that suits the characteristics of students are the main obstacles. Therefore, innovations are needed in mathematics learning in the lower grades of elementary school that can present a fun, concrete, and contextual learning atmosphere.

Research's State of the Art

Several previous studies have shown the potential of using traditional games in learning. For example, the traditional Balinese megoak-goakan game has group dynamics that allow students to interact actively (Dharmadia, Parwatab, Arianic, and SpyanawatidSibarani, 2022). In its implementation, the concept of adding and subtracting the number of group members naturally occurs, providing opportunities for students to understand mathematical concepts concretely (Widya Pratama et al., 2023). In addition, traditional games are also loaded with educational values such as cooperation, sportsmanship, and logical thinking skills (Syahrial et al., 2022; Kamid et al., 2022).

To increase the effectiveness of traditional games, it is necessary to apply learning models that can accommodate various learning styles of students, such as the VAK (Visual, Auditory, Kinesthetic) learning model (Handayani, *et al.,* 2025). This model integrates three main learning styles, so that learning can reach all students, whether they are dominant visual, auditory, or kinesthetic (Mahbubah & Darmawan, 2026). Support from systematic teaching tools, such as Student Worksheets (LKS), is also needed (Wardani Rambe, 2022; Sulistyowati, *et al*., 2022). LKS specifically designed based on the steps of the megoak-goakan game and adapted to the syntax of the VAK model can help students reflect on their learning experience and become a formative assessment tool for teachers.

Novelty, Research Gap, & Objective

Previous studies have indeed explored the use of traditional games and the VAK model separately. However, there has been no research that specifically integrates the traditional megoak-goakan game with the VAK learning model and is supported by specifically designed Student Worksheets. The integration of these three is expected to overcome the challenges of mathematical understanding experienced by students in the lower grades in the modern era.

The novelty of this research lies in the development of an innovative learning approach that combines elements of a traditional game (megoak-goakan), a multisensory learning model (VAK), and supporting teaching tools (LKS) in an integrated manner for mathematics learning. This approach not only offers an alternative strategy but also contributes to the preservation of local culture.

The research gap that this study aims to bridge is the lack of research that tests the effectiveness of the synergy between a specific traditional game, a modern learning model, and structured teaching tools to improve the understanding of mathematical concepts in Phase A elementary school students, especially in a specific context and relevant to the problems found in the field.

The main objective of this research is to find out whether the traditional megoak-goakan game based on the VAK learning model assisted by LKS can improve the understanding of mathematical concepts of Phase A elementary school students. In addition, this study also aims to describe the learning steps using this approach and assess students' responses to the application of this method.

This research is expected to make a theoretical contribution to the development of contextual and applicable learning models, as well as provide a practical contribution for teachers in implementing fun and effective mathematics learning in the classroom.

METHOD

Type and Design

This study used a quantitative approach with a quasi-experimental method. This method was chosen because it allows researchers to evaluate the effect of a treatment on the

dependent variable, namely students' understanding of mathematical concepts, even without using full randomization in the group under study. The research design used is a time series design, which involves repeated measurements before and after the treatment is given (Diggle & Giorgi, 2025). This design is effective for observing trends or changes that occur in the research subjects over time.

Data and Data Sources

The variables in this study consisted of two types:

a. Independent variable: The learning model based on the traditional megoak-goakan game combined with the Visual, Auditory, Kinesthetic (VAK) approach and equipped with Student Worksheets (LKS).
b. Dependent variable: The improvement in students' understanding of mathematical concepts.

The data sources for this research were first-grade students in the 2023/2024 school year from two public elementary schools in Bekasi City, namely SDN Kayuringin Jaya VI and SDN Kranji VI. The research subjects consisted of two classes, with a total of 30 students in each class. The selection of locations and subjects was carried out by purposive sampling, based on the suitability of the characteristics of Phase A students and the readiness of the teachers to implement the designed learning model.

Data Collection Technique

The data collection techniques in this study used several main instruments:

a. Test of Mathematical Concept Understanding: Used to measure students' initial (pre-test) and final (post-test) abilities in understanding addition and subtraction concepts. This test was in the form of multiple choice and short descriptions adapted to the curriculum indicators.
b. Student Activity Observation Sheet: Used to record student involvement and participation during the learning process, such as cooperation, active participation, and responses to tasks.
c. Student Response Questionnaire: Used to determine students' perceptions and experiences of the learning method used, using a 4-point Likert scale.

Before use, all instruments were validated by basic education experts and tested on students outside the research sample. Content validity was determined through expert judgment, while the instrument reliability test was carried out using the Cronbach's Alpha formula with a result of 0.78, which is classified as high.

Data Analysis

The data obtained were analyzed through several stages. First, prerequisite analysis was conducted, which included a normality test using the Kolmogorov-Smirnov method and a homogeneity test using Levene's Test (Atmojo, *et al.*, 2025).

Next, to determine the effectiveness of the treatment, an effectiveness analysis was carried out using the N-Gain calculation to measure the improvement in student learning outcomes after the treatment.

To determine the significance of the difference in student learning outcomes before and after the treatment, an inferential statistical test was used. Based on the research design, the most relevant test for comparing two scores from the same group (pre-test and post-test) is the paired sample t-test. This test is used to test the hypothesis that there is a significant average difference between the pre-test and post-test scores with a significance level of 0.05.

Specifically, the t-test formula used is as follows:

$$t = \frac{\bar{d}}{S_{\bar{d}}}$$

where:

$\bar{d}$ = the average of the difference between pre-test and post-test scores

$S_{\bar{d}}$ = the standard error of the mean difference

In addition, data from the activity observation sheets were analyzed descriptively quantitatively, while the questionnaire results were processed in the form of a percentage of student attitude trends.

With this analytical method, it is expected to obtain a clear and objective picture of the effectiveness of the megoak-goakan game-based learning model in improving students' understanding of mathematical concepts.

RESULTS

This study aims to examine the effectiveness of traditional megoak-goakan games integrated into the VAK (Visual, Auditory, Kinesthetic) learning model assisted by LKS to improve the understanding of mathematical concepts of Phase A elementary school students. The research was conducted in two schools: SDN Kayuringin Jaya VI and SDN Kranji VI, Bekasi City. The research design used was a quasi-experiment with a one group pretest-posttest approach. The subjects consisted of grade 1 students from two experimental classes. Data collection was conducted through mathematics concept understanding tests, student activity observations, and student response questionnaires.

A. Instrument Validity and Reliability

The test instrument used had gone through a content validation process by experts. A trial was conducted on 16 students to determine the level of difficulty and distinguishing power. The results of the analysis showed that 4 questions were classified as easy, 2 questions were moderate, and 1 question was difficult, with all items having good differentiating power.

Table 1. Problem Difficulty Level

Question	Difficulty Index	Category
1	0.923	Easy
2	0.872	Easy
3	0.897	Easy
4	0.949	Easy
5	0.615	Moderate
6	0.667	Moderate
7	0.282	Difficult

Furthermore, the instrument's reliability was measured using the Cronbach's Alpha formula, and the result was 0.78, which indicates a high level of reliability.

B. Prerequisite Test Results

Before conducting the treatment effectiveness test, the data were tested for normality and homogeneity. The Kolmogorov-Smirnov test for normality showed that all pre-test and post-test data were normally distributed, with p-values (Asymp. Sig.) greater than 0.05. For instance, the pre-test data for SDN Kayuringin Jaya VI had a p-value of 0.211, and the post-test data had a p-value of 0.205. Levene's homogeneity test showed that the variance between the pre-test and post-test data was homogeneous, with a p-value greater than 0.05. These results confirm that the data meet the assumptions required for further statistical analysis.

C. Effectiveness of the Learning Model

The effectiveness of the learning model was measured by comparing the pre-test and post-test scores using the N-Gain approach and a paired sample t-test.

1. N-Gain Score Analysis

The N-Gain analysis was performed to determine the increase in students' understanding of mathematical concepts. The results are summarized in Table 2.

Table 2. Average N-Gain Score of Pretest and Posttest Results

Observation	SDN Kranji VI (N-Gain Score)	Category	SDN Kayuringin Jaya VI (N-Gain Score)	Category
1	0.3826	Medium	0.4885	Medium
2	0.5537	Medium	0.4537	Medium
3	0.4759	Medium	0.3811	Medium
4	0.2276	Low	0.5755	Medium
5	0.0906	Low	0.6306	Medium
Average	**0.3461**	**Medium**	**0.5059**	**Medium**

Based on the table, the results of the students' mathematics concept understanding test showed a significant increase from the pretest to the posttest. The average N-Gain at SDN Kranji VI was 0.3461, which is in the medium category, although it shows fluctuations between observations. Furthermore, the average N-Gain at SDN Kayuringin Jaya VI was 0.5059, which is also in the medium category and showed a

consistent upward trend in the 4th and 5th observations. Specifically, the average pre-test score at SDN Kayuringin Jaya VI was 59.12, which increased to 71.19 in the post-test. Meanwhile, at SDN Kranji VI, the pre-test score of 62.28 increased to 72.92. This increase reflects the success of the learning intervention used.

2. Paired Sample T-Test Results

A paired sample t-test was conducted to determine the statistical significance of the increase in students' understanding of mathematical concepts. The test results for both schools are as follows:

a. SDN Kayuringin Jaya VI: The t-test showed a t-value of 10.35 and a significance value (Sig. 2-tailed) of 0.000.
b. SDN Kranji VI: The t-test showed a t-value of 9.87 and a significance value (Sig. 2-tailed) of 0.000.

Since the significance values for both schools (0.000) are much smaller than the significance level (α) of 0.05, it can be concluded that the increase in students' mathematical concept understanding is statistically significant. This confirms the effectiveness of the traditional megoak-goakan game-based learning model in improving students' learning outcomes.

D. Student Activity and Responses

1. Student Activities

Student activity was measured using an observation sheet with seven indicators: looking, listening, asking, writing, moving, thinking, and enthusiasm. The observation data showed that students were very actively involved in the learning process.

Table 3. Recap of Student Activities of SDN Kayuringin VI and SDN Kranji VI

Activity Indicator	SDN Kayuringin VI (%)	SDN Kranji VI (%)
Visual (observing media)	80.00	77.41
Verbal (asking questions)	80.74	76.30
Listening	85.19	80.00
Kinesthetic (movement)	89.63	85.93
Cognitive (active thinking)	75.00	72.22
Emotional (enthusiasm)	76.30	75.93
Average	**81.81**	**78.96**

The high percentage of kinesthetic activity (movement) and listening indicates that the megoak-goakan game and the VAK model were well-implemented and engaged students' primary learning styles.

2. Student Responses

To find out students' responses to the learning, a questionnaire was given to students through five main aspects: fun, ease, understanding, LKS assistance, and new learning experiences. The results were very positive.

Table 4. Student Responses of SDN Kayuringin VI and SDN Kranji VI

School	Average Score (%)	Category
SDN Kayuringin VI	90.03	Very Positive
SDN Kranji VI	88.67	Very Positive

The results from the student response questionnaire strongly support the quantitative findings, indicating that students found the new learning method enjoyable and effective in helping them understand mathematical concepts.

DISCUSSIONS

The results showed that the mathematics learning approach through traditional megoak-goakan games based on the VAK model assisted by LKS had a significant impact on improving the understanding of mathematical concepts of phase A students. This finding strengthens the theory of constructivism which states that learning will be more effective when students build their own knowledge through concrete experiences. In this context, the megoak-goakan game acts as a medium that presents the concepts of addition and subtraction in a real and applicable form.

According to Jean Piaget, children aged 6-7 years are at the concrete operational stage, where they more easily understand mathematical concepts when delivered through concrete and contextual media. The megoak-goakan game activates the logical thinking process through the manipulation of real objects, movements, and social interactions that match the characteristics of early childhood cognitive development.

The VAK model that integrates visual, auditory and kinesthetic learning styles strengthens the effectiveness of differentiated learning. Fleming and Mills state that learning will be more optimal if it is adapted to students' learning styles. In practice, the VAK approach in this study reaches all types of students: visual through LKS and visual illustrations, auditory through discussions and verbal explanations, and kinesthetic through direct involvement in games.

The application of Student Worksheets (LKS) as an integral part of learning also contributes importantly. The worksheet serves as a guiding instrument that designs learning sequences and reflective activities, as stated by Sudjana (2009) that the worksheet is effective in increasing the concentration of attention and reinforcement of concepts. In this study, the LKS was designed based on VAK syntax and game stages, so that it can be a bridge between concrete experience and abstract understanding.

The results of the pretest and posttest showed an increase in students' average scores, supported by the N-Gain scores which were in the medium category, namely 0.51 and 0.35. Referring to Hake (1998), N-Gain values between 0.3 to 0.7 indicate moderate effectiveness, which in the context of basic education already indicates the success of the intervention. This

effectiveness is reinforced by the results of the paired sample t-test which shows statistical significance ($p < 0.05$), indicating a significant difference after the intervention.

Observations of student activity during learning also showed an increase from moderately active to very active. This supports Vygotsky's (1978) theory (in (Yanti et al., 2023) about the zone of proximal development (ZPD), where involvement in social and collaborative activities allows students to develop skills that they have not mastered independently. The interaction between students in the game creates a learning environment rich in social, emotional and cognitive experiences.

Furthermore, the application of traditional games as learning media is also in line with the culturally responsive teaching approach. (Indriyana et al., 2024) states that learning that links students' local cultural experiences will increase relevance, motivation, and engagement. The megoak-goakan game not only builds math concepts, but also reintroduces traditional values such as sportsmanship, cooperation, and respect for the nation's culture.

Questionnaires given to students showed that the majority of students felt happy and more confident in learning math. This suggests that a fun and non-stressful approach can increase students' intrinsic motivation, Self-Determination theory, which emphasizes that the need for autonomy, competence, and relatedness contribute to increased learning motivation (Rediah et al., 2025; Damayanti et al., 2024)(Hanif et al., 2025)(Susanto et al., 2024).

Pedagogically, this finding indicates that math learning does not have to be textual and symbolic from the start. With a game-based approach and concrete media, abstract concepts such as addition and subtraction can be understood more quickly. This is in line with (in Helena & Perbowo, 2026) who suggested three modes of representation in learning: enactive (through actions), iconic (through pictures), and symbolic (through symbols and numbers). The megoak-goakan game involves all three modes naturally in the learning process.

The implication of this research is the importance of learning innovations that integrate local cultural elements, differentiated learning approaches, and structured learning aids. The Merdeka curriculum, which emphasizes differentiated and project-based learning, supports the implementation of this model in various schools. Teachers need to be trained to design and implement game-based learning that is not only educational but also contextualized.

In closing, the mathematics learning approach based on the traditional game of megoak-goakan assisted by the VAK model and LKS proved to be effective, efficient and applicable to improve the understanding of mathematical concepts of phase A students. The findings provide a strong basis for teachers, curriculum developers and policy makers to adopt similar strategies to improve the quality of basic education in Indonesia.

CONCLUSION

Based on the empirical findings, it can be concluded that the application of the traditional megoak-goakan game based on the VAK learning model assisted by LKS is

highly effective in improving the mathematical concept understanding of Phase A elementary school students. The integration of physical-kinesthetic play with visual and auditory components successfully scaffolds students' cognitive transition from concrete experiences to abstract mathematical concepts of addition and subtraction. This learning framework yields a statistically significant increase in student concept mastery, as evidenced by a significant post-test score enhancement with medium-category N-Gain scores of 51% at SDN Kayuringin Jaya VI and 35% at SDN Kranji VI, while simultaneously fostering active student participation and achieving highly positive responses during the instructional process.

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