Analysis of The Implementation of Ethnomathematics Through The Bendrong Lesung Dance In Improving Students' Mathematical Reasoning Skills In Number Patterns

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Abstract.
This study was motivated by students' low mathematical reasoning ability and the limited integration of local culture into mathematics instruction. The study aimed to analyze the application of ethnomathematics through the Bendrong Lesung Dance in teaching number patterns, the improvement of students' mathematical reasoning ability, students' mathematical reasoning ability after instruction, and students' responses to the learning process. This study employed a mixed-methods approach with a sequential explanatory design involving 30 eighth-grade students at SMPN 3 Cilegon. The quantitative phase used a one-group pretest-posttest design. Data were collected through a mathematical reasoning test and interviews. Quantitative data were analyzed using the Wilcoxon Signed-Rank Test and N-Gain, while qualitative data were analyzed through data reduction, data presentation, and concluding. The results of the study indicate that ethnomathematics was implemented by relating the rhythmic patterns of the pestle and mortar, as well as the dancers' formations in the Bendrong Lesung dance, to the concept of number patterns through the Think-Pair-Share model. Students' mathematical reasoning skills improved, as evidenced by an increase in the average score from 8.43 on the pretest to 15.03 on the posttest, with an N-Gain score of 0.5749, which is categorized as moderate. The Wilcoxon test showed a significance value of 0.000 < 0.05, indicating a significant difference in students' mathematical reasoning skills before and after the instruction. After the instruction, students were able to make conjectures, perform mathematical manipulations, provide reasons for the solutions they found, and draw conclusions. Interview results also revealed positive feedback from students, as the instruction helped them understand number patterns more easily, made learning more engaging, and provided an opportunity to explore local culture. Therefore, ethnomathematics through the Bendrong Lesung dance can serve as an alternative approach to teaching number patterns that supports students' mathematical reasoning skills.

Keywords: *Ethnomathematics, Bendrong Lesung Dance, Mathematical Reasoning Ability and Number Patterns.*

I. INTRODUCTION

Mathematics is one of the fundamental sciences that plays a very important role in human life as well as in the development of science and technology. Therefore, mathematics is taught at every level of education because almost all activities in life are related to mathematical concepts (Cahyani & Sritresna, 2023). Mathematics instruction aims not only to help students master concepts but also to develop their thinking skills, one of which is mathematical reasoning. Mathematical reasoning is a crucial aspect of mathematics learning because it involves the thought processes required to conclude, construct arguments, and solve problems logically. Through reasoning, students not only learn the final result but also understand the reasoning behind a concept, thereby making learning more meaningful (Cahyani & Sritresna, 2023). However, in reality, students' mathematical reasoning skills remain relatively low. Research findings support this. indicate that students struggle to understand problems, construct arguments, and draw logical conclusions (Isnaeni et al., 2018). Additionally, students face challenges in identifying patterns and making generalizations, particularly in the topic of number patterns (Ariyanti & Setiawan, 2019). These conditions indicate that students' higher-order thinking skills—particularly mathematical reasoning—still need to be improved.

The low level of students' mathematical reasoning skills is also evident from the results of the 2022 Programme for International Student Assessment (PISA). The OECD noted that the average mathematics score for Indonesian students was 366 points, lower than the OECD average of 472 points. Furthermore, only 18% of Indonesian students reached Level 2 or higher in mathematics, while the OECD average was 69%.

At Level 2, students are at least able to recognize and interpret how a simple situation can be represented mathematically without direct instruction. Meanwhile, Levels 5 and 6 require students to be able to model complex situations mathematically and to select, compare, and evaluate problem-solving strategies (OECD, 2023). These findings indicate that students' ability to use mathematical knowledge to understand and solve problems remains a challenge.

This situation is also evident among the students who were the subjects of this study. Based on the results of a pre-test administered to 30 eighth-grade students at SMPN 3 Cilegon, an average score of 8.43 out of a maximum of 20 was obtained. These results indicate that the students' mathematical reasoning skills are still relatively low and need to be improved.

One of the factors contributing to low mathematical reasoning skills is the learning process, which remains conventional. Instruction tends to be presented in an abstract manner and is not sufficiently linked to students' real-life contexts. This situation makes it difficult for students to understand concepts in depth (Irawan & Kencanawaty, 2017). Therefore, a learning approach is needed that can connect mathematical concepts to students' real-life experiences. One approach that can be used is ethnomathematics. This approach links mathematical concepts to the culture that has developed within a community, thereby making learning more contextual and meaningful (Muhammad, 2023). Furthermore, ethnomathematics-based learning has also been shown to improve students' mathematical abilities and make the learning process more engaging (Bimantara, 2024).

In the context of ethnomathematics, various cultural activities can be utilized as media for mathematics instruction. This is because cultural activities incorporate mathematical concepts such as counting, measuring, and identifying patterns (Ekowati et al., 2017). Thus, mathematics instruction is no longer abstract but can be linked to students' real-life experiences. One form of culture that can be utilized is traditional dance. The movements and formations in dance contain mathematical patterns and structures that can be used to teach mathematical concepts (Rahmawati et al., 2025). This demonstrates that dance has the potential to serve as a contextual and engaging learning medium.

The Bendrong Lesung dance, as a form of traditional art, has the potential to be integrated into mathematics instruction, particularly in the topic of number patterns. This topic requires mathematical reasoning skills, as students must be able to identify patterns, formulate generalizations, and draw conclusions. However, in reality, students still struggle to understand this material (Ariyanti & Setiawan, 2019).

Based on this description, there is a need for instructional innovations capable of enhancing students' mathematical reasoning skills through a contextual approach. Therefore, the application of ethnomathematics through the Bendrong Lesung Dance is expected to serve as a solution for improving students' mathematical reasoning skills in number patterns, while simultaneously fostering a love for local culture. Consequently, this study was conducted to analyze the implementation of ethnomathematics through the Bendrong Lesung Dance in number pattern instruction; the improvement in students' mathematical reasoning skills following the application of ethnomathematics via the Bendrong Lesung Dance; students' mathematical reasoning skills in solving number pattern problems after the implementation of ethnomathematics-based instruction through the Bendrong Lesung Dance; and students' responses to ethnomathematics-based learning.

II. RESEARCH METHOD

This study employed a mixed-methods approach with a sequential explanatory design. In the quantitative phase, a one-group *pretest-posttest* design was used to determine the improvement in students' mathematical reasoning skills before and after the implementation of ethnomathematics-based learning through the Bendrong Lesung Dance. The research design used was:

$$O_1 \; X \; O_2$$

Notes:

O_1: *pretest* of mathematical reasoning ability

X: ethnomathematics instruction through the Bendrong Lesung Dance

O_2: *posttest* of mathematical reasoning ability.

The population in this study consisted of all eighth-grade students at SMP Negeri 3 Cilegon. The research sample consisted of 30 students from one of the eighth-grade classes selected using purposive sampling. The selection of this class was based on the consideration that the class conditions were deemed most suitable and cooperative for implementing ethnomathematics-based learning through the Bendrong Lesung Dance.

The data collection techniques used were tests and interviews. Tests were used to measure students' mathematical reasoning skills regarding number patterns and were administered before instruction (*pretest*) and after instruction (*posttest*). The tests consisted of open-ended questions designed based on the indicators of mathematical reasoning skills identified by Hidayah et al. (2023), namely formulating hypotheses, performing mathematical manipulations, providing evidence or reasoning for solutions, and concluding. Interviews were conducted after the posttest with several eighth-grade students at SMPN 3 Cilegon to obtain information regarding their thought processes, the difficulties they encountered, and their responses when solving mathematical reasoning problems on number patterns. The interview data were used to reinforce, clarify, and describe the findings from the quantitative data.

The research instruments consisted of test and non-test instruments. The test instrument comprised questions assessing mathematical reasoning skills on the topic of number patterns, while the non-test instrument consisted of interview guidelines. Additionally, a learning support instrument in the form of a teaching module was used; this module was designed to implement ethnomathematics-based learning through the Bendrong Lesung Dance on the topic of number patterns by applying the *Think-Pair-Share* (TPS) model.

Data analysis in this study comprised both quantitative and qualitative components. Quantitative analysis was used to determine improvements in students' mathematical reasoning skills, while qualitative analysis was used to describe the implementation of the learning process and students' responses. Descriptive statistical analysis was performed on the pretest and *posttest* data by examining the mean, maximum, minimum, and standard deviation using SPSS version 26. Furthermore, the improvement in mathematical reasoning skills was analyzed using N-Gain.

A normality test was conducted to determine the data distribution. Based on the results of the normality test, the posttest data were not normally distributed; therefore, hypothesis testing used the *Wilcoxon Signed-Rank* Test—a nonparametric statistical test—to determine differences in students' mathematical reasoning abilities before and after instruction. Additionally, this study used the Actual Mastery Threshold (AMT) as supporting information to assess students' achievement levels after instruction.

Qualitative data obtained through interviews were analyzed using the Miles and Huberman (1994) interactive analysis model, which comprises three stages: data reduction, data presentation, and concluding. The results of the qualitative analysis were then cross-referenced with the results of the quantitative analysis to gain a more comprehensive understanding of the research findings,

III. FINDINGS AND DISCUSSION

3.1 Ethnomathematical Findings in the Bendrong Lesung Dance

Based on an analysis of the Bendrong Lesung Dance, several elements were identified that exhibit regularity and can be linked to mathematical concepts. These elements are found in the dancers' formations as well as in the rhythms of the pestle and mortar. In the dancers' formations, several numerical patterns were identified, namely even-number patterns and repeating number patterns. Meanwhile, repeating number patterns were found in the rhythms of the pestle and mortar. These findings indicate that the activities in the Bendrong Lesung Dance not only hold artistic and cultural value but also contain mathematical regularity that can be utilized as a context for learning number patterns.

In the dancers' formations, even number patterns are found in the arrangement of the number of dancers: 2, 4, 6, and so on. The number of dancers increases regularly by a common difference of 2. With the first term as 2 and a common difference of 2, the formula for the nth term can be determined as follows:

$$Un = a + (n - 1)b$$
$$Un = 2 + (n - 1)\,2$$
$$Un = 2n$$

This formula shows that the number of dancers at each stage can be determined based on the stage's ordinal number. For example, for the 10th stage, we get:

$$U10 = 2(10) = 20$$

Thus, at the 10th stage, there are 20 dancers on stage.

In addition to the even-number pattern, a repeating number pattern is found in the dancers' formation. In certain sections, the number of dancers performing movements forms the sequence 6, 4, 2, 4, 2, 6. This pattern can be represented as 6, (4, 2), (4, 2), 6. This sequence indicates a repetition of the number of dancers—namely, 4 and 2—which alternates.

In the rhythms of the pestle and mortar, a repeating number pattern is found with the sequence 1, 2, 3, 4, 1, 2, 3, 4, and so on. This repetition occurs after a sequence of beats is completed, forming a regular pattern. This beat pattern can be utilized in mathematics education to help students observe regularity, identify the patterns formed, and predict the next beat based on the patterns they have identified.

Implementation of Ethnomathematics through the Bendrong Lesung Dance in Teaching Number Patterns Instruction using the ethnomathematics approach, which incorporates the Bendrong Lesung Dance, was conducted in the 8th-grade class at SMPN 3 Cilegon with 30 students. This approach was applied so that the abstract concept of number patterns could be learned through local culture that is closely related to the students' lives. The lesson began with a pretest to assess the students' initial abilities before participating in the instruction. Next, the researcher introduced the concept of ethnomathematics and explained the connection between elements of the Bendrong Lesung Dance and the number patterns curriculum.

During the learning process, two main elements of the Bendrong Lesung Dance were used as learning resources: the rhythmic beats of the pestle and mortar and the dancers' formations. Regarding the rhythmic beats of the pestle and mortar, students observed the beat patterns that emerged during the performance. These rhythms exhibit a repeating pattern of 1, 2, 3, 4, then looping back to 1, 2, 3, 4. Meanwhile, regarding the dancers' formations, students observed changes in the number of dancers forming patterns of 2, 4, 6, as well as the repeating pattern of 6, 4, 2, 4, 2, 6.

The use of these two cultural elements demonstrates that the concept of number patterns is not only learned through examples found in textbooks but can also be discovered in the cultural activities of the community. This helps students connect their learning experiences to real-world objects, making the process of identifying patterns easier.

After understanding the connection between the Bendrong Lesung dance and number patterns, students worked in pairs to complete the worksheet using the *Think-Pair-Share* method. In the *Think* stage, students first observe and understand the problem independently. Next, in the *Pair* stage, students discuss in pairs to compare their observations and solve the given problem. In the *Share* stage, several pairs present the results of their discussion and solutions to the entire class. The lesson concludes with a posttest to assess the development of students' mathematical reasoning skills following the lesson.

Based on this lesson, the implementation of ethnomathematics through the Bendrong Lesung Dance was carried out by integrating elements of local culture into the number patterns material through activities such as observing, identifying patterns, discussing, and solving problems in the worksheets using the *Think-Pair-Share* stages. The *"Think"* stage provided students with the opportunity to understand and identify patterns independently; the *"Pair"* stage was used to discuss their observations with a partner; and the *"Share"* stage gave students the opportunity to present the results of their discussions.

The results of this implementation align with the research by Muhammad (2023) and Bimantara (2024), which shows that ethnomathematics-based learning can provide a more meaningful learning experience because mathematical concepts are linked to local culture, making them easier for students to understand.

3.2 Improvement in Students' Mathematical Reasoning Skills Following the Implementation of Ethnomathematics through the Bendrong Lesung Dance

After the ethnomathematics lesson using the Bendrong Lesung Dance was conducted, students' mathematical reasoning skills were analyzed based on *pretest* and *posttest* results. Based on a descriptive analysis of 30 eighth-grade students at SMPN 3 Cilegon, the average mathematical reasoning score was 8.43 on *the pretest*, with a lowest score of 2, a highest score of 14, and a standard deviation of 3.126. Meanwhile, the average *posttest* score increased to 15.03, with a lowest score of 10, a highest score of 19, and a standard deviation of 2.341.

Table 1. Results of the Descriptive Analysis

Data	Pretest	Posttest
Mean	8.43	15.03
Minimum score	2	10
Maximum value	14	19
Standard deviation	3.126	2.341

Based on Table 1, there was an increase in students' average mathematical reasoning ability following ethnomathematics instruction through the Bendrong Lesung dance.

This improvement was further analyzed using Normalized Gain (N-Gain). The analysis results showed an average N-Gain of 0.5749, which falls within the range of $0.30 \leq g < 0.70$ and is therefore classified as moderate. The lowest N-Gain value was 0.36, and the highest was 0.88. Overall, the average N-Gain of 57.49% indicates that ethnomathematics instruction through the Bendrong Lesung Dance is quite effective in helping students develop mathematical reasoning skills regarding number patterns.

Next, a normality test was conducted using the Shapiro-Wilk method. The test results showed that the significance value for the pretest data was 0.077, while that for the posttest data was 0.017. Since the significance value for the pretest was greater than 0.05, the pretest data were normally distributed. Conversely, the significance value for the posttest was less than 0.05, so the posttest data were not normally distributed. Therefore, hypothesis testing was conducted using a nonparametric statistic, namely the Wilcoxon Signed-Rank Test.

results of the Wilcoxon test showed a Z-value of -4.802 with an Asymp. Sig. (2-tailed) value of 0.000. Since the significance value is less than 0.05 ($0.000 < 0.05$), H_0 is rejected, and H_1 is accepted. Thus, there is a significant difference between students' mathematical reasoning abilities before and after the application of the ethnomathematics approach through the Bendrong Lesung Dance in the number patterns unit. This difference indicates that the application of the ethnomathematics approach has a positive effect on improving students' mathematical reasoning abilities.

In addition to the Wilcoxon test and N-Gain, this study used Actual Proficiency Threshold (BTA) analysis. The BTA value obtained was 78.08. Of the 30 students, 14 reached the BTA, while 16 did not. Meanwhile, based on the Minimum Passing Score (KKM) of 75, 17 students met the KKM, while 13 students did not meet the KKM.

These results indicate that ethnomathematics-based learning through the Bendrong Lesung dance is capable of improving students' mathematical reasoning skills, although this improvement was not uniform across all students. The difference in the number of students who met the ACT and the MCC indicates that the ACT standard is based on students' actual abilities in this study, whereas the MCC is a mastery standard set by the school.

3.3 Students' Mathematical Reasoning Abilities Based on Indicators

Students' mathematical reasoning skills were analyzed based on four indicators according to Hidayah et al. (2023), namely making conjectures, performing mathematical manipulations, providing evidence or reasons for solutions, and drawing conclusions. The analysis was conducted based on the results of students' work after participating in ethnomathematics-based learning through the Bendrong Lesung Dance.

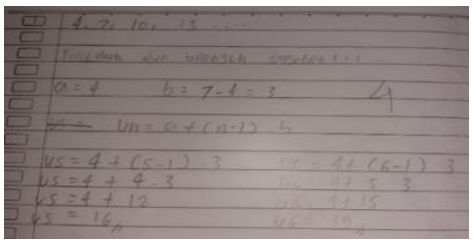

Fig. 1. "Formulating Hypotheses" Indicator

In Problem 1, which assesses the "formulating conjectures" indicator, students were able to determine the first term and common difference in the sequence 4, 7, 10, 13, ... Students identified the first term as 4. The common difference as 3, then determined the fifth term to be 16 and the sixth term to be 19. This demonstrates that students were able to identify patterns before arriving at a solution.

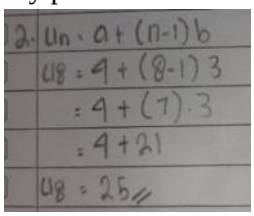

Fig. 2. Indicator: Performing Mathematical Manipulations

In Question 2, which assesses the indicator of performing mathematical manipulations, students were able to use the formula `$Un = a + (n - 1)\ b$` to determine the 8th term. Given that `$a = 4$` and `$b = 3$`, students substituted `4 + (7) × 3`, resulting in 25. This result demonstrates that students can transform the information in the problem into a mathematical form and apply the appropriate formula.

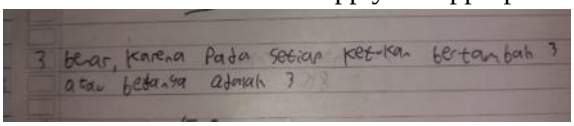

Fig. 3. Indicator: Providing Evidence or Justification for the Solution

In Question 3, which assesses the ability to provide evidence or reasoning for a solution, the student was able to explain that the number pattern has a constant difference between each term and can therefore be classified as an arithmetic sequence. The student not only determined the answer but was also able to explain the basis for the answer provided.

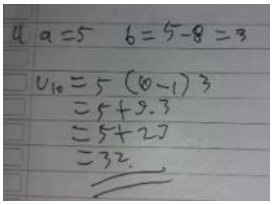

Fig. 4. Indicator: Performing Mathematical Manipulations

In Question 4, which assesses the ability to perform mathematical manipulations, students are able to determine the initial value$a$ = 5 and the common difference$b$ = 3, then use the formula$Un = a + (n - 1)b$ to determine the 10th term. Through the calculation$U$ 10 = 5 + (10−1) × 3, the result 32 is obtained. This demonstrates that students are able to apply concepts and problem-solving procedures to different types of problems.

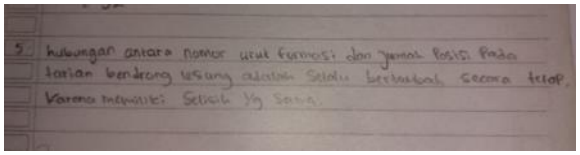

Fig. 5. Drawing Conclusions Indicator

In Question 5, which assesses the ability to conclude, students were able to explain the relationship between the sequence numbers of the formation and the number of dancers, which increases at a constant rate due to a consistent difference. This conclusion demonstrates that students understand the relationship between mathematical concepts and the formation in the Bendrong Lesung dance.

Overall, the results of the analysis based on the indicators show that students were able to identify patterns, use mathematical concepts and procedures, provide reasons for their solutions, and draw conclusions based on the observed patterns. These results are reinforced by interviews that indicate that the rhythm patterns and formations of the Bendrong Lesung Dance helped students understand the regularity in number patterns.

3.4 Student Responses to the Learning Process

Qualitative data were obtained through semi-structured interviews with six student representatives from the eighth grade at SMPN 3 Cilegon after the entire series *of posttests* had been completed. The interview data were analyzed through the stages of data reduction and narrative data presentation based on the students' mathematical reasoning ability groups, namely high, moderate, and low ability groups.

In terms of mathematical reasoning, students in the high-ability group were able to identify the characteristics of number sequences based on the regularity of the differences and draw accurate conclusions. Students in the moderate-ability group were able to recognize patterns and calculate the differences between numbers, although their conclusions were still relatively simple. Meanwhile, students in the low-ability group understood that there were regular changes in the number sequences but still faced difficulties or hesitations when dealing with large numbers.

In terms of thinking processes, high-ability students demonstrated a systematic approach by identifying known components and using formulas as well as manual methods to verify answers. Students in the moderate-ability group tended to rely on formulas and sometimes experienced confusion in selecting the correct formula or performing calculations. Meanwhile, students in the low-ability group relied more on rote memorization of structural patterns and faced difficulties when they forgot a formula or feared making calculation errors.

In terms of ethnomathematics, students responded positively to the use of the Bendrong Lesung Dance in the lesson. High-ability students stated that the lesson was exciting and helped them recognize patterns through the number of dancers and the beats. Medium-ability students stated that the lesson was not boring and helped them recognize patterns from the beats and the dancers' movements. Meanwhile, low-ability students stated that the lesson was quite interesting and that the dancers' formations helped them see examples of patterns directly.

The analysis of interview data revealed differences in students' tendencies regarding the use of ethnomathematics. Students in the high- and medium-ability groups tended to be more attuned to the auditory-rhythmic aspects, specifically the patterns of the pestle beats. In contrast, students in the low-ability group relied more on visual-spatial aspects, such as the dancers' formations, to concretize their understanding.

3.5 Integration and *Mixed-Method* Findings

Quantitative results show that students' mathematical reasoning skills improved after the implementation of ethnomathematics learning through the Bendrong Lesung Dance. This is evidenced by an increase in the average score from 8.43 on the pretest to 15.03 on the posttest, an average N-Gain of 0.5749 in the moderate category, and a Wilcoxon test result with a significance level of $0.000 < 0.05$.

Qualitative results from interviews provided a deeper insight into this process. Students stated that the rhythm patterns and dancer formations helped them understand the regularity of number patterns. Students also demonstrated differences in how they understood and solved problems based on their levels of mathematical reasoning ability.

Thus, the quantitative and qualitative results mutually support each other in demonstrating that the application of ethnomathematics-based learning through the Bendrong Lesung Dance helps students understand the concept of number patterns and improves their mathematical reasoning skills.

3.6 Strengths, Weaknesses, and Factors Influencing Learning Outcomes

The implementation of ethnomathematics-based learning through the Bendrong Lesung Dance has the advantage of providing a local cultural context that can be used to connect mathematical concepts with real-world objects. The rhythmic beats of the pestle and mortar, along with the dancers' formations, help students

perceive the regularity of patterns more concretely. Additionally, the implementation of *the Think-Pair-Share* approach provides students with the opportunity to understand patterns independently, discuss them with a partner, and present the results of their discussion.

Although the results were positive, improvements in mathematical reasoning skills were not uniform across all students. This is evident from the 14 students who achieved the BTA standard and the 16 students who did not. Interview results also indicated that students still faced several challenges, such as calculation errors, confusion in determining formulas, and anxiety about making mistakes when solving problems.

Factors influencing learning outcomes included the use of local cultural contexts, the implementation of the *Think-Pair-Share* approach, the use of worksheets, and differences in students' characteristics and abilities. Students with high and moderate abilities tended to be more sensitive to rhythm patterns, while the dancers' formations better supported students with low abilities. Differences in prior knowledge, the ability to understand patterns, precision in calculations, and the ability to use formulas resulted in varying levels of students' mathematical reasoning skills.

Overall, the research results indicate that the implementation of ethnomathematics-based learning through the Bendrong Lesung Dance can be used in teaching number patterns and demonstrates an improvement in students' mathematical reasoning abilities. The use of local cultural contexts provides a learning experience that connects mathematical concepts with cultural elements observed by students. At the same time, the interview results reinforce the quantitative findings regarding the development of students' understanding and thinking processes.

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