# Analysis of The Implementation of Ethnomathematics-Based Mathematics Instruction Using The Traditional "Rampak Bedug" Instrument On Students' Mathematical Connectivity Skills

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***Abstract.***
*This study aims to describe the implementation of ethnomathematics-based mathematics instruction through Rampak Bedug, analyze improvements in students' mathematical connection skills, and describe students' responses to this instruction. This study employed a mixed-methods approach with a sequential explanatory design. The quantitative component utilized a one-group pretest-posttest design, while the qualitative component was obtained through semi-structured interviews. The research subjects were 20 eighth-grade students at MTs Islamiyah Ciomas, Serang Regency, Banten Province, selected using total sampling. Quantitative data were analyzed using descriptive statistics, the paired-sample t-test, N-Gain analysis, and the Actual Proficiency Threshold (BTA). In contrast, qualitative data were analyzed using the Miles, Huberman, and Saldaña model. The results of the study indicate that: (1) the implementation of ethnomathematics-based mathematics learning through Rampak Bedug was successfully carried out using the Problem-Based Learning (PBL) model, with students actively engaged in exploring the concept of curved-sided three-dimensional shapes through the cultural context of Rampak Bedug; (2) students' mathematical connection skills showed a significant improvement, as evidenced by an increase in the average pretest score from 72.30 to 92.30 on the posttest; this significant difference was confirmed by a Paired Sample t-test (Sig. < 0.001), and the average N-Gain of 0.7656 (76.56%), which falls into the high and effective category; and (3) students responded positively to the learning experience because the material was easier to understand, more concrete, and more engaging through the use of the Rampak Bedug cultural context, although some students still required guidance in solving problems that required the integration of multiple mathematical concepts. The integration of quantitative and qualitative data shows that the two types of data mutually confirm and complement each other in providing a more comprehensive understanding of the effectiveness of ethnomathematics-based learning through Rampak Bedug in improving students' mathematical connection skills.*

***Keywords:*** *Ethnomathematics; mathematical connection skills; Rampak Bedug; mixed methods and curved-sided three-dimensional shapes.*

## I. INTRODUCTION

Mathematics education in Indonesia continues to face various challenges in its efforts to improve students' mathematical proficiency. According to the results of the 2022 Programme for International Student Assessment (PISA) released by the OECD, Indonesian students' mathematics scores reached 366, which remains below the OECD average (OECD, 2023). PISA results measure not only computational skills but also students' ability to formulate, apply, and interpret mathematics in various real-life situations—a capacity closely related to mathematical connection skills.

Mathematical connection skills involve the ability to link mathematical concepts, relate mathematics to other fields of study, and apply it in daily life. Various studies indicate that these skills remain relatively low among Indonesian students. (Khairunnisak et al., 2020). Preliminary observations at MTs Islamiyah Ciomas in Serang confirm this situation: eighth-grade students are able to solve procedural problems but struggle to connect mathematical concepts to real-world contexts or across disciplines. Students tend to rely on memorizing formulas without establishing meaningful conceptual connections.

This situation is partly due to conventional teaching approaches that prioritize procedural instruction over the development of conceptual connections and rarely utilize local cultural contexts as learning resources. As a result, mathematics is viewed as an abstract discipline disconnected from students' lives (Nursanti et al., 2024). To address this, an ethnomathematics-based approach—integrating local cultural practices into mathematics instruction—is considered relevant, especially when combined with the Problem-Based Learning (PBL) model to foster student-centered, contextual learning (Diana & Kusuma, 2025).

Rampak Bedug, a traditional art form unique to Banten Province, Indonesia, contains a wealth of mathematical elements. The bedug physically resembles a cylinder: its lid represents the base of the cylinder, its body represents the lateral surface, and the space inside represents the volume of the cylinder. The arrangement of the performers also reflects geometric patterns such as parallel lines and symmetrical formations. These characteristics make Rampak Bedug a highly relevant context for teaching curved-sided three-dimensional shapes to eighth-grade students (Ramadan & Astuti, 2023).

Previous research on ethnomathematics-based learning has consistently reported positive results. Pratama and Yelken (2024) found that the ethnomathematics approach effectively improves mathematical literacy by connecting concepts to real-life cultural contexts. Sidauruk et al. (2026) demonstrated that ethnomathematics integrated with PBL supports the development of mathematical connection skills. Kusuma et al. (2025) reported an improvement in mathematical connection skills through ethnomathematics-based learning innovations. However, research specifically exploring Rampak Bedug as a learning medium for mathematical connection skills using a mixed-methods approach remains very limited. This research gap forms the basis of this study.

This study aims to: (1) describe the implementation of ethnomathematics-based mathematics learning through Rampak Bedug; (2) analyze whether there is a significant improvement in students' mathematical connection skills after participating in the learning activity; and (3) describe students' responses to the learning.

The novelty of this study lies in the systematic implementation of Rampak Bedug as a learning context for curved-sided three-dimensional shapes using a sequential explanatory mixed-methods design.

## II. RESEARCH METHODS

This study employs a mixed-methods approach with a sequential explanatory design. In this design, quantitative data are collected and analyzed first, and then qualitative data are used to elaborate on and explain the quantitative findings (Creswell, 2014). The quantitative component uses a one-group pretest-posttest pre-experimental design to measure changes in students' mathematical connection skills before and after the learning intervention.

### 2.1 Research Participants and Location

The study was conducted at MTs Islamiyah Ciomas, Serang Regency, Banten Province, Indonesia. The research subjects were 20 eighth-grade students selected using total sampling because it was the only class at that grade level in the school. All students took the pretest and posttest, while six students were purposively selected to participate in semi-structured interviews representing three ability categories: high, moderate, and low,$(n = 2)$, based on their pretest scores.

### 2.2 Learning Intervention

The learning intervention consisted of six sessions that integrated the Problem-Based Learning (PBL) model with an ethnomathematics approach, using Rampak Bedug as the learning context. The five stages of PBL implemented were: (1) orienting students to the problem—students were presented with a contextual problem related to Rampak Bedug; (2) organizing students to learn—students worked in groups to identify the cylindrical components of the bedug; (3) guiding group investigation—students investigated the radius, diameter, and height of the bedug; (4) developing and presenting work—groups present their findings and connect mathematical formulas to the bedug; and (5) analyzing and evaluating the problem-solving process—students reflect on the relationship between Rampak Bedug and the concept of a cylinder.

The teaching module and Student Worksheets (LKPD) were developed specifically for this study. Validation by two mathematics education professors yielded average validity scores of 90.0% and 95.8%, respectively, both falling into the "highly valid" category. The material covers the geometry of curved-sided three-dimensional shapes, specifically cylinders, including surface area, lateral surface area, and volume.

### 2.3 Instruments

Mathematical connection skills were measured using an essay-type test instrument based on the three NCTM (2000) indicators of connections: (a) connections between mathematical concepts, (b) connections between mathematics and other disciplines, and (c) connections between mathematics and everyday life. The pretest consisted of 3 items; the posttest consisted of 5 items. Content validation by experts (validity scores:

91.4% and 92.9%) and empirical validation through a pilot study with 9th-grade students yielded Pearson correlations of 0.736–0.838 (all significant at $p < 0.001$) with a Cronbach's Alpha reliability of 0.870 (high). Discriminant validity ranged from 0.591 to 0.730 (good to very good).

Qualitative data were collected through semi-structured interviews covering six aspects: connections between mathematical topics, connections with other disciplines, connections with the real world, drawing conclusions, ethnomathematical experiences, and learning experiences. The interview instrument was validated by two faculty members with average validity scores of 87.5% and 85.0% (highly valid).

### 2.4 Data Analysis

Quantitative data were analyzed using: (1) descriptive statistics (mean, standard deviation, minimum, and maximum values); (2) the Shapiro-Wilk normality test; (3) Levene's test for homogeneity of variances; (4) the paired-sample t-test to determine the significance of differences between pretest and posttest scores; (5) N-Gain analysis to determine the magnitude of improvement, interpreted using Hake's criteria (1998); and (6) the Actual Mastery Threshold (BTA = $\bar{X} + 0.25S$) to assess individual learning mastery. All statistical analyses were conducted using IBM SPSS Statistics version 27.

Qualitative data from the interviews were analyzed using the model proposed by Miles, Huberman, and Saldaña (2014): data reduction, data presentation, and concluding. Data integration was performed by linking quantitative and qualitative findings to gain a more comprehensive understanding of the phenomenon under study.

## III. RESULTS AND DISCUSSION

### 3.1 Implementation of Ethnomathematics-Based Mathematics Learning through Rampak Bedug

Ethnomathematics-based mathematics instruction through Rampak Bedug was conducted over six sessions, covering the topics of surface area, lateral surface area, and the volume of a cylinder. All stages of the PBL model were carried out systematically. During the problem-orientation stage, students were presented with a contextual situation involving Mr. Rahmat, a craftsman who needed help identifying the components of a cylinder in a bedug for production purposes. This real-world context immediately encouraged students to connect cultural artifacts with mathematical concepts. During the investigation stage, students observed the bedug and successfully identified the elements of a cylinder: the bedug's lid as the base circle, the body of the bedug as the cylinder's lateral surface (which, when "unfolded," forms a rectangle), and the space inside as the cylinder's volume.

The students' Worksheets (LKPD) provide concrete evidence of the development of conceptual connections. Students wrote conclusions such as: "A bedug craftsman needs to know the bedug's height, radius, diameter, and the area of the circle in order to make a bedug of the appropriate size." This demonstrates that students are not merely solving math problems but are also connecting mathematical knowledge to practical cultural contexts. During the reflection phase, students remarked: "The shape of the Rampak Bedug resembles a cylinder, so it can be calculated using mathematical concepts and formulas"—demonstrating the internalization of ethnomathematical connections.

Overall, the implementation of this learning activity demonstrated that integrating the Rampak Bedug into PBL creates an active, contextual, and meaningful learning environment. This aligns with D'Ambrosio's (2001) view that mathematics is part of human cultural activity and can be meaningfully learned through cultural contexts.

### 3.2 Students' Mathematical Connectivity Skills: Quantitative Results

Table 1 presents descriptive statistics of students' pretest and posttest scores.

**Table 1**. Descriptive Statistics of Pretest and Posttest Scores

| Statistics | Pretest | Posttest |
|---|---|---|
| N | 20 | 20 |
| Minimum | 60 | 85 |
| Maximum | 85 | 95 |
| Average | 72.30 | 92.30 |
| Standard Deviation | 7.087 | 2.716 |

The mean score increased from 72.30 (pretest) to 92.30 (posttest), reflecting a substantial improvement. The standard deviation decreased from 7.087 to 2.716, indicating that after instruction, students' scores were more homogeneous, suggesting a more consistent understanding of the material.

Before conducting inferential analysis, the assumptions were tested first. The Shapiro-Wilk normality test yielded significance values of 0.904 (pretest) and 0.877 (posttest), both of which exceeded 0.05, confirming a normal distribution. Levene's test for homogeneity yielded a Sig. = 0.058 > 0.05, confirming homogeneous variances. These results allowed for the use of the paired-sample t-test.

The Paired-Sample t-test yielded a Sig. (2-tailed) < 0.001 with a mean difference of -19.000, confirming a statistically significant improvement in students' mathematical connection skills. $H_0$ was rejected, and $H_1$ was accepted.

**Table 2**. N-Gain Analysis Results

| Statistics | Value |
|---|---|
| Average N-Gain Score | 0.7656 |
| Average N-Gain (%) | 76.56% |
| N-Gain Score Range | 0.56 – 0.89 |
| N-Gain Category | High |
| Effectiveness Category | Effective |

The average N-Gain value of 0.7656 (76.56%) falls into the "high" category based on Hake's (1998) criteria ($g > 0.70$) and the "effective" category based on the interpretation of effectiveness (>76%). This indicates that the learning intervention resulted in a substantial and effective improvement in students' mathematical connection skills.

The Actual Mastery Threshold (BTA) is calculated as: BTA = 92.30 + (0.25 × 2.716) = 92.979 ≈ 93. Of the 20 students, 9 students (45%) met or exceeded the BTA. However, 19 students (95%) met the school's Minimum Proficiency Criteria (KKM = 80), indicating that the majority of students have met the school's learning standards.

### 3.3 Analysis of Student Responses Based on Mathematical Connections Competency Indicators

An analysis of the posttest responses reveals how students demonstrated each of the three NCTM connection indicators:

(1) Connections between mathematical concepts: Students connected the concepts of a circle (the base of the cylinder), a rectangle (the unrolled lateral surface), circumference, radius, diameter, surface area, and volume in solving problems about the drum. One student explained that "when the cylinder's lateral surface is unfolded, it forms a rectangle with a length equal to the circumference of the circle and a width equal to the height of the cylinder"—demonstrating a deep connection between concepts.

(2) Connections between mathematics and other disciplines: Students linked the volume of a cylinder to the physics of acoustics, explaining that the space inside a drum functions as a resonance chamber—"the larger the volume, the lower the frequency of the sound produced." Another student connected surface area to the craftsmanship involved in making drums, including the selection of wood types and the material for the drumhead.

(3) Connections between mathematics and everyday life: Students applied the concept of volume to real-world situations such as calculating the capacity of a water tank, determining the amount of materials needed for production, and estimating the volume of online shipping packages.

### 3.4 Student Responses to Learning: Qualitative Findings

An analysis of interviews with six students selected through purposive sampling (two each from the high, medium, and low categories) revealed patterns consistent with the quantitative findings while providing deeper insights.

Regarding connections between mathematical concepts, students in the high-performing category (KT-1, KT-2) articulated the relationships between the components of a cylinder clearly and systematically. KT-1 stated: "The geometry of curved-sided three-dimensional shapes, the cylinder", when asked about interrelated mathematical concepts, and explained: "Because the shape of a drum is very similar to a cylinder." KT-2 identified the relationship between a circle and the base of a cylinder. Students in the intermediate category identified connections but with more limited elaboration, while students in the low category were only able to recognize basic relationships (for example, "the top of a cylinder is like a circle").

Regarding connections to other disciplines, all six students were able to link the bedug to at least one other subject. High-performing students linked it to Arts, Culture, and History, explaining how mathematical calculations help determine the appropriate materials for making traditional musical instruments. Students in the moderate category linked it to Social Studies through regional cultural heritage. In contrast, students in the low category linked it more to Science—recognizing that larger bedugs produce sounds with lower frequencies.

Regarding connections to daily life, students from all categories provided examples of real-world applications. High-performing students gave examples such as calculating the capacity of a water tank. Intermediate-performing students mentioned drums and water storage tanks. Low-performing students referred to the process of making the bedug itself. Although the depth of their explanations varied, all students recognized that volume calculations have practical applications—an encouraging outcome of this ethnomathematics approach.

In general, student responses to the learning experience were positive. They described the lessons as "easier to understand," "more concrete," and "more interesting" compared to conventional math classes. Some students expressed admiration upon discovering mathematical content in traditional art, indicating that the learning experience also fostered cultural appreciation.

Some students, particularly those in the lower performance category, acknowledged difficulties with problems requiring the integration of multiple concepts simultaneously or calculations involving decimals (especially those related to the value of $\pi$). These findings underscore the importance of differentiated scaffolding in ethnomathematics-based learning.

### 3.5 Ethnomathematics Findings on Rampak Bedug

Based on observations and interviews with the director of the Harum Sari Pandeglang Art Studio, the physical characteristics of the traditional Rampak Bedug instruments were successfully documented. Various types of instruments were identified, including gedug, dolongdong, anantuk, anting carang, anting kerap, pongpet, and tilingtit, with diameters ranging from 15 cm (smallest) to 100 cm (largest). Table 3 presents the mathematical elements identified in the physical form of the bedug.

**Table 3**. Identification of Mathematical Elements in the Physical Form of the Bedug

| Part of the Bedug | Mathematical Representation | Related Concepts |
|---|---|---|
| Bedug Cover (Membrane) | Circle at the base of a cylinder | Area of a circle, circumference, radius, diameter |
| Cylinder body (lateral surface) | Cylinder lateral surface | Lateral surface area, total surface area of the cylinder |
| Internal volume of the drum | Volume of a cylinder | Volume of the cylinder; connection to science (acoustics/echo) |
| Material requirements | Applications of Area and Volume | Mathematical Connections to Everyday Life |

The patterns of performer formations in the Rampak Bedug performance—including straight lines, circles, and triangular arrangements—also reflect geometric concepts such as parallel lines, regular spacing, symmetry, and angles. However, in this study, the element of performer formations is supplementary and not the primary context of the test instrument, given that the focus of the research material is curved-sided three-dimensional shapes (cylinders).

### 3.6 Discussion: Integration of Findings

The quantitative finding—a significant improvement in mathematical connection skills (Paired Sample t-Test: Sig. $< 0.001$; mean N-Gain = 0.7656, high category)—is substantively explained by the qualitative data. Students' active engagement in observing, investigating, and connecting the bedug to mathematical concepts during PBL sessions created the cognitive processes necessary for building mathematical connections (NCTM, 2000). Structured worksheet activities provided students with facilitated opportunities to discover these connections through exploration rather than direct instruction.

These findings are consistent with and extend existing research. Kusuma et al. (2025) reported that ethnomathematics-based PBL is effective in developing mathematical connection skills; this study provides empirical confirmation within the specific context of Rampak Bedug. Rodríguez-Nieto et al. (2025)

demonstrated the potential of ethnomathematical connections in pre-service teacher education; this study extends that evidence to classroom practice with eighth-grade students. The identification of mathematical elements in Rampak Bedug by Ramadan and Astuti (2023) is confirmed and operationalized here through a comprehensive learning intervention with measurable outcomes.

The finding that 95% of students met the minimum competency standard (80) indicates that the learning intervention was broadly effective for the majority of students. However, the BTA analysis (only 45% achieved the higher BTA standard of 93) suggests there is still significant room for improvement, particularly for students who require more intensive support in integrating multiple mathematical concepts simultaneously.

Students' positive responses provide qualitative confirmation of the quantitative improvements. Students' descriptions of enhanced conceptual understanding and engagement are consistent with D'Ambrosio's (2001) theoretical proposition that contextualizing mathematics within a familiar cultural framework enhances the meaningfulness of learning. This also resonates with the findings of the meta-analysis by Pratama and Yelken (2024) that ethnomathematics-based learning effectively improves mathematical literacy by anchoring abstract concepts in cultural and real-life contexts.

## IV. CONCLUSION

This study demonstrates that ethnomathematics-based mathematics learning through Rampak Bedug, implemented using the PBL model, was successfully carried out over six sessions with active student engagement. The instruction resulted in a statistically significant and practically meaningful improvement in students' mathematical connection skills (mean N-Gain = 0.7656, high category; 95% achievement of the minimum competency standard). Students' overall response was positive, with the Rampak Bedug context making mathematical concepts more concrete, easier to understand, and engaging.

Qualitative findings elaborated on and confirmed the quantitative results: high-ability students demonstrated rich connections between concepts, while students of moderate and low ability showed basic connections that could be further developed. All students connected the concept of cylinders to at least one other academic discipline and to real-life applications, indicating that the ethnomathematics approach effectively supports the development of all three NCTM indicators of mathematical connections.

These findings contribute to the growing body of evidence for ethnomathematics-based learning and offer a practical model for integrating local cultural heritage into formal mathematics education. Future research is recommended to use a control group design, expand the study to more schools, explore other cultural contexts in Banten (Debus, Pencak Silat, traditional crafts), and extend to other mathematical topics. Teachers are advised to implement ethnomathematics-based learning with differentiated scaffolding, particularly for students who struggle with calculations involving the value of $\pi$ and multi-concept integration.

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