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# Integrating Ethnomathematics in Learning to Reduce Students' Cognitive Load

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***Abstract***

This study aims to describe the implementation of ethnomathematics-based learning in reducing students' cognitive load on the topic of similarity and congruence. Conducted through classroom action research involving ninth-grade students in a junior high school in Yogyakarta, the study consisted of two cycles. Each cycle included planning, implementation, observation, and reflection stages. The learning integrated cultural elements from local heritage sites—Ratu Boko Temple for similarity and Vredeburg Fort Museum for congruence—to provide meaningful and contextual learning experiences. Data were collected through observations, tests, and cognitive load questionnaires. The results showed a significant decrease in students' cognitive load, from an average score of 7.5 (difficult) in the pre-cycle to 6.0 (moderate) in the first cycle and 2.6 (easy) in the second cycle. These findings indicate that learning based on ethnomathematics not only helps in reducing cognitive load but also enhances student engagement and conceptual understanding. The approach aligns with Cognitive Load Theory by minimizing extraneous load and promoting germane load, making mathematical learning more accessible and relevant to students' cultural backgrounds.

***Keywords:*** *Ethnomathematics, Cognitive Load; Similarity; Congruence; Contextual Learning*

## *Introduction*

Indonesian education is currently faced with fundamental problems that include issues of educators, students, learning, and the quality of education (Angga & Muhtar, 2022). This shows that learning is the focus of attention and criticism in an effort to improve the quality of education. The learning process has always been a separate position to continue to innovate in it. However, in reality, learning practices tend to still use conventional systems that have been used for generations in the world of education (Fahrudin et al., 2021). The conventional learning system is still used almost every time the teaching process is carried out, especially in the lower level education system. Conventional learning systems are known to be uninnovative in learning (Magdalena, 2018). The approach used in learning affects the learning outcomes of learning subjects. Both conventional and modern learning approaches are very influential in creating effective and efficient learning. Therefore, the use of a learning approach needs to be continuously developed by teachers so that the process of exchanging information in learning becomes more effective in achieving learning objectives (Dewi, 2018).

The conventional approach makes the learning process more boring, and students are only active in taking notes. Students taught with conventional methods have lower learning outcomes. The conventional method used tends to make students passive and less engaged in the learning process, which can lead to boredom and a lack of motivation to learn (Perangin-Angin, 2020). As a result, students will not be stimulated to engage in more complex thinking processes, causing the cognitive load that is formed to vary depending on each individual's ability. Moreover, with the conventional learning approach, teachers will find it difficult to gauge students' understanding levels during the learning process (Tambak, 2014). This is certainly due to the fact that only the teacher is active in the learning process. Therefore, it is important to involve students in the learning process. Students who actively participate in learning will make the process of measuring success easier.

Along with the development of all aspects of life, including in the field of education, there have been many innovations in mathematics learning. The approach to learning has begun to continuously evolve by involving students in the learning process (Abdullah, 2017). This is because true learning is not just about transferring knowledge, but also about applying the development of students' abilities (Prasetyo, 2021). Learning that involves students will show that the learning is more meaningful, because the essence of learning is the activity within it.

A variety of innovative instructional approaches have been proposed to enhance the effectiveness and efficiency of the learning process. It is essential to consider how students process the instructional content and the cognitive load involved in that process (Paas & Sweller, 2014). These considerations are encapsulated in a theoretical framework known as Cognitive Load Theory. This theory provides insights into students' cognitive processes, enabling educators to design instructional materials that are appropriately aligned with learners' cognitive capacities, thereby optimising the learning experience. Effective management of cognitive load can reduce the likelihood of learning difficulties (Paas et al., 2016). Cognitive Load Theory offers a robust framework for explaining empirical evidence related to the enhancement of students' learning outcomes in mathematics (Center for Education Statistic and Evaluation, 2017). Cognitive load has been shown to influence student performance, particularly in terms of their problem-solving abilities during mathematics instruction (Gupta & Zheng, 2020).

Cognitive Load Theory distinguishes three types of cognitive load: (1) Intrinsic Load, which pertains to the inherent complexity of the material being learned and is a characteristic of the task itself (Sweller, 2010). In the context of mathematics education, intrinsic load may be influenced by the level of difficulty of the mathematical concepts being taught. (2) Extraneous Load, which arises from the manner in which information or instructional content is presented (Sweller, 2011). Inefficient or unclear instruction can increase extraneous load, thereby hindering the learning process. Poorly designed materials or unnecessary distractions are typical examples of high extraneous load. (3) Germane Load, which refers to the cognitive effort that directly contributes to learning and the development of schemas. Germane load is considered beneficial, as it supports the understanding and integration of new information into existing cognitive structures (Kirschner et al., 2018). Cognitive Load Theory thus offers an effective framework for optimising the learning process by minimising unnecessary cognitive load and enhancing the efficient use of working memory.

The complexity of mathematical content can increase students' cognitive load (Nari et al., 2023), making it more difficult for them to process and comprehend the information presented. Consequently, it is essential for teachers to consider the importance of simplifying information through the presentation of material within contexts that are both relevant and familiar to students. Instructional approaches that not only manage cognitive load but also provide meaningful contexts are therefore crucial. One such approach is ethnomathematics, which aligns mathematical concepts with students' cultural experiences. The integration of ethnomathematics supports the principles of Cognitive Load Theory by offering culturally relevant contexts, thereby enhancing the meaningfulness and comprehensibility of learning. For example, exploring geometric shapes found in traditional architectural forms can serve as a means to teach geometric concepts grounded in students' real-life experiences. This approach can also facilitate their understanding of higher-level geometric thinking (Laukum et al., 2024; Yanti et al., 2024).

Ethnomathematics is a field of study that explores the relationship between mathematics and culture (Rawani & Fitra, 2022). The term was first introduced by Ubiratan D'Ambrosio in the 1980s and encompasses the ways in which specific cultural groups understand, express, and utilise mathematical concepts in their everyday lives. By integrating ethnomathematics into instruction, mathematics education can become more contextualised and meaningful for students (d'Ambrósio, 2006). Through ethnomathematics, students are able to grasp mathematical concepts in a more concrete and meaningful manner (Septiani, 2024), which in turn helps to reduce the cognitive load often associated with the high level of abstraction in mathematics learning. This approach is closely aligned with the aims of Cognitive Load Theory, which seeks to optimise learning processes by considering the limitations of students' working memory capacity.

Indonesia possesses a rich diversity of cultural artefacts that can serve as valuable resources for mathematics education (Ansori & Iskandar, 2023). Among these are the Ratu Boko Palace Temple and the Vredeburg Fort Museum, two cultural heritage sites that hold significant historical and geometrical value, making them highly relevant for integration into mathematics learning. The architectural structures, symmetrical patterns, and design elements of these sites reflect principles of similarity and congruence that can be incorporated into instruction. This study implements a learning approach based on the ethnomathematical context of the Ratu Boko Palace Temple and the Vredeburg Fort Museum to facilitate instruction on similarity and congruence, with the aim of reducing students' cognitive load.

## *Methods*

This study is a Classroom Action Research (CAR) conducted as a strategy to address challenges in mathematics learning, specifically in reducing students' cognitive load. The primary focus of this research is to describe how ethnomathematics-based instruction can contribute to lowering students' cognitive load in understanding the topics of similarity and congruence.

The research was conducted in a Year IX class at a state junior high school (SMP Negeri) in Yogyakarta during the first semester of the 2024/2025 academic year, from 1 October to 30 November 2024. The research subjects consisted of all 32 students in one Year IX class. The sample was selected purposively, as this class was under the guidance of the teacher-researcher and had been identified as experiencing difficulties related to high cognitive load in understanding certain mathematical concepts.

This study is a classroom action research (CAR) conducted through several cycles. Each cycle consists of four stages: planning, implementation of action, observation, and reflection. Every action in the cycle is designed to reduce students' cognitive load. The research proceeds to the next cycle if there is no increase in the average (mean) student learning outcomes. Conversely, if there is a significant improvement, the action is considered successful and the cycle is terminated.

The learning materials in this study include similarity and congruence. The topic of similarity is taught using an ethnomathematics approach with cultural context from Ratu Boko Palace Temple. Meanwhile, the topic of congruence is presented using the cultural context of Fort Vredeburg Museum.

Data were collected through observation, testing, and documentation. Observations were used to record the implementation of the ethnomathematics-based learning process and students' active participation during instruction. Tests were employed to assess students' perceived cognitive load related to the topics being taught. These tests consisted of open-ended questions accompanied by a cognitive load questionnaire administered at three stages: before the intervention (pre-test), after the first cycle (post-test 1), and after the second cycle (post-test 2).

The cognitive load questionnaire used a numerical scale from 1 to 9, with 1 indicating that the item was extremely easy and 9 indicating that it was extremely difficult. Students were asked to rate the difficulty level of the questions by circling a number on the scale. The scores from the questionnaire were used as indicators of the cognitive load experienced by students in understanding the material.

Documentation was used to support the data collected, including samples of students' work, photographs of learning activities, and reflection notes recorded throughout the intervention. All research instruments were validated by experts to ensure that each measured aspect aligned with the research objective, namely, to reduce students' cognitive load.

The data were analysed using descriptive quantitative methods. Analysis focused on students' cognitive load questionnaire scores from the pre-test to post-test 2. Changes in the mean scores were used to determine whether a reduction in cognitive load occurred following the implementation of the ethnomathematics-based instruction. The mean score was calculated using the following formula:

$$Mean = \frac{Total\ Score}{Number\ Of\ Scores}$$

The results of this analysis served as the basis for drawing conclusions about the effectiveness of ethnomathematics-based instruction in reducing students' cognitive load in the topics of similarity and congruence.

## *Results*

### Ethnomathematics of Ratu Boko Palace Temple in the Topic of Similarity

The Ratu Boko Palace Temple, as depicted in the figure, is a historical site that contains numerous mathematical elements, including the concept of similarity, which can be identified through the structural design of its architecture.

Figure 1. Ratu Boko Palace Temple

The following presents an identification of ethnomathematical elements related to the topic of similarity found in the Ratu Boko Palace Temple:

1. Similarity in the Staircase

The staircase at Ratu Boko Temple exhibits a symmetrical geometric pattern. Each step has similar dimensions, reflecting the principle of similarity in the form of rectangles or trapezoids. This demonstrates consistent proportional calculations to maintain both balance and aesthetic appeal.

2. Similarity in the Main Gate

The main gate of Ratu Boko Temple consists of several symmetrical sections. Each part on the left and right sides appears to have comparable size and shape, illustrating the principle of similarity. This structure serves as an effective learning medium for understanding the comparison of lengths of congruent sides.

3. Pattern of Tiered Structures

The tiered buildings at the site follow a modular pattern, where each level maintains structural similarity but with proportionally different sizes. This architectural feature can be used to explore the concept of similarity ratios.

4. Use of Symmetry

The building structures also display symmetrical properties that support the concept of similarity. These symmetrical aspects can further be explained to introduce geometric concepts such as reflection and translation.

Through an ethnomathematical approach, these elements serve as valuable learning resources in mathematics education, integrating local culture with the geometric concept of similarity.

**Ethnomathematics of Vredeburg Fort Museum in the Topic of Congruence**

The ethnomathematical exploration of the Vredeburg Fort Museum focuses on the topic of congruence. The fort itself is shaped like a rectangular prism, with each corner featuring a pentagonal prism structure. When viewed from above, the base of Vredeburg Fort forms a square, with each of its four corners occupied by a regular pentagon. These pentagonal structures are congruent, illustrating uniformity in shape and size, making them an ideal context for studying the concept of congruence in geometry.

Figure 2. An Aerial View of Fort Vredeburg

When viewed from the front, there is a rectangular-shaped building which functions as the entrance ticket booth.

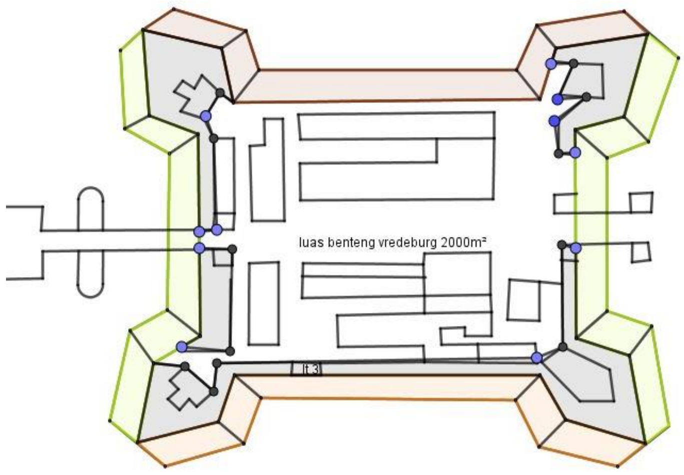


Figure 3. A Sketch of Fort Vredeburg from Above

Congruence in This Sketch Includes:

1. Pentagonal Shapes at Each Corner

The four bastions located at each corner of Fort Vredeburg share identical shapes and dimensions. These bastions are congruent structures, as they possess equal angles and side lengths.

2. Congruence in Building Structures

The buildings within the fort also exhibit similarity in their basic design, reflecting uniform proportionality and consistent architectural patterns.

The following image presents a frontal cross-sectional view of the Fort Vredeburg Museum.


Figure 4. Fort Vredeburg from the Front

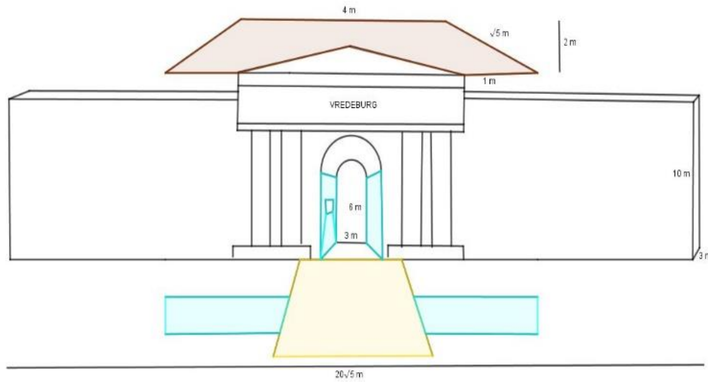


Figure 5. A Sketch of Fort Vredeburg from the Front

Congruence in This Image Includes:

1. Pillars at the Entrance

The entrance pillars at the front of the building appear symmetrical and share similar shapes. These pillars are examples of congruent figures, as they are identical in both size and form, indicating that they possess equal dimensions and shapes.

2. Supports on the Fence

The supporting elements of the front fence also exhibit congruence. The small triangular shapes at the front of the structure can be compared with those along the sloped sections. All these triangles have corresponding angles and sides of equal length, demonstrating congruent geometric properties.

**Pre-Cycle Phase**

Teachers need to consider students' prior knowledge, their ability to grasp mathematical concepts, and provide appropriate support throughout the learning process in order to manage students' cognitive load effectively. In the pre-cycle phase of this study, observations were conducted to identify the level of students' cognitive load.

The observation results indicated that students experienced difficulties in understanding the concepts of congruence and similarity. This was evident from the high number of information elements they were required to process simultaneously, which contributed to an increase in extraneous cognitive load. In addition, the limited connection between the learning material and culturally familiar contexts for students further contributed to a higher intrinsic cognitive load.

The following presents the cognitive load test administered during the pre-cycle phase.

Table 1. Results of the Pre-Cycle Cognitive Load Test

| | | **Very, very easy ------------------------------------------------ Very, very difficult** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Frequency** | Question 1 | 0 | | | 8 | | | 21 | | |
| | Question 2 | 0 | | | 4 | | | 25 | | |
| **Mean** | | | | | | | | 7,5 | difficult | |

As part of data collection, a pretest was also conducted to analyse the extent to which the complexity of the material affects students' working memory capacity. For both the first and second questions, the students' cognitive load ranged from 7 to 9 (Difficult). The average cognitive load was calculated to be 7.5 (Difficult). The analysis of the pretest results indicates that the majority of students faced difficulties in integrating relevant information elements with mathematical concepts. This reinforces the initial finding that their cognitive load at this stage was very high.

The primary factor identified during this pre-cycle phase was the lack of learning strategies that could reduce extraneous cognitive load, such as ethnomathematics-based learning, which could connect abstract concepts with students' cultural experiences. This highlights the need for learning interventions based on local cultural contexts, such as the Vredeburg Fort Museum and Ratu Boko Palace Temple, to help manage and reduce students' cognitive load.

**First-Cycle Phase**

The first cycle of this study focuses on the implementation of the concept of similarity, which was taught at the Ratu Boko Palace Temple, a historical site rich in cultural and geometric significance that serves as a relevant learning object. In this cycle, students were expected to better understand the concept of congruence, reduce the cognitive load that often arises in mathematics learning, and become more connected to the material being taught.

In the first cycle, the learning process was conducted in several stages. Each stage aimed to identify issues, design solutions, implement the learning process, and evaluate the outcomes. This process was repeated within the cycle to optimise the learning experience.

Planning began with the selection of the concept of similarity to be taught. As an initial step, the lesson planning involved linking the concept of similarity to real-world objects surrounding the students, specifically at the Ratu Boko Palace Temple. The geometric patterns found in the temple's gateway, which exhibit symmetry, shape similarity, and proportionality, could be used to explain the concept of congruence.

The implementation of learning involved observing images of the Ratu Boko Palace Temple gateway to study the various buildings and artefacts found there. For these artefacts, students were asked to observe the structures and identify any geometric patterns present. The teacher provided instructions to identify objects that were similar in shape and size, and explained how these patterns could be related to the concept of similarity. Students were also tasked with drawing or modelling a building or part of the temple that they found to exhibit geometric patterns of similarity. In this way, students not only learned the concept theoretically but also gained practical experience through direct observation and creative activities.

During the learning process, observations were made regarding how students interacted with the material. This involved monitoring how students understood the concept of similarity and how they connected it with objects in their surroundings. Observations also included how students interacted with the teacher and their peers during discussions of the findings they made during their observations. Data collected from these observations were used to assess the extent to which the ethnomathematics-based learning approach helped reduce the students' cognitive load.

After the learning process, an evaluation was conducted to assess how well students understood the material taught and whether the ethnomathematics approach helped them reduce cognitive load. Evaluation was carried out through tests or quizzes measuring students' understanding of the concept of congruence, as well as a cognitive load questionnaire. Additionally, a reflection was performed to evaluate how the learning process unfolded, what worked well, and what needed improvement in the next cycle.

Table 2. Results of the Cognitive Load Test in Cycle 1

<table>
<tr><td colspan="11">Very, very easy ------------------------------------------------- Very, very difficult</td></tr>
<tr><td></td><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td rowspan="2">Frequency</td><td>Question 1</td><td colspan="3">4</td><td colspan="3">12</td><td colspan="3">13</td></tr>
<tr><td>Question 2</td><td colspan="3">1</td><td colspan="3">14</td><td colspan="3">14</td></tr>
<tr><td>Mean</td><td colspan="10">6 Moderate</td></tr>
</table>

Based on the table above, many students experienced a reduction in cognitive load. The mode of the cognitive load score for the first question was in the range of 7-9 (Difficult), but it decreased compared to the pre-cycle results. The mode of the cognitive load score for the second question was in the range of 4-6 (Moderate) and 7-9 (Difficult). These results also show a reduction in cognitive load compared to the pre-cycle results. The average cognitive load score was 6 (Moderate), showing a decrease from the pre-cycle result of 7.5 (Difficult).

Cycle 1 showed that students who participated in the ethnomathematics-based learning using the Ratu Boko Palace Temple for the topic of similarity were able to identify similar objects within the temple buildings and understood that these objects had proportional shapes and sizes, even though they might differ in position or orientation. By using real-world examples from their surroundings, students found it easier to grasp abstract mathematical concepts. Students also demonstrated the ability to draw or represent similar patterns more accurately and creatively. This suggests that ethnomathematics-based learning, which connects the material with local culture, can help students understand mathematical concepts in a more visual and contextual way.

The first cycle of this study indicates that ethnomathematics-based learning using the Ratu Boko Palace Temple for the topic of similarity effectively reduced students' cognitive load. This approach, which links mathematics with local culture, provides a more meaningful learning experience and can increase student engagement in the learning process.

However, this study also highlights the need to provide additional support for students who require more time to understand the concepts being taught. Some students needed more time to comprehend the relationship between the objects they observed in the images of the Ratu Boko Palace Temple and the mathematical concepts being taught. Some students also struggled with accurately drawing or representing geometric patterns. The second cycle of this study will refine and optimise the learning strategies to achieve better results. In the second cycle, sketches of the Vredeburg Fort Museum will also be introduced.

**Second-Cycle Phase**

In the second cycle, students were invited to study the concept of congruence through observation and analysis of the architectural forms at the Vredeburg Fort Museum. By using a visual approach to the fort’s structure, students were able to easily understand that congruence relates to shapes that are similar and have the same size. Students identified these elements, measured the length, width, and height, and determined the dimensions between the shapes to confirm their congruence.

***Langkah 1. Stimulation stimulasi/pemberian rangsangan)***

- Guru membagi siswa menjadi beberapa kelompok yang terdiri 4-5 orang
- Siswa dalam memperhatikan dan mengamati penjelasan yang diberikan guru yang terkait dengan permasalahan yang berkaitan dengan *Menentukan bangun-bangun geometri yang kongruen* pada bidang secara umum
- Siswa dalam kelompok mengamati gambar museum benteng vredeburg yang tamak dari depan dan tampak dari atas untuk *Menentukan bangun-bangun geometri yang kongruen* dalam gambar tersebut

Figure 6. Images Provided to Students During the First Step of Learning

The inclusion of sketches in the second cycle was an effort to assist students who had difficulty identifying the geometric shapes found in the museum. During the learning process, they were able to identify congruence between two buildings with the same basic shape, as well as understand the formulas used to calculate the proportions of length, width, and height in similar shapes. Below are the results of the concept understanding test and the cognitive load test for students in the second cycle.

Table 3. Results of the Cognitive Load Test in Cycle 2

| **Very, very easy ------------------------------------------------- Very, very difficult** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Frequency** | Question 1 | 24 | | | 5 | | | 0 | | |
| | Question 2 | 19 | | | 10 | | | 0 | | |
| **Mean** | 2,6 easy | | | | | | | | | |

Based on the table above, the majority of students experienced a reduction in cognitive load. The mode of the cognitive load score for the first question was in the range of 1-3 (Easy). Similarly, the mode of the cognitive load score for the second question also fell within the range of 1-3 (Easy). These results show a decrease in cognitive load compared to the results from Cycle 1. The average cognitive load score was 2.6 (Easy), a reduction from the pre-cycle result of 6 (Moderate).

One of the most prominent results from Cycle 2 was the reduction in cognitive load for students. No students had a cognitive load in the range of 7-9, indicating that ethnomathematics-based learning was able to reduce students' cognitive load across the board. Ethnomathematics-based learning provided a more tangible and easily understood context for students, as they could directly link mathematical concepts to cultural objects they were familiar with or could observe in person. As a result, students no longer had to grapple with abstract concepts that lacked a clear connection to their everyday experiences.

When students were asked to determine the dimensions and angles between two parts of the museum structure, they not only learned mathematical formulas but also visualised these relationships within a broader context—i.e., within the building structures they were observing. This made it easier for them to remember and understand the concepts, as the cultural context provided a strong background for the mathematical material being taught. Furthermore, the use of visual resources such as sketches of the museum helped students reduce the mental effort required to understand the concept of congruence. This visual learning approach was highly effective in reducing the cognitive load that students often experience when studying complex geometry topics.

Below is a summary of the cognitive load test results from the pre-test, Cycle 1, and Cycle 2.

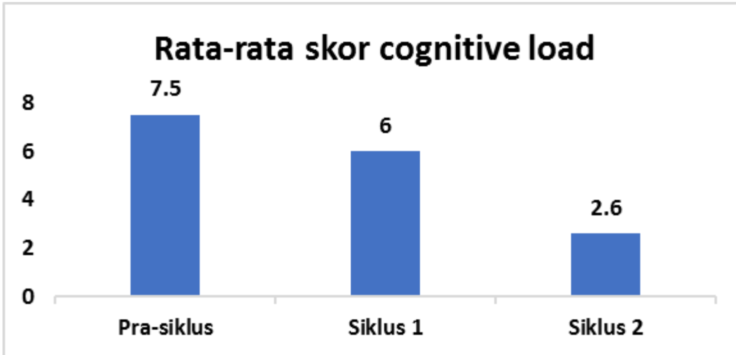


Figure 7. Cognitive Load Test Graph

Both the first and second cycles of this study, which taught the concept of similarity based on ethnomathematics at the Ratu Boko Temple and congruence based on ethnomathematics at the Vredeburg Fort Museum, successfully achieved the set objectives. Through this approach, students were able to reduce their cognitive load, enhance their understanding of the concept of similarity, and connect mathematics learning with local culture. As a result, mathematics learning became not only easier to understand but also more engaging and meaningful for the students.

The use of relevant local resources, such as the Ratu Boko Temple and the Vredeburg Fort Museum, proved effective in improving students' understanding and reducing the difficulties often faced when learning abstract mathematical concepts. Therefore, the implementation of an ethnomathematics approach in mathematics education in schools is highly recommended, especially to reduce students' cognitive load and improve the overall quality of learning.

***Discussion***

The results of this study demonstrate that the implementation of ethnomathematics-based learning significantly reduces students' cognitive load in understanding the topics of Similarity and Congruence. This reduction is evident from the cognitive load questionnaire results, which show that the average score decreased from 7.5 (difficult) in the pre-cycle to 6 (moderate) in the first cycle, and dropped dramatically to 2.6 (easy) in the second cycle. These findings align with the principles of Cognitive Load Theory (CLT), which posits that learning is more effective when unnecessary cognitive load is reduced, and the material is presented in contexts that are familiar to students (Sweller, 2023).

Learning by integrating elements of local culture, such as the Ratu Boko Temple and the Vredeburg Fort Museum, provides a concrete context that makes it easier for students to associate abstract mathematical concepts with their real-life experiences. This strategy is effective in reducing extraneous cognitive load, which arises from poorly designed information delivery (Sweller, 2020). When students can directly observe similarity in the staircase structures or congruence in the bastion shapes, they can process this information more easily without being burdened by overly abstract representations.

The ethnomathematics approach has also proven to increase student engagement and active participation during the learning process. This is supported by observations showing an increase in student activity during group discussions, visual observations of cultural objects, and tasks such as redrawing or representing geometric shapes. This involvement aligns with constructivist theory, which suggests that students learn better when they are actively engaged in constructing their own knowledge

(Iskandar et al., 2022). Moreover, this approach encourages germane cognitive load, which enhances the learning process as it focuses on the formation of knowledge schemas.

The reduction in cognitive load is also influenced by visual presentations, such as sketches in the second cycle, which help students understand building shapes in a more structured way. Visual presentations have been shown to be effective in improving mathematical understanding, especially in geometry, as noted by (Stylianou et al., 2009), who state that visualisation and spatial representation are crucial in building geometric concepts. Furthermore, these findings support previous research indicating that integrating local culture into mathematics education can enhance student understanding and the relevance of the material to their lives (Wulandari et al., 2024).

Overall, this study shows that ethnomathematics-based learning is not only effective in reducing students' cognitive load but also contributes to enhancing the quality of the learning experience. By relating mathematics to the context of local culture, learning becomes more contextual, meaningful, and enjoyable for students.

## *Conclusion*

This study concludes that ethnomathematics-based mathematics learning is effective in reducing students' cognitive load in the topics of Similarity and Congruence. The integration of local cultural contexts through real-world objects, such as the Ratu Boko Temple and the Vredeburg Fort Museum, provides a more meaningful, contextual, and easily understood learning experience for students. The results from the cognitive load questionnaire show a significant reduction from the pre-cycle to the second cycle, shifting from the "difficult" category to "easy."

The application of the ethnomathematics approach also enhances active student engagement in the learning process and encourages the understanding of mathematical concepts through visual and contextual activities. This strategy supports the principles of Cognitive Load Theory by reducing extraneous cognitive load and increasing germane load, which plays a role in the formation of students' understanding schemes.

The implications of this study suggest that mathematics teachers should utilise local cultural richness as a contextual learning resource to optimise students' thinking processes. Ethnomathematics-based learning not only enriches mathematical understanding but also fosters students' appreciation for their local culture.

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## *Declarations*

| | | |
|---|---|---|
| Author Contribution | : | Author 1: Conceptualization, Writing - Original Draft, Formal Analysis, Editing, and Visualization.<br>Author 2: Methodology and Supervision.<br>Author 3: Validation and Reviewing |
| Funding Statement | : | No funding. |
| Conflict of Interest | : | The authors declare no conflict of interest. |

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