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Mathematics in the Tradition of Nusantara Architecture: An Effort to Improve Students' Problem-Solving Skills

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ABSTRACT

Previous research has explored students' problem-solving abilities, yet few studies have incorporated elements of Nusantara architecture into the mathematics learning process. This study aims to examine the changes in students' problem-solving skills following the implementation of Nusantara architecture-based learning in the topic of number patterns. This approach is operationalized through the utilization of carving motifs, symmetrical structures of traditional buildings, and construction rhythms as concrete representations of number pattern concepts. The research employed a one-group pretest–posttest design, involving 33 eighth-grade students from SMP Negeri 7 Bandar Lampung as participants. The research instruments consisted of a problem-solving ability test and a student response questionnaire, while the learning process was conducted over four meetings. Because the data did not meet the assumption of normality, the analysis was conducted using the Wilcoxon Signed Rank Test and N-gain calculations to determine the magnitude of improvement in learning outcomes. The results of the analysis showed a significance value of $0.000 < 0.05$, indicating a significant difference between the scores before and after the treatment. The N-gain value of 0.7700 falls into the high category, indicating that Nusantara architecture–based learning is able to improve students' mathematical problem-solving abilities. In addition, the questionnaire results showed that most students gave positive responses to the implementation of this learning approach. Overall, Nusantara architecture–based learning has been proven effective in strengthening students' understanding of mathematical concepts and providing a more contextual, creative, and culturally grounded learning experience.

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Introduction

Mathematics is often considered an abstract field of study and difficult for students to understand because it lacks connections to the real world. However, in fact, mathematics is present everywhere in many aspects of life, and mathematical ideas can be found in various cultural contexts, such as in traditional Nusantara architecture (Dirma et al., 2024). The development of mathematics cannot be separated from the dynamics of human culture, which continuously change over time. This is reflected in various ancestral heritage artifacts that demonstrate the application of mathematical concepts in their daily lives. Each society has a different cultural background; therefore, perspectives and applications of mathematical concepts vary according to their respective cultural contexts. For example, spatial arrangements in houses often use certain number-based patterns, such as carefully calculated divisions of space for core family members and guests (Mailani et al., 2024).

Nusantara architecture contains various numerical regularities that can be represented as number patterns, such as arithmetic sequences, geometric sequences, and special number patterns. These regularities can be observed in the arrangement of traditional architectural elements, such as the constant increase in the number of stupas at Borobudur Temple, the brick arrangements in Balinese gates, the ventilation patterns of Toraja houses, and the sizes of Dayak floorboards that form arithmetic sequences. Similar findings have also been reported by ethnomathematics studies, which have identified patterns of regularity and geometry in various forms of traditional Indonesian architecture, such as triangular and trapezoidal patterns, as well as spatial proportions in Komering houses (Agustian & Sastrawati, 2025), as well as geometric forms found in the Madurese traditional house known as "tanean lanjang" (Sari et al., 2022). In addition, geometric patterns can be observed in the decreasing diameter of the Kawung batik motif, the repetition of shapes in bamboo weaving, and the pillar structures of Sasak granaries, while square number patterns can be identified in the layered carving arrangements of traditional Javanese gateways. These numerical patterns not only demonstrate mathematical relationships within culture but can also serve as visual and contextual stimuli in learning number patterns.

Through the implementation of Nusantara architecture in mathematics learning, students can relate mathematical concepts to cultural elements and their surrounding environment (Sarwoedi et al., 2018). This contextual approach is believed to be able to enhance students' conceptual understanding, self-confidence, and interest in learning mathematics. Therefore, in the experimental class, the researcher implemented a contextual learning approach. This approach was chosen because it is able to connect learning materials with students' real-life experiences, making the learning process more meaningful. Contextual learning requires students to actively discover mathematical concepts on their own through observation and direct engagement with the surrounding environment. Through this strategy, students are trained to think critically, understand concepts deeply, and solve problems related to everyday life.

According problem-solving ability is an essential and relevant component for addressing various problems. Problem-solving ability in mathematics learning refers to students' ability to solve mathematical problems. Therefore, in the mathematics learning process, it is very important to implement and develop students' mathematical problem-solving abilities. Problem solving is an important part of the mathematics learning process. This skill is regarded as a fundamental ability that needs to be developed and mastered by every student. The importance of problem solving can be seen in its role as the core of mathematics learning, which encompasses various methods, steps, and problem-solving strategies. By solving problems, students actively enhance their knowledge and develop thinking strategies that are useful for finding solutions (Ended & Masalah, 2018).

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Several previous studies have shown that the implementation of Nusantara architecture can enhance students' conceptual understanding and engagement in learning. According to a study conducted by Rakhmawati (2016) the integration of local culture in learning can enhance students' sense of ownership of mathematical material and foster positive attitudes toward the subject. Research conducted by revealed that the design and structure of traditional buildings exhibit patterns of regularity and consistent repetition of measurements. Architectural elements such as the number of pillars, the spacing between supports, and roof shapes exhibit ordered regularities that can be represented through arithmetic and geometric number patterns. The results of this study confirm that learning number pattern concepts can be contextualized through traditional architecture, enabling students to recognize mathematical regularities that are naturally embedded in cultural practices. However, the number of studies that specifically relate to Nusantara architectural traditions is still very limited.

Various previous studies have discussed the implementation of Nusantara architecture and local wisdom in the mathematics learning process. These findings indicate that the integration of cultural values, including traditional architectural forms, is able to create more meaningful learning experiences and strengthen students' understanding of mathematical concepts. Nevertheless, most previous studies remain descriptive in nature, as they merely identify regularities in forms and geometric patterns without directly examining the effectiveness of their implementation in classroom learning. There are still limited studies that comprehensively examine the integration of various forms of Nusantara architecture in mathematics learning, particularly on number pattern topics related to students' problem-solving abilities. In addition, research that specifically links Nusantara architectural traditions to the improvement of students' mathematical abilities remains very limited.

Therefore, to address this gap, this study implements Nusantara architecture–based contextual learning directly in the topic of number patterns, while also identifying number patterns that emerge in traditional building structures as concrete representations. This study also examines improvements in students' problem-solving abilities using a pretest–posttest design, thereby providing empirical evidence of the effectiveness of traditional architecture in strengthening students' logical, analytical, and systematic thinking skills. This study aims to examine the utilization of Nusantara architectural contexts in teaching number patterns and to investigate how the application of this context influences students' mathematical problem-solving abilities.

Method

Type of Research

This study was conducted at SMP Negeri 24 Bandar Lampung. The study employed a quantitative approach. Theoretically, the quantitative approach was chosen because it provides objective, measurable, and statistically testable data, allowing changes in students' abilities to be clearly identified based on numerical evidence (Creswell, 2018). This approach enables researchers to examine cause-and-effect relationships through statistical analysis and to empirically confirm the effectiveness of a treatment through evidence-based evaluation (Jack R. Fraenkel, 2009). Pedagogically, the quantitative approach supports evidence-based teaching practices, namely instructional decision-making based on measurable learning outcome data rather than assumptions (Hattie, 2009). The study also employed a pre-experimental design, namely a one-group pretest–posttest design. This study focuses on the measurement of numerical data to identify changes in students' mathematical problem-solving abilities following the implementation of the treatment (Sugiyono, 2019). In the One-Group Pretest–Posttest research design, the research subjects are given a pretest before the treatment, followed by the implementation of the treatment, and then a posttest to determine the effect of the treatment and compare it with the condition before the treatment (Diana Isrianti & Yulina Ismiyanti, 2025). In addition, this study was also accompanied by a student response questionnaire administered after all learning activities had been completed. The questionnaire aimed to identify students' responses and perceptions toward contextual learning that connects number pattern material with elements of Nusantara architecture. The questionnaire data were used to support the posttest results by assessing students' levels of activeness, motivation, and perceptions of the learning process that had taken place.

Population and Sample

The sample consisted of students aged 14–15 years, comprising 17 male students and 16 female students. The instruments used were pretest–posttest questions on number patterns and a learning style questionnaire. The population consisted of eighth-grade students at SMP Negeri 24 Bandar Lampung, from which a sample of 33 students was selected using purposive sampling. The selection of the class was based on the equivalence of academic ability and the availability of learning time. The research subjects were selected because they were at a grade level relevant to the topic under study and had already learned the basic concepts of number patterns. In addition, the characteristics of the students in this class were considered to represent actual classroom learning conditions, allowing the researcher to obtain a more comprehensive understanding of learning outcome improvements after the implementation of Nusantara architecture–based learning. Through this, the researcher can observe differences in students' mathematics learning outcomes before and after the implementation of Nusantara architecture–based learning.

Instruments

Two methods were used to collect data in this study, namely tests and questionnaires. The test was used to measure students' ability to solve mathematical problems before and after the material was taught (Yuliani et al., 2021). The results of this test indicate the extent to which local wisdom–based learning is able to improve students' abilities to understand problems, formulate solution plans, apply strategies, and reflect on the results obtained in accordance with the steps of problem solving. Because this test is in the form of open-ended questions and requires students to demonstrate their thinking processes and solution strategies in detail, the instrument must be tested for validity and reliability beforehand.

Content validity of the test instrument was obtained through expert judgment, namely a process in which the test items are evaluated by experts who have competence in the relevant field. One commonly used method to calculate content validity is Aiken's V coefficient (Aiken, 1985). Meanwhile, the reliability of the essay-type instrument was tested using inter-rater reliability techniques to ensure consistency of scores across raters; methods and interpretations of inter-rater agreement measures (e.g., Cohen's Kappa, Fleiss' Kappa, or ICC) are discussed by McHugh (2012). The reliability calculation for essay-type test instruments is generally presented in the form of a coefficient indicating the level of consistency or agreement among raters. An instrument is considered reliable if the coefficient value falls within an acceptable category, such as a Kappa or ICC value at a moderate to high level.

In addition to tests, questionnaires were also used in this study to measure students' reactions and perceptions toward learning materials related to Nusantara architectural traditions. The questionnaire measurements used a 1–5 Likert scale as the basis for assessment (Bagis et al., 2025). However, this study employs a four-point Likert scale, which is a

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modification of the five-point Likert scale (Sugengriadi et al., 2024). The purpose of the Likert scale is to identify the tendency of respondents' opinions, whether they agree or disagree. The validity of the questionnaire was established through expert judgment, while its reliability was evaluated using Cronbach's Alpha coefficient. Guidelines regarding the meaning and use of Cronbach's alpha (α) are explained in detail by Tavakol & Dennick (2011), who discuss the interpretation and limitations of this coefficient. A questionnaire is considered to have good reliability when the α value reaches 0.70, as this value indicates adequate internal consistency for quantitative analysis. The following table presents important information regarding the instruments used in this study.

Table 1. Description of the Test

Test	Test Charaacteristics
Question #1. The number of stupas at each level of Borobudur Temple forms the sequence 8, 12, 16, … Determine the formula for the nth term of this sequence.	To measure students' ability to identify arithmetic patterns and determine the formula for the *n*th term, while relating mathematical concepts to local cultural contexts.
Question #2. The wooden roof framework of a traditional Joglo house is arranged in tiers following an odd number pattern (1, 3, 5, …). Determine the total number of wooden beams up to the 15th level.	To measure students' ability to recognize odd number patterns and apply the concept of arithmetic series summation within the context of traditional architecture.

Table 2. Questionnaire Description

Aspect	Indicator	Description	Rating Scale
Interest in Learning	Shows interest in learning mathematics through a cultural context.	Students feel interested and enjoy learning mathematics when it is connected to Nusantara architecture.	1-4
Conceptual Understanding	Feels it is easier to understand number pattern material.	Students perceive that problems presented in a cultural context facilitate their understanding of number pattern concepts.	1-4

Procedures

At the initial stage, the researcher prepared all instruments and materials to be used throughout the study. The activities included the development of instructional materials and student learning activity sheets designed using a Nusantara architecture–based approach. The researcher also designed two data collection instruments, namely a mathematical problem-solving test and a questionnaire to capture students' responses to the implemented learning process. Next, the implementation stage of the learning process began with the administration of a pretest to obtain baseline information regarding students' mathematical problem-solving abilities prior to the treatment. After the pretest, the learning process was conducted by integrating mathematical elements found in Nusantara architectural traditions, particularly number pattern materials observed in traditional houses, temples, and other cultural structures. Finally, at the evaluation stage, students were given a posttest to measure improvements in their mathematical problem-solving abilities after the implementation of the treatment. At the same stage, the researcher also distributed a questionnaire to the students to obtain additional data regarding their impressions, responses, and perceptions of the learning process.

Data Analysis

The problem-solving instrument employed in this study was developed based on Polya's four-stage problem-solving framework (Polya, 2004), which consists of understanding the problem, devising a solution plan, implementing the plan, and reviewing the solution. This framework was selected because it provides a strong cognitive theoretical foundation for explaining how students construct knowledge, organize information, and evaluate problem-solving strategies. Furthermore, this framework is consistent with prior studies in Indonesian mathematics education, which emphasize that problem-solving indicators should be aligned with Polya's stages to ensure the construct validity of the instrument (Sumarmo et al., 2011). This study adopted a quantitative approach, as it is suitable for objectively measuring changes in students' problem-solving abilities through the comparison of pretest and posttest results (Creswell, 2013). Pedagogically, this approach helps teachers obtain measurable evidence of the effectiveness of the implemented learning model (Gay, 2012). Theoretically, the quantitative method is aligned with the experimental design employed in this study, which focuses on the collection of numerical data, objective data analysis, and allows for the replication of research findings across different contexts (Fraenkel, 2011).

The data analysis process in this study included a normality test, non-parametric statistical testing, and questionnaire analysis. The normality test was conducted to determine whether the distribution of students' learning outcome data was normal. The results of the normality test indicated that the data were not normally distributed. Therefore, a non-parametric test, namely the Wilcoxon Signed-Rank Test, was employed to examine differences between the pretest and posttest scores, while N-Gain analysis was used to determine the improvement in students' learning outcomes. In addition, a questionnaire was administered to explore students' responses to the implementation of the learning model. A detailed description of the one-group pretest–posttest design is presented in Table 3.

Table 3. *one group pretest posttest design*

Class	Pretest	Treatment	Posttest
Experimental	O_1	X	O_2

Notes:
X: Treatment administered to the experimental class
O_1: Pretest (test conducted before the treatment)
O_2: Posttest (test conducted after the treatment)

In this study, N-gain analysis was used to determine the improvement in students' abilities after the treatment was administered. The formula for calculating N-gain according to Hake (1998) is presented as follows:

$$N - gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

The N-gain results were then categorized based on the following criteria:

Table 4. N-Gain Criteria

N-gain Value	Category
$g \geq 0.70$	High
$0.30 < g \leq 0.70$	Moderate
$g < 0.30$	Low

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Table 4 presents the classification of N-gain values used to assess the effectiveness of improvements in students' learning outcomes. The N-gain value is obtained by comparing the difference between pretest and posttest scores with the maximum possible score. When the N-gain value is $g \geq 0.70$, the improvement is classified as high; when it falls within the range of $0.30 < g < 0.70$, the improvement is considered moderate; and when $g < 0.30$, the improvement is categorized as low. This classification serves to determine the level of success of the learning process in enhancing students' understanding.

Research Findings

The pretest and posttest results were analyzed using a normality test, non-parametric testing (Wilcoxon Signed-Rank Test), and questionnaire analysis. The non-parametric test was employed because the data were not normally distributed and to determine whether there was a significant difference between the pretest and posttest scores. This study examined the effect of implementing Nusantara architecture–based mathematics learning on students' problem-solving abilities in number pattern topics. The research subjects consisted of 33 eighth-grade students of SMP Negeri 24 Bandar Lampung, who were selected through purposive sampling and involved in a pre-experimental one-group pretest–posttest design. By connecting number patterns with elements of Nusantara architecture, this design aimed to identify students' problem-solving abilities before and after the learning intervention.

Normality Test Results

The normality test was conducted to determine whether the pretest and posttest data were normally distributed. Data normality was analyzed using the Shapiro–Wilk test, and the results are presented in Table 5.

Table 5. Results of the Normality Test

Data	Statistic	df	Sig.	Statistic (Shapiro Wilk)	df (Shapiro Wilk)	Sig. (Shapiro Wilk)
Pretest Score	0.174	33	0.013	0.901	33	0.006
Posttest Score	0.243	33	0.000	0.835	33	0.000

Based on Table 5, the significance values of the pretest and posttest normality tests were lower than 0.05, indicating that the students' learning outcome data were not normally distributed. Therefore, hypothesis testing was continued using a non-parametric test, namely the Wilcoxon Signed-Rank Test.

Non-Parametric Test Results

The subsequent analysis employed was a non-parametric test, namely the Wilcoxon Signed-Rank Test, which is a non-parametric statistical analysis used to compare two paired conditions, particularly when the data are not normally distributed (Afifah et al., 2025). This test aimed to determine whether there was a significant difference after the implementation of Nusantara architecture–based mathematics learning. The results of this analysis are presented in Figure 1.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between pretest and posttest equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 1. Results of the Wilcoxon Signed-Rank Test)

Based on the results of the non-parametric test (Wilcoxon Signed-Rank Test), the significance value was 0,000 < 0,05. These results indicate that there was a significant difference between students' pretest and posttest scores. In other words, the implementation of mathematics learning based on Nusantara architectural traditions was able to improve students' mathematical problem-solving abilities in number pattern topics.

N-gain Analysis

Descriptive statistical analysis of N-gain was conducted to provide an overall view of the improvement in students' learning outcomes before and after the treatment was administered. The results of the analysis are presented in Table 6.

Table 6. Results of the N-gain Analysis

Variabel	N	Minimum	Maximum	Mean	Std.Deviation
N-gain Score	33	-0.03	1.00	0.7700	0.27217
N-gain Persen	33	-2.86	100.00	76.9953	27.21741

The descriptive analysis results indicate that the average N-gain score was 0.7700, which is equivalent to 76.99% and falls into the high category. This finding demonstrates a significant improvement in students' learning outcomes after the implementation of Nusantara architecture–based learning. On the other hand, the minimum N-gain value was recorded at −0.03. This negative value indicates that a small number of students obtained posttest scores that were lower than their pretest scores. Such a condition may occur in N-gain analysis when a decrease in scores automatically results in a negative value. This decline may be influenced by several factors, such as lack of concentration, carelessness, or decreased motivation when completing the posttest. Nevertheless, this very small negative value does not affect the main conclusion of the study, as the overall improvement in learning outcomes remains in the high category. Therefore, the null hypothesis H_0 is rejected and the alternative hypothesis H_1 is accepted, indicating that Nusantara architecture–based learning is effective in improving students' mathematical problem-solving abilities. The comparison between pretest and posttest results is presented in the following graph to illustrate the improvement in students' learning outcomes after the treatment was administered.

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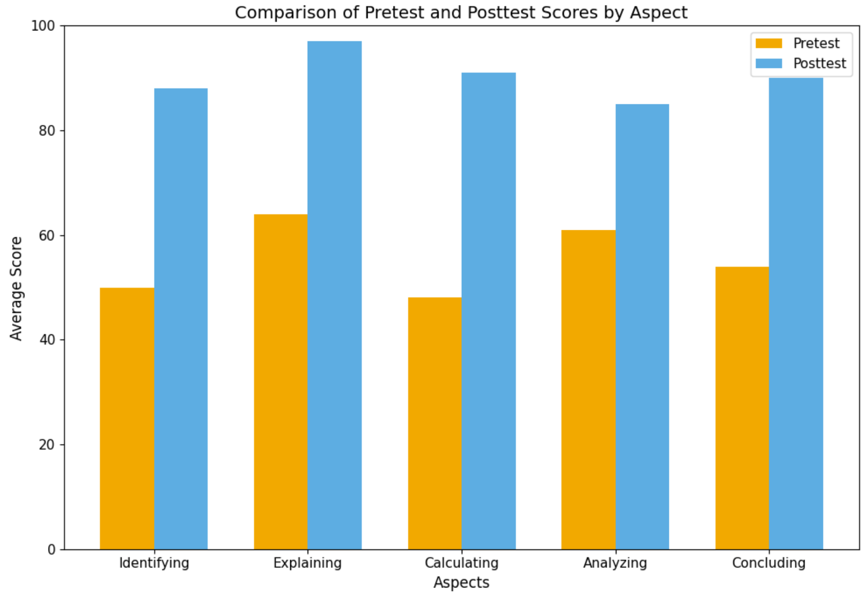

Figure 2. Comparison of Pretest and Posttest Results

Figure 2, the pretest and posttest results show an improvement in students' abilities across all assessed aspects, namely identifying, explaining, calculating, analyzing, and drawing conclusions. In the pretest, students' understanding was still limited, with many errors observed in identifying information, providing explanations, and performing calculations. After the learning process, posttest scores increased in all aspects. Students were able to understand ideas more clearly, perform calculations accurately, analyze patterns or relationships more critically, and draw appropriate conclusions. These findings indicate that the implementation of contextual learning based on Nusantara architecture not only improved students' basic understanding but also enhanced their higher-order thinking skills (HOTS) in mathematics (Hayati & Nidiasari, 2023). Thus, the findings of this study provide additional evidence that learning designed to actively engage students and require deep thinking—such as through real-world contexts or open-ended problems—is effective in developing and enhancing students' higher-order thinking skills in mathematics.

Questionnaire Analysis

This analysis was conducted after the questionnaire data had been collected. The purpose of this analysis was to determine whether the questionnaire results accurately reflected the actual conditions, specifically whether Nusantara architectural traditions helped students understand mathematical concepts. Therefore, the results of this questionnaire analysis are expected to provide an accurate description of students' problem-solving abilities and the effectiveness of the method used in this study.

Based on the descriptive analysis conducted using SPSS on data from 33 respondents, the total mean score was 31.24, with a maximum score of 38 and a minimum score of 19. When compared to the ideal maximum score of 40, this mean score corresponds to a percentage of 78.1%. According to the interpretation criteria (0–25% = very low, 26–50% = low, 51–75% = high, and 76–100% = very high), this result falls into the very high category. The results indicate that the scores for each questionnaire item show that students perceived cultural contexts as helpful in understanding number patterns, increasing learning interest, and facilitating connections between number patterns and real-life situations. These findings are consistent with the purpose of the questionnaire instrument, which was to identify students' perceptual tendencies regarding the extent to which Nusantara architectural traditions supported their mathematical thinking processes, particularly in problem-solving related to number pattern topics. Thus, the questionnaire results indicate that the learning approach incorporating elements of Nusantara architecture was not only well received by students but was also perceived as an effective method for helping them understand mathematical concepts and solve mathematical problems in a more contextual manner.

Discussion

This study was conducted at SMP Negeri 24 Bandar Lampung involving eighth-grade students in the topic of number patterns. The research involved one class as the research subject and employed a pre-experimental design using a one-group pretest–posttest approach. Before the learning activities began, students were administered a pretest to identify their initial abilities. Subsequently, mathematics learning related to number patterns was implemented by integrating elements of Nusantara architecture over two instructional sessions. After the completion of the learning activities, a posttest was administered to examine changes in students' learning outcomes following the treatment.

The study focused on the topic of number patterns and was conducted with eighth-grade students. The learning activities were implemented using a Contextual Teaching and Learning (CTL) approach, which connects mathematical concepts to real-life situations experienced by students in their daily lives. Prior to the learning activities, a pretest was administered to assess students' initial understanding of number pattern concepts. The pretest results indicated that students experienced difficulties in identifying patterns and determining the formulas of number sequences. Subsequently, the learning process was carried out over two instructional sessions by applying various contextual learning activities designed to encourage students to independently discover number pattern concepts through observation. During the learning process, students demonstrated enthusiasm, active participation, and direct engagement in the activities. They conducted observations and attempted to identify relationships among recurring elements within specific patterns. After the completion of the learning activities, a posttest was administered to measure improvements in students' understanding and mathematical problem-solving abilities related to number patterns. The posttest results were then compared with the pretest results to evaluate the effectiveness of the contextual learning approach implemented during the study.

The analysis of using Nusantara architectural contexts indicates that cultural elements can help enhance students' problem-solving abilities by providing visual examples and observable real-world patterns. This aligns with constructivist theory, which emphasizes that understanding develops when learners connect abstract concepts with concrete experiences. These findings are further supported by previous studies that incorporated cultural contexts into mathematics learning (Sudiarta, 2019). The findings indicate that the integration of local cultural contexts into mathematics learning can enhance students' higher-order thinking skills, as learning activities become more closely related to real-life experiences. These results are consistent with previous studies, while offering added value through the more specific utilization of Nusantara architectural contexts in teaching number pattern topics.

Based on the results of the study and the analysis of pretest and posttest scores using the Wilcoxon Signed-Rank Test, there was a significant difference between pretest and posttest scores, with a significance value of $0,000 < 0,05$. The analysis of the average N-gain score was 0,7700, which falls into the high category. These findings confirm that Nusantara architecture–based learning can strongly enhance students' problem-solving abilities. However, the presence

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of negative N-gain values for a small number of students indicates that this improvement was not experienced uniformly by all participants. This variation may reflect differences in students' abilities, motivation, or attentiveness during the posttest. Overall, the effectiveness of Nusantara architecture–based learning is demonstrated by the significant difference between pretest and posttest scores as well as the high average N-gain value of 0,7700. Despite a few students showing negative N-gain scores, the findings still emphasize that this approach is an effective instructional strategy for improving students' mathematics learning outcomes. The effectiveness of this approach is further supported by the questionnaire results. The total mean score of the questionnaire was 31,24 out of a maximum possible score of 40, equivalent to 78.1%, which falls into the very high category. This indicates that students held very positive perceptions of the Nusantara architecture–based learning approach. Overall, these results demonstrate that teaching mathematics through Nusantara architectural traditions has a positive effect on students' problem-solving abilities in number pattern topics. Students showed improved abilities in identifying patterns, understanding number regularities, and applying mathematical knowledge to real-life situations.

To support the analysis of students' questionnaire responses, this study referred to Keller's ARCS motivation model (Attention, Relevance, Confidence, Satisfaction) (Keller, 2010). This theory emphasizes that context-based learning can enhance students' attention and make the material more relevant to them. In addition, Krathwohl's affective domain was used to assess students' emotional engagement and interest during the learning process (Morshead, 1965). Based on the questionnaire results, students perceived the learning process as more engaging and meaningful, which ultimately encouraged them to put greater effort into solving problems.

These findings are consistent with the principles of Contextual Teaching and Learning (CTL), which state that students achieve more significant learning outcomes when they are able to relate lessons to real-world situations (Johnson, 2002). In this study, Nusantara architecture was employed as a practical learning context. Students were encouraged to discover mathematical patterns that reflect arithmetic and geometric sequence concepts by observing traditional architectural elements such as the number of pillars, roof shapes, and decorative patterns. This process promoted critical and systematic thinking as students explored the relationships among mathematical elements within architectural structures. The findings also align with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) framework, which posits that learning integrating arts, culture, and sciences can enhance creativity, collaboration, and problem-solving skills (Bedewy et al., 2024) In the context of this study, Nusantara architecture–based mathematics learning serves as a STEAM practice by connecting mathematics with local arts and culture. Through observation of traditional architectural forms, students not only learned to calculate number patterns but also appreciated the aesthetic and philosophical values embedded in these structures. This approach fosters multidimensional intelligence, encompassing cognitive, affective, and aesthetic aspects.

These results are also supported by previous research by Naufal et al. (2025) which found that cultural traditions in Nusantara architecture strengthen conceptual understanding and mathematical thinking skills. In this study, architectural elements were used to explain the regularity of shapes and geometric patterns, helping students gain a deeper understanding of the relationship between culture and mathematics. This demonstrates that cultural contexts serve as authentic learning resources to enhance mathematical thinking, rather than merely providing illustrative examples. Furthermore, Chen & Ja'Faruddin (2021) highlighted that concepts of projective and symmetrical geometry are embedded in traditional houses, reflecting intuitive human mathematical intelligence. These theories support the argument that elements of Nusantara architecture such as spatial proportions, pillar patterns, and roof shapes exhibit regularities that can be modeled through number patterns. Therefore, teaching students about the relationship between mathematics and Nusantara architecture provides an opportunity to understand that mathematics is not only composed of numbers and symbols but also serves as an expression of culture and art.

Conclusion

Based on the data obtained during the study, there was a significant improvement in students' mathematical problem-solving abilities between the pretest and posttest scores of eighth-grade students at SMP Negeri 24 Bandar Lampung. The Wilcoxon Signed-Rank Test indicated a significance value of 0,000 < 0,05, the average N-gain score reached 0.7700, which falls into the high category, and the total mean questionnaire score was 31.24 out of a maximum score of 40 (76.1%), also categorized as high. These results indicate that students perceived the learning process as engaging, relevant, and helpful in understanding mathematical concepts. The improvement demonstrates that the implementation of Nusantara architecture–based contextual learning is highly effective in enhancing students' abilities to understand and solve problems in number pattern topics. These findings have implications for mathematics teachers, suggesting that integrating local cultural contexts can serve as an effective instructional strategy to improve both conceptual understanding and students' learning motivation. The novelty of this study lies in testing the effectiveness of Nusantara architectural contexts as a mathematics learning medium, rather than merely describing cultural elements. Through observation of the regularities in architectural forms, number patterns, and structural elements, students gained concrete learning experiences that facilitated pattern recognition, concept comprehension, and independent knowledge construction. This mechanism contributes to the effectiveness and meaningfulness of the learning intervention. It is recommended that future research further develop Nusantara architecture–based contextual learning, both in terms of instructional design and the scope of content. This study has several limitations, including a relatively small sample size involving only one class, which restricts the generalizability of the findings. Moreover, other potential factors influencing learning outcomes were not examined. Since this study employed a pre-experimental design, external variables could not be fully controlled; therefore, factors such as classroom conditions, learning environment, and students' initial motivation may have affected the results. Future research should involve additional variables—such as larger participant samples, motivation, interest, and learning styles—to obtain more in-depth and comprehensive findings.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contributions

N. contributed to the development of the research title, formulation of the introductory sentences, and the basic conceptualization of the study. I.D.L. and W.E. actively participated in drafting the manuscript, composing sentences, conducting tests, and performing the research directly at the school. A.Q.M. assisted in manuscript preparation, sourcing references, and supporting the implementation of the treatment at the school. F.N. contributed by providing supporting references without direct involvement in the research or school activities. All authors have read and approved the final version of this manuscript. The percentage contributions for conceptualization, drafting, and revising the article are as follows: N.: 25%, I.D.L.: 25%, W.E.: 25%, A.Q.M.: 15%, and F.N.: 10%.

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Data Availability Statement

The authors declare that the data supporting the findings of this study will be made available by the corresponding author, W.E., upon reasonable request.

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