

Exploring the Cultural Fabric: A Study on Indonesia's Unique Architectural Marvels for Ethno-STEAM Education System

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Abstract – This study delves into the rich cultural tapestry of Indonesia by examining ten distinctive architectural wonders, offering insights into Ethno-STEAM education for university students. The study aims to analyse ten unique architectural marvels, evaluate students' understanding of ethno-STEAM, and explore their perceptions. The findings of our investigation reveal a multifaceted understanding of the architectural heritage of Indonesia, as well as insights into the effectiveness of ethno-STEAM education in fostering holistic learning experiences. Student understanding of Ethno-STEAM has increased significantly after learning. Their perception of ethno-STEAM has a significant positive effect, particularly regarding their cultural perspectives, STEAM understanding, and appreciation of cultural diversity. Guided by the Ethno-STEAM framework, educational interventions are designed to ignite curiosity, nurture creativity, and deepen appreciation for Indonesia's architectural heritage among university students.

Keywords – Architectural marvel, ethno-STEAM education.

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1. Introduction

In terms of architectural diversity and cultural heritage, Indonesia is a vibrant tapestry of history, tradition, and innovation [1]. Its architectural landscape reflects centuries of cultural exchanges, indigenous wisdom, and modern aspirations. Understanding and appreciating these architectural gems enriches one's knowledge and fosters a profound connection to Indonesia's rich cultural heritage.

This paper explores Indonesia's ten most distinctive architectural marvels, presenting an interdisciplinary approach tailored for university students under the Ethno-STEAM (Science, Technology, Engineering, Arts, and Mathematics) education framework [2]. By integrating elements of ethnography, history, engineering, and artistic expression, this study aims to provide students with a holistic understanding of these architectural wonders, transcending mere structural analysis to delve into the socio-cultural contexts that shaped them [3], [4], [5].

Ethno-STEAM is an interdisciplinary approach integrating elements of science, technology, engineering, arts, and mathematics (STEAM) with cultural or ethnographic perspectives [4]. It emphasizes combining traditional knowledge, cultural practices, and indigenous wisdom with modern scientific and technological advancements [6], [7]. Ethno-STEAM seeks to bridge the gap between knowledge systems, promoting diversity, inclusivity, and innovation in education, research, and problem-solving.

This study showcases various architectural masterpieces that result from a unique blend of indigenous wisdom, religious significance, and architectural innovation. Indonesia's architectural heritage is as diverse as it is fascinating, ranging from the ancient wonders of Borobudur and Prambanan temples to the colonial grandeur of Dutch Indies architecture and the contemporary marvels of Jakarta's skyline [1], [8].

Moreover, this study seeks to nurture students' critical thinking, creativity, and cultural appreciation using the Ethno-STEAM approach to explore architectural treasures. Through hands-on activities, discussions, and immersive experiences, students will learn about architectural design and its cultural, environmental, and socio-economic influences. Additionally, it emphasizes the importance of integrating indigenous knowledge and cultural perspectives into STEAM education for a more inclusive learning approach. This bridges science, technology, engineering, arts, mathematics, and ethnography to cultivate conscientious global citizens who value cultural diversity.

This study targets to foster a love for Indonesia's architectural heritage among university students while nurturing their ethno-STEAM competencies. Thus, the study aims to analyze ten unique architectural marvels, evaluate students' understanding of ethno-STEAM, and explore their perceptions. By uncovering the stories behind these architectural wonders, the aim is to inspire a new generation of architects, engineers, artists, and cultural stewards who will continue to cherish and preserve Indonesia's rich architectural legacy for future generations.

2. Methodology

Our Ethno-STEAM exploration of Indonesia's architectural wonders for university students begins with scholarly inquiry and experiential learning [5], [7], [8]. The study deploys a multi-faceted approach, blending literature review, fieldwork, interdisciplinary analysis, and experimental study to investigate ten unique marvels comprehensively.

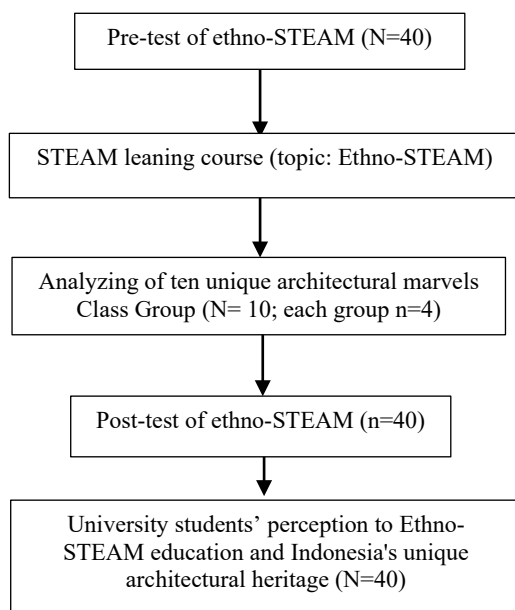


Figure 1. Research process

The process uncovers hidden stories and indigenous wisdom woven into these architectural masterpieces by engaging in immersive site visits, data collection, and analysis. Guided by the Ethno-STEAM framework, our tailored educational interventions aim to ignite curiosity, nurture creativity, and deepen appreciation for Indonesia's architectural heritage [8]. Figure 1 illustrates the research process. The data analysis consists of three ways as listed in Table 1.

Table 1. Illustration of data analysis

Focus of problem	Instrument	Technique of analysis
Analyzing of ten unique architectural marvels	Identification sheet	✓ Descriptive analysis
Student understanding on Ethno-STEAM	Test of ethno-STEAM	✓ Paired <i>t</i> test
University students' perception regarding Ethno-STEAM	A Likert scale questionnaire (Appendix)	✓ Partial Least Square Structural Equation Modelling (PLS-SEM) [9], [10]

3. Results

This section reports three main results of the research: analysis of ten unique architectural marvels, university student understanding on Ethno-STEAM, and their perception regarding Ethno-STEAM.

3.1. Analysis of Ethno-STEAM among the Unique Architectural Marvels

The grouping students analyse ten unique architectural marvels, including *Menara Pinisi*, Bina Nusantara Campus building, *Pertamina* Energy Tower, New Media Tower - Universitas Multimedia Nusantara (UMN), The Regatta Hotel, Bakrie Tower, *Palma Tower*, *Menara Karya*, *Wisma BNI 46*, and The UOB Buana Tower. This section illustrates the following sample results of grouping students' analysis of Ethno-STEAM among unique architectural marvels.



Figure 2. Menara Pinisi, Universitas Negeri Makassar (UNM)

The UNM campus building in South Sulawesi (Figure 2), also known as *Tellu Cappa* (three peaks), is inspired by the *Pinisi* boat, a typical symbol of the Bugis people. It was designed by Yu Sing, and stands tall at 17 floors. It uses the Hyperbolic Paraboloid facade system. At night, the lights on the building's tower twinkle beautifully from the 17th floor, and the 12 different colors represent the number of faculty members on the UNM campus [12], [13].

Students' identification of ethno-STEAM:

- ✓ the Bugis *Pinisi* boat → science
- ✓ standing 17 floors tall and adorned with 12 colored lights → math, technology, & engineering
- ✓ blending local heritage with modern technology → art



Figure 3. The Bina Nusantara (Binus) Campus building

The Binus Campus building is a 22-floor, unique, innovative structure based on the concept of regular zoning. It is environmentally friendly and energy efficient. The building features a checkerboard pattern and large windows to maximize natural lighting. The campus is also equipped with a rainwater storage system that can be used for landscape irrigation and toilets, which helps to address the groundwater crisis [13].

Students' identification of ethno-STEAM:

- ✓ a 22-floor structure → engineering
- ✓ a rainwater storage system → technology
- ✓ energy efficiency concerns → science and math
- ✓ a checkerboard pattern and large windows → art

The third building is *Pertamina* Energy Tower stands at a towering height of 530 meters. The building aims to serve as an energy icon and will utilize all potential sources of renewable energy, including geothermal, water, solar, and gas. To promote sustainability, 55 percent of the land will be dedicated to open green areas, and a rainwater recycling system has been installed [11], [13].

Students' identification of ethno-STEAM:

- ✓ renewable energy sources (i.e. geothermal & solar power) → science and math
- ✓ a rainwater recycling system → technology & engineering
- ✓ blending traditional wisdom with modern practices → art

The fourth building is New Media Tower - Universitas Multimedia Nusantara (UMN). It has a unique eggshell shape with grey highlights from its perforated metal casing. It has been designed with environmentally friendly architecture and high technology, which allows it to save up to 53.25 kilowatt-hours of energy per year per square meter. The building's double-skin facade, which uses aluminum panels, can reduce heat by up to 70 percent and save on air conditioning costs. Additionally, they were constructed using a mixture of super foam and concrete, which helps to reduce heat and muffles sound [13].

- ✓ eggshell-shaped design → art
- ✓ environmentally friendly features and innovative materials (the double-skin facade and porous walls) → science, engineering, technology
- ✓ save up to 53.25 kilowatt-hours of energy per year per square meter → science, math

The fifth building is the Regatta hotel. The complex consists of ten apartment towers, each 24 floors high, and one hotel. Each tower lobby has a unique design according to the name of each tower (such as Dubai et al.). The Regatta Hotel has a very distinctive shape that resembles the letter "O" and has the potential to become a world-class icon [13].

Students' identification of ethno-STEAM:

- ✓ ten apartment towers, each 24 floors high → math, engineering
- ✓ Each tower lobby has a unique design → art, technology
- ✓ a very distinctive shape that resembles the letter "O" → art
- ✓ a world-class icon → engineering

Then, the Bakrie Tower is an A+ grade office building with unique, asymmetrical, and artistic twist-style architecture. It uses dark blue glass that resembles scales, making the facade look exotic with a wide front appearance but slim sides. Designed to become a unique icon in the center of Jakarta, the 48-story building stands 216 meters high and has been twisted three times to form a distinctive silhouette from every angle. The building rotation is clockwise from floors 1 to 17, then turns around from floors 18 to 34, and finally returns clockwise from floors 35 to 48 [13]. Students' identification of ethno-STEAM:

- ✓ a unique, asymmetrical, and artistic twist-style architecture → art
- ✓ dark blue glass that resembles scales → science
- ✓ standing 216 meters high with a distinctive silhouette formed by three clockwise twists → technology, engineering, math.

The next building is the *Palma Tower*. It is a uniquely designed building. The tower's shape is inspired by the letter A, which resembles the Jakarta skyline. The sloping side facade comprises blue glass, while the trapezoidal side in the middle is constructed using black glass with protruding horizontal lines. The design is asymmetrical, with one tower being taller than the others and appearing to lean on the lower tower. The letter A shape represents the most solid and unshakable basic shape, reflecting the modern management concept of a company operating in the plantation sector [13]. Students' identification of ethno-STEAM:

- ✓ a uniquely designed building created by DCM Architects → technology and engineering
- ✓ inspiration from the letter A → art
- ✓ mirroring the Jakarta skyline → math and art
- ✓ asymmetrical design features → math
- sloping blue glass on one side and trapezoidal black glass → science

3.2. Student Understanding on Ethno-STEAM

The concept of understanding is captured from paired *t*-tests among 40 university students. Table 2 depicts the results of this test. Accordingly, the mean of the differences = -40.5, the standard deviation of the differences (SD) = 15.681, the number of paired observations (n) = 40, the degrees of freedom (df)=39, Sig. (2-tailed) = .000. Thus, a statistically significant difference exists between the scores before and after the STEAM learning course (topic: Ethno-STEAM). Thus, university student understanding of Ethno-STEAM has increased significantly after learning. This finding is in line with the study by previous researchers [3], [4].

Table 2. The results of paired *t* test for student understanding of ethno-STEAM

Paired Differences				<i>t</i>	<i>df</i>	Sig. (2-tailed)	
Mean Diff.	SD	SE	95% Conf. Interv. Diff.				
			Lower	Upper			
40.50	15.68	2.48	-45.52	-35.48	-16.33	39	.000*

Note. **p* < .001.

3.3. University Students' Perception Regarding Ethno-STEAM

Figure 4 displays the path model representing university students' perception regarding Ethno-STEAM. Latent variables (represented by ovals) include Ethno-STEAM Perception (as the focal latent variable), Cultural Perspectives, Understanding of STEAM Concepts, and Appreciation of Cultural Diversity. Arrows (paths) indicate the relationships between latent variables and their indicators [9]. Manifest variables (observed indicators) are typically included in the model (such as Code A, B, C) (see Appendix). All the pathways have positive coefficients, *t*-stats, and *p*-values below 0.05. The perception of ethno-STEAM significantly positively affects university students, particularly regarding their cultural perspectives, STEAM understanding, and appreciation of cultural diversity.

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Appendix

Questionnaire of university students' perception regarding Ethno-STEM of ten unique architectural marvels

Code	Item	Likert scale				
		1	2	3	4	5
Cultural Perspectives						
A1	How interested are you in learning about the cultural significance of Indonesia's architectural marvels through Ethno-STEM education?					
A2	To what extent do you believe that integrating cultural perspectives into STEM education enhances your understanding and appreciation of architectural innovation?					
A3	How likely are you to engage in interdisciplinary analysis to understand the cultural fabric of Indonesia through its architectural marvels?					
Understanding of STEAM Concepts						
B1	How important do you					

	believe it is to integrate Ethno-STEM principles into university curriculum to enhance the overall learning experience?					
B2	How important do you consider hands-on exploration and experiential learning in understanding the Ethno-STEM principles behind Indonesia's unique buildings?					
B3	How likely are you to participate in guided tours or workshops focused on exploring the Ethno-STEM aspects of Indonesia's unique buildings?					
B4	In your opinion, how does the fusion of traditional knowledge with modern science and technology in Ethno-STEM education benefit your academic development?					
Appreciation of Cultural Diversity						
C1	To what extent do you believe that studying the architectural heritage of Indonesia fosters a deeper connection with the country's cultural identity?					
C2	In your view, how can Ethno-STEM education contribute to promoting diversity, inclusivity, and innovation in architectural studies and beyond?					
C3	How likely are you to participate in Ethno-STEM educational interventions tailored to exploring Indonesia's unique buildings?					

Note:

- 1 = Not at all interested; Not at all; Very unlikely; Not important at all; Not beneficial at all
- 2 = Slightly interested; Slightly; Unlikely; Slightly important; Slightly beneficial;
- 3 = Moderately interested; Moderately; Neutral; Moderately important;
- 4 = Very interested; Extremely; Likely; Very important; Very beneficial;
- 5 = Extremely interested; Very Extremely; Very likely; Extremely important; Extremely beneficial