ETDC Indonesian Journal of Research and Educational Review
Volume 6, No. 1, 2026, pp 333 - 346
e–ISSN 2809-3682
p–ISSN 2809-7505

https://doi.org/10.51574/ijrer.v6i1.5521

Integrating Pinisi Indigenous Knowledge into Cultural-Based Curricula: An Ethnopedagogical Framework

Ahmad Jabal[1], Irfan[2], Abd. Aziz Ahmad[3], Fajar Aswat[4], Fatwatul Ikhwan[5]
[1, 2, 3, 4, 5] Postgraduate Program, Universitas Negeri Makassar, Indonesia

Article Info

Article history:

Received June 16, 2026
Accepted September 03, 2026
Published September 15, 2026

Keywords:

Cultural-Based Education;
Ethnopedagogy;
Indigenous Knowledge;
Maritime Curriculum Integration;
Pinisi Shipbuilding.

ABSTRACT

Pinisi shipbuilding, executed by the *Panrita Lopi* craftsmen of the Bugis-Makassar people in Tanah Beru, Bulukumba, incorporates sophisticated technical engineering with rich ritual, symbolic, and orally transmitted indigenous knowledge. Although recognized as UNESCO Intangible Cultural Heritage in 2017, its pedagogical dimension within formal educational systems remains systematically under-examined. Grounded in place-based pedagogy and ethnopedagogical theory, this descriptive qualitative study investigates the pedagogical values embedded in *Pinisi* construction and formulates a novel Maritime Ethnopedagogy Integration Model (MEIM) for formal curricula. Data was collected via non-participant observation, semi-structured interviews with 12 purposively selected informants (including 7 master *Panrita Lopi*, 3 community leaders, and 2 local educators), and archival documentation. Data analysis followed Miles and Huberman's interactive model, incorporating double triangulation for trustworthiness. Findings indicate that the *Sawerigading* origin narrative and sequential technical-ritual stages—from determining auspicious days (*anrangang nassabari*) and timber selection to keel-laying, keel-joining (*Annattara*), rib assembly, and launching (*Annyorong Lopi*)—encode critical educational values encompassing environmental stewardship, contextual geometry, cooperative labor (*gotong royong*), and spiritual discipline. To mitigate the intergenerational transmission gap caused by modernizing pressures and external timber sourcing, this study constructs a structural model translating indigenous maritime domains into localized ethnoscience, contextual mathematics, and character education modules. These actionable pathways provide curriculum developers with a scalable framework for place-based educational policy and cultural preservation.

Corresponding Author:

Ahmad Jabal,
Postgraduate Program, Universitas Negeri Makassar, Indonesia
Email: ahmadjabal.240011301008@student.unm.ac.id

1. INTRODUCTION

Indonesia's identity as an archipelagic nation consisting of over 17,000 islands is fundamentally anchored in its maritime heritage (Rochwulaningsih et al., 2019). Central to this heritage is the Pinisi vessel, a traditional wooden sailing ship constructed for

centuries by the Bugis-Makassar people of South Sulawesi (Demmallino et al., 2026; Syafruddin et al., 2024). Beyond serving as a testament to historical seafaring prowess, Pinisi shipbuilding represents an intricate indigenous knowledge system (IKS) incorporating wooden dowel joinery without metal fasteners, precise oral design calculations, and deeply embedded cosmological rituals (David et al., 2025; Nurn et al., 2026). Recognition of its global cultural significance, UNESCO inscribed the "Art of Boatbuilding in South Sulawesi" on the Representative List of the Intangible Cultural Heritage of Humanity in 2017 (Liebner, 2018; Ubertazzi, 2022).

Ethnopedagogy posits that indigenous knowledge systems, local wisdom, and community-based practices constitute legitimate, rich foundational material for formal educational curricula rather than merely peripheral folklore (Sakti et al., 2024; Selasih & Sudarsana, 2018). Concurrently, critical pedagogy of place highlights that anchoring educational content within the specific ecological and cultural realities of a learner's immediate environment fosters civic agency, ecological responsibility, and deep academic engagement (Ajaps & Forh Mbah, 2022; Gutiérrez-Ujaque & Degen, 2024; Yemini et al., 2025). Internationally, place-based ethnoscience integration has been proven to enhance contextual scientific understanding across diverse indigenous settings, from Arctic ecological monitoring in Inuit curricula (Fahrudin & Saputro, 2023; Karsgaard et al., 2024; Muis & Sintang, 2026; Rifa'I et al., 2025) to Polynesian navigational geometry in Hawaiian STEM frameworks (Furuto, 2015). In the Indonesian context, prior research has demonstrated the effectiveness of translating local wisdom into science instruction, such as the environmental conservation practices of the Ammatoa Kajang community (Surtikanti et al., 2017) and ethnoscience learning modules among the Malind community in Papua (Supriyadi & Nurvitasari, 2019). Furthermore, ethnopedagogical approaches have been shown to significantly elevate student engagement, scientific literacy, and cultural self-awareness across secondary education (Rahmawati & Sriyati, 2024).

Despite these advances, existing scholarship on Pinisi shipbuilding has predominantly focused on historical origin narratives, descriptive ethnographic accounts of rituals, or structural engineering specifications (Ramadhani, 2018; Sukardi & Busri, 2024; Wahyuni & Sadik, 2022). While these descriptive studies offer valuable cultural documentation, a critical research gap persists: previous literature has not systematically conceptualized how the technical-ritual stages of Pinisi construction can be transformed into actionable, structured learning modules within formal school curricula. As a result, the transmission of Pinisi indigenous knowledge remains restricted to informal, family-based apprenticeships. Under the pressures of rapid modernization, declining youth craft participation, and a shift toward imported pre-cut timber, this reliance on informal transmission threatens the continuity of this intangible heritage. Bridging this gap requires establishing a formal bridge between traditional shipbuilding craft and school-based learning.

To address this disconnect between indigenous maritime practice and formal education, this study formulates a novelty-driven theoretical synthesis: the Maritime Ethnopedagogy Integration Model (MEIM). By regularly mapping indigenous

knowledge domains directly onto formal curricular subjects—specifically ethnoscience (biology and physics), contextual mathematics, and character education—this study advances place-based education theory into maritime contexts. The investigation is guided by three central research questions:

1. What indigenous knowledge systems and historical narratives govern the practice of Pinisi shipbuilding in Tanah Beru?
2. What specific ethnopedagogical values are embedded within the technical and ritual construction sequence of the Pinisi vessel?
3. How can this indigenous maritime knowledge be regularly integrated into formal culture-based education curriculum?

2. METHOD

This study employed a qualitative descriptive design framed by an ethnopedagogical theoretical lens. A descriptive qualitative design was selected to capture the nuanced, practice-embedded, and orally transmitted nature of indigenous knowledge systems without imposing rigid, pre-determined quantitative variables. Fieldwork was conducted in Tanah Beru, Bonto Bahari Sub-district, Bulukumba Regency, South Sulawesi Province, Indonesia. Located approximately 176 kilometers southeast of Makassar, Tanah Beru serves as the global epicenter of traditional Pinisi shipbuilding, where master craftsmen actively preserve the complete technical-ritual sequence along coastal shipyards (*kalibiseang*).

Informants were selected using purposive sampling based on strict inclusion criteria: (a) minimum of 15 years of active experience in traditional Pinisi construction, (b) verified status as a master craftsman (*Panrita Lopi*) or recognized cultural elder, or (c) active involvement in local curriculum development in Bulukumba. A total of $N = 12$ key informants participated in the study. Detailed demographic and operational profile data are presented in Table 1.

Table 1. Operational Profile of Research Informants (N = 12)

Informant Code	Role / Designation	Age (Years)	Experience (Years)	Primary Knowledge Domain
PL-01 (H. Ulli)	Senior Master Craftsman (*Panrita Lopi*)	64	42	Keel layout, ritual formulae, oral geometry
PL-02	Master Craftsman (*Panrita Lopi*)	58	35	Timber selection, *Annattara* ritual, hull assembly
PL-03	Master Craftsman (*Panrita Lopi*)	52	30	Wooden dowel joinery, rib alignment
PL-04	Craftsman / Boat Builder	45	22	Planking, mast erection (*Apallajareng*)
PL-05	Craftsman / Boat Builder	41	18	Hull shaping, caulking techniques
PL-06	Craftsman / Boat Builder	39	16	Rigging, sail fitting (*Sombala*)
PL-07	Junior Craftsman / Apprentice	28	10	Assistive assembly, timber preparation

Informant Code	Role / Designation	Age (Years)	Experience (Years)	Primary Knowledge Domain
CL-01	Customary Community Leader (*Tokoh Adat*)	68	45	La Galigo epic history, ritual cosmology
CL-02	Local Historian / Cultural Custodian	61	38	Symbolism, lineage of *Panrita Lopi*
CL-03	Shipyard Business Operator	50	25	Timber sourcing dynamics, trade logistics
ED-01	Local Content Curriculum Developer	48	20	Local-content (*Muatan Lokal*) pedagogy
ED-02	Senior Secondary Science Teacher	44	18	Contextual ethnoscience integration

Field data collection was conducted over an 8-month period (November 2025 – June 2026) using three primary instruments:

- Observation Guide: Non-participant field observation protocols were used to record the step-by-step construction sequence, structural joinery, ritual offerings, and spatial arrangements across 4 active shipyards in Tanah Beru. Observations totaled 120 field hours.
- Semi-Structured Interview Schedule: In-depth, audio-recorded interviews (ranging from 45 to 90 minutes per session) were conducted using an interview guide focused on history, cosmological philosophy, oral calculations, and educational value perceptions.
- Documentation Protocol: Systematic collection of photographic archives, field logs, local historical records, and policy documents from the Bulukumba Education and Culture Office.

Formal ethical clearance was obtained from the Institutional Ethics Committee of Postgraduate Program, Universitas Negeri Makassar. Prior to data collection, written informed consent was secured from all 12 participants. For senior informants with limited formal literacy, verbal informed consent was audio-recorded in the presence of a community witness. Participant confidentiality was maintained through code anonymization (PL-01 through ED-02), while historical quotes were used with explicit permission.

Data analysis followed the interactive qualitative analysis model of Miles and Huberman, consisting of data reduction, data display, and conclusion drawing/verification. Methodological rigor and trustworthiness were ensured through double triangulation:

- Data Source Triangulation: Cross-verifying findings across different informant categories (master craftsmen, customary leaders, and educators).
- Methodological Triangulation: Cross-checking observational data against interview transcripts and documentary photographs.

- Member Checking: Key analytical interpretations and ritual translations were presented back to PL-01 and CL-01 in review sessions to eliminate interpretation bias.

3. RESULTS AND DISCUSSION

Results

Origin Narrative, Structural Typology, and Cultural Terminology

The origin of Pinisi shipbuilding is rooted in the epic legend of Sawerigading from the *La Galigo* manuscript. According to oral tradition verified by informant H. Ulli (PL-01) and CL-01, Sawerigading, crown prince of Luwu, built a giant vessel to voyage to China. Upon his return, a violent storm destroyed the vessel of *Tanjung Bira*, fragmenting the ship into three major sections.

Figure 1. Depiction of Sawerigading, the legendary figure associated with the origin of Pinisi

The main keel (*kalabiseang*) washed ashore at Ara, establishing Ara as the center for timber working and structural joinery.

- The hull planking and frame drifted to Lemo-Lemo, designating Lemo-Lemo as the specialists in hull shaping.
- The sails and rigging drifted to Bira, designating Bira as the traditional home of master navigators and captains (*nakhoda*).

This historical narrative underpins a specialized socio-technical division of labor among Bugis-Makassar coastal communities. Over centuries, two primary vessel typologies evolved:

- Pinisi Palari: The classic, sail-powered variant featuring a curved stempost, broad keel, twin lateral rudders (*guling pantara* and *guling tangnga*), and seven sails driven solely by wind energy.
- Pinisi Lambo: The contemporary motorized variant developed since the 1990s, featuring a straight stempost, single central transom rudder, and diesel propulsion

alongside auxiliary sails, primarily utilized for commercial cargo and luxury eco-tourism.

Figure 2. Pinisi Lambo, the motorised variant of the Pinisi vessel

Figure 3. Pinisi Palari, the traditional sail-powered variant of the Pinisi vessel

Glossary of Indigenous Terminology:

- *Panrita Lopi*: Master shipwright possessing both technical mastery and spiritual authority.
- *Kalabiseang*: The main wooden keel, serving as the foundational structural spine of the vessel.
- *Anjang*: Triangular decorative and aerodynamic stem-extension fitted at the bow.
- Sombala: The massive main mainsail, traditionally symbolizing reliance on divine providence.
- *Annattara*: The sacred ritual ceremony performed during the precision joining of keel sections.
- *Ammosi*: The "navel-piercing" ritual marking the spiritual birth of the completed hull.
- *Annyorong Lopi*: The communal launching ceremony hauling the ship into the ocean.

Operationalizing the Construction and Ritual Sequence

Field observation revealed that Pinisi construction is an integrated technical-ritual progression comprising seven sequential stages. Unlike modern naval architecture, which relies on written blueprints and mechanical fasteners, *Panrita Lopi* construct

vessels using body-based oral measurements and wooden dowel joinery. Table 2 details the empirical findings for each stage.

Table 2. Empirical Mapping of Technical-Ritual Stages in Pinisi Construction

Stage & Indigenous Name	Technical Procedures & Tooling	Associated Rituals & Cultural Offerings
Temporal Scheduling *(Anrangang Nassabari)*	Calculation of lunar phase; selection of 5th or 7th day of the construction month based on traditional calendrical systems.	Invocation prayers requesting spiritual alignment; avoidance of inauspicious dates to prevent structural failure at sea.
Timber Selection & Harvesting	Selection of durable hardwoods: Bitti (*Vitex copassus*), Ironwood (*Eusideroxylon zwageri*), and Teak (*Tectona grandis*). Evaluation of grain curvature.	*Appasituju:* Ritual offering to forest spirits requesting permission to fell trees, acknowledging nature's guardianship.
Keel Cutting *(Annakbang Kalabiseang)*	Felling of selected trees; preliminary adzing into rectangular beams. Keel length measured using the master craftsman's footsteps (*fangka*).	Ritual slaughter of a rooster; pouring blood on the cut tree stub to appease nature spirits and protect woodcutters.
Keel-Laying	Alignment of primary keel beams along a precise North-East geographic axis on timber blocks.	Distribution of sweet traditional cakes (*onde-onde*) to workers, symbolizing sweet fortune and harmonious labor relations.
Keel-Joining *(Annattara)*	Chiseling mortise-and-tenon joints to connect forward and aft keel beams; insertion of wooden dowels.	Placement of 4 sacred objects at the joint: Gold (nobility), Iron (strength), Rice (sustenance), Kapok (comfort). Recitation of Islamic prayers.
Rib & Hull Assembly *(Ancana Papan & Apallajareng)*	Planking assembled first, followed by internal rib insertion; drive ~3,000 wooden dowels. Calculation of 2 main mast positions.	Craftsmen maintain silence (*tapa*) during dowel driving; internal structural ribs conceptualized as human ribcage.
Launching Sequence *(Appasili, Ammosi, Annyorong Lopi)*	Hull caulking with bark fibers; placement on coconut-log rollers. Communal hauling using block-and-tackle and manual ropes	*Appasili* (purification overnight); *Ammosi* (center keel drilling/navel-piercing); *Maccera Lopi* (goat sacrifice).

Separation of Descriptive Empirical Findings from Pedagogical Interpretation

To preserve analytical rigor, descriptive empirical data gathered from shipyard observations are maintained separately from theoretical pedagogical interpretations. Empirical observations confirm that *Panrita Lopi* execute hull design without written scale drawings. Keel length dictates all subsequent dimensions through proportional ratio formulae preserved in memory. For instance, hull beam width is calculated as exactly one-third of keel length, while mast height is derived from the sum of beam width and hull depth. Planking is joined edge-to-edge using blind wooden dowels (*pasak*) made of ironwood, expanding upon contact with seawater to form a watertight seal without iron nails.

The symbolic structure of the vessel encodes distinct philosophical systems: the two main masts represent the two declarations of faith (*syahadatain*), while the seven sails represent the seven verses of Surah Al-Fatihah, fusing Islamic theology with Bugis maritime cosmology. The forward keel section is designated as male (*laniang*) and the aft section as female (*baji*); their union during the *Annattara* ceremony signifies marital union and procreation.

Discussion

Critical Synthesis and Comparative Analysis

The empirical findings confirm that Pinisi shipbuilding in Tanah Beru is not merely an archaic handicraft, but a sophisticated indigenous knowledge system (IKS) integrating structural engineering, botanical science, ethnomathematics, and social ethics. Contrasting these findings with global literature highlights the universality of place-based technical wisdom. The oral proportional ratios used by *Panrita Lopi* parallel the traditional Polynesian canoe-building methods documented by Ali (2022), Demmalino et al. (2019), and Furuto (2015), where body-centric measurements substitute for standardized metric tools. Furthermore, the ecological ethics governing timber harvesting (*Appasituju*) closely mirror Native American indigenous forestry principles described by Barnhardt and Kawagley (Ahanonye et al., 2024; Colicol, 2024), where resource extraction requires reciprocal spiritual acknowledgment.

However, while prior Indonesian studies have documented the cultural rituals of Pinisi (Ramadhani, 2018; Sukardi & Busri, 2024; Wahyuni & Sadik, 2022), they have treated boatbuilding as a static historical artifact. This study demonstrates that Pinisi construction functions as a dynamic pedagogical medium. The critical challenge facing this IKS is the severe disruption of informal intergenerational transmission. Field interviews revealed that over 80% of current apprentices in Tanah Beru are over 35 years old, with younger generations migrating toward urban white-collar employment. Additionally, the shift toward importing 85% of timber from external provinces (e.g., Southeast Sulawesi) has severed youth connection to local forest conservation rituals. Informal apprenticeship alone is no longer sufficient to sustain this heritage.

The Maritime Ethnopedagogy Integration Model (MEIM)

The Maritime Ethnopedagogy Integration Model (MEIM) is conceptualized as a strategic response to the systemic disruption in the intergenerational transmission of indigenous maritime knowledge within coastal communities. By bridging the critical nexus between localized heritage and mainstream schooling, MEIM provides a robust operational matrix designed to systematically embed traditional ecological wisdom into contemporary instructional designs. The architecture of this model leverages three interconnected pedagogical pillars: ethnoscience, contextual ethnomathematics, and character education. Through ethnoscience, empirical indigenous practices—such as traditional oceanographic observations, sustainable navigation techniques, and weather forecasting—are analyzed through a scientific lens, cultivating rigorous scientific literacy grounded in local reality. Concurrently, contextual ethnomathematics utilizes

traditional spatial reasoning, vessel construction geometry, and tide-based computational methods to transform abstract mathematical concepts into culturally resonant learning experiences (Payadnya et al., 2024; Sugiman et al., 2025; Wildaniati et al., 2026).

Complementing these cognitive dimensions, the Character Education pillar embeds core maritime socio-cultural values—including community solidarity (gotong royong), ecological stewardship, and coastal resilience—into affective learning outcomes, thereby fostering a deep-seated sense of identity and environmental ethics among coastal youth (Jordan et al., 2023; Manaf et al., 2020; Syvertsen et al., 2024). As visually delineated in the structural architecture of MEIM (Figure 4), the model functions not as a static repository of traditional lore but as a dynamic, bidirectional bridge that legitimizes indigenous epistemology within formal curricula. By aligning local heritage with national educational standards, MEIM ensures that academic attainment does not occur at the expense of cultural alienation (Putra et al., 2024; Selasih & Sudarsana, 2018; Sugiarto et al., 2025). Ultimately, this integrative framework enhances students' domain-specific cognitive capacities while simultaneously safeguarding coastal intangible cultural heritage, offering a scalable blueprint for sustainable educational reform in maritime regions.

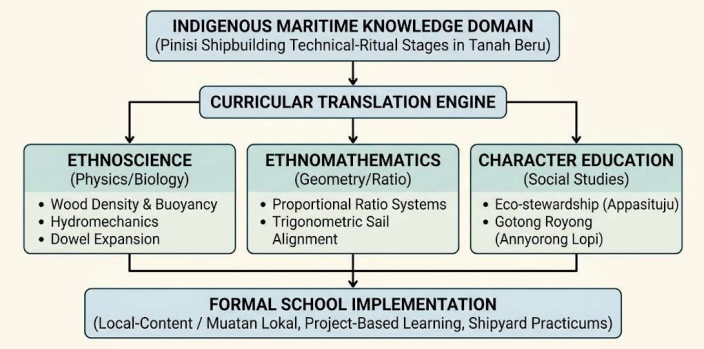

Figure 4. The Maritime Ethnopedagogy Integration Model (MEIM) Architecture

Table 3 operationalizes the MEIM framework by mapping specific construction stages directly into formal subjects, learning objectives, and practical classroom activities.

Table 3. Comprehensive Mapping of Pinisi Indigenous Knowledge to Formal Curricular Subjects

Construction Stage	Indigenous Domain	Target Subject	Mapped Curricular Concept & Learning Objective	Practical Classroom / Field Activity
Timber Selection & Harvesting	Ethnobotany & Material Selection	Biology / Environmental Science	Wood Density & Tensile Strength: Analyze natural water-resistance properties of *Vitex copassus* and *Tectona grandis*.	Laboratory testing of wood buoyancy and water absorption rates; school forestry projects.

Construction Stage	Indigenous Domain	Target Subject	Mapped Curricular Concept & Learning Objective	Practical Classroom / Field Activity
Keel Measurement & Layout	Body-based Numeracy	Mathematics (Geometry)	Scale Ratios & Measurement Units: Convert non-standard body measurements (*fangka*) into metric linear equations.	Calculating hull volume and length-to-beam ratios based on traditional 1:3 scaling rules.
Keel-Joining *(Annattara)*	Wooden Dowel Engineering	Physics (Mechanics)	Friction, Expansion & Tensile Force: Principles of joinery without metal fasteners; hygroscopic swelling of wood.	Building scale joint models; testing shear strength of wooden dowels vs. steel bolts.
Structural Rib & Hull Assembly	Hydrodynamics & Load Balance	Physics (Fluid Dynamics)	Center of Gravity & Buoyancy: Center of mass distribution in vessel stability (Archimedes' Principle).	Simulating hull stability in water tanks using scaled 3D-printed Pinisi hull profiles.
Sail & Mast Fitting *(Apallajareng)*	Aerodynamics & Navigation	Physics / Geography	Vector Forces & Wind Dynamics: Aerodynamic lift generated by 7 sails; triangulation of mast placement.	Vector diagramming of wind force components on main sails (*sombala*) and auxiliary sails.
Launching *(Annyorong Lopi)*	Communal Labor & Social Ethics	Social Studies / Ethics	Gotong Royong & Social Cohesion: Analyze communal cooperative mechanisms in moving heavy infrastructure.	Case study analysis of community solidarity; field observation of launching events.

Barriers to Implementation and Actionable Mitigation Strategies

Translating MEIM into formal educational practice faces three primary structural barriers:

- **Institutional Resistance and Curriculum Overload:** Standardized national curricula often prioritize generic national examination topics over localized content. *Mitigation:* Embed MEIM modules within existing project-based learning frameworks (such as Indonesia's *Projek Penguatan Profil Pelajar Pancasila* / P5) rather than introducing standalone, competing subjects.
- **Teacher Pedagogical Knowledge Gap:** Formal science and mathematics teachers frequently lack deep familiarity with specialized indigenous shipbuilding terminology. *Mitigation:* Conduct mandatory co-designed professional development workshops pairing teachers with master *Panrita Lopi* to develop standardized teacher instructional guides.

- **Resource Constraints for Field Practicums:** Regular school visits to active shipyards present logistical and safety challenges. *Mitigation:* Establish virtual reality (VR) shipyard simulations and mobile ethnoscience kits containing timber specimens, wooden dowel joinery models, and scaled sail assembly sets.

4. CONCLUSION

This study concludes that Pinisi shipbuilding in Tanah Beru constitutes a rich, highly structured indigenous knowledge system whose educational value extends far beyond historical and symbolic documentation. Through the formulation of the Maritime Ethnopedagogy Integration Model (MEIM), this research demonstrates that the technical and ritual sequence of Pinisi construction—from temporal scheduling and timber selection to keel-joining (*Annattara*), structural assembly, and launching (*Annyorong Lopi*)—can be systematically integrated into formal ethnoscience, contextual mathematics, and character education curricula . The theoretical contribution of this study lies in bridging place-based educational theory with maritime indigenous knowledge, offering a scalable blueprint for culture-based curriculum development. Practically, the study provides local educational authorities in Bulukumba with concrete curricular mapping, mitigating the threats posed by modernizing pressures and declining informal apprenticeships.

To operationalize these findings and advance ethno-pedagogical discourse, actionable policy recommendations alongside explicit study parameters must be delineated. Educational authorities should formalize the Maritime Ethnopedagogy Integration Model (MEIM) into official local-content (*Muatan Lokal*) curriculum frameworks across secondary schools in Bulukumba Regency, while school administrators establish strategic partnerships with the *Panrita Lopi* guild to facilitate structured shipyard apprenticeships and guest lecture series; concurrently, cultural and tourism ministries ought to allocate targeted funding for digital ethnoscience learning hubs in Tanah Beru to foster place-based educational tourism. Nevertheless, the scope of this investigation remains constrained by its single-site geographic focus in Tanah Beru and a qualitative sample of 12 key informants, necessitating that future research empirically pilot and evaluate MEIM-infused instructional modules through classroom intervention trials to quantitatively gauge their impact on students' scientific literacy, spatial reasoning, and cultural identity preservation, alongside conducting comparative evaluations across traditional maritime boatbuilding communities throughout Southeast Asia.

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