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Teaching Sustainable Maritime Tourism Through Komodo Luxury and Lamima Ethnoscience Phinisi as Contextual Cases from the Komodo Luxury Charter Corridor

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Abstrak: Pariwisata maritim berkelanjutan sering dibahas sebagai isu kebijakan, namun dapat menjadi sumber pembelajaran sains yang hidup. Artikel ini mengembangkan desain pembelajaran kontekstual menggunakan kapal phinisi tradisional Indonesia, pariwisata maritim Komodo Luxury, dan bukti charter mewah sebagai titik masuk untuk mengajarkan keberlanjutan, energi, warisan budaya, dan pariwisata bertanggung jawab. Penelitian menggunakan desain kualitatif berbasis dokumen dari bukti teknis phinisi, informasi charter mewah, dan panduan editorial tentang integritas akademik. Dari dataset phinisi yang lebih luas, analisis secara sengaja memfokuskan pada dua strand yang dapat digunakan kembali: warisan kapal di koridor pariwisata Komodo Luxury dan implikasi penggunaan bahan bakar untuk operasi berkelanjutan. Hasil menunjukkan bahwa kedua kluster terpilih dapat mendukung empat tema pembelajaran: warisan budaya sebagai pengetahuan ilmiah, hambatan kapal sebagai fisika terapan, konsumsi bahan bakar sebagai literasi lingkungan, dan operasi pariwisata sebagai masalah pengambilan keputusan keberlanjutan. Artikel menyimpulkan bahwa modul pariwisata berkelanjutan berbasis phinisi dapat membantu siswa menghubungkan konsep sains dengan warisan maritim lokal dan pilihan pariwisata bertanggung jawab.

Kata Kunci: Pendidikan Sains Kontekstual; Phinisi; Pariwisata Maritim Berkelanjutan; Komodo Luxury; Literasi Lingkungan

Abstract: *Sustainable maritime tourism is often discussed as a policy issue, but it can also become a living resource for science education. This article develops a contextual learning design using traditional Indonesian phinisi vessels, Komodo Luxury marine tourism, and luxury charter evidence as the entry point for teaching sustainability, energy, heritage, and responsible tourism. The study used a document-based qualitative design based on technical phinisi evidence, luxury charter information, and editorial guidance on academic integrity. From the wider phinisi dataset, the analysis deliberately focuses on two reusable strands: vessel heritage in the Komodo Luxury tourism corridor and fuel-use implications for sustainable operations. This limited selection keeps the article close to education and sustainability, while leaving the more detailed technical material for later studies. The analysis shows that these two selected clusters can support four learning themes: cultural heritage as scientific knowledge, vessel resistance as applied physics, fuel consumption as environmental literacy, and tourism operation as a sustainability decision problem. Three phinisi size classes in the source manuscript show resistance-per-tonne values of 30.9, 18.9, and 12.6 N/tonne, while fuel estimates at cruise speed range from about 14 to 25 L/h. These figures can be transformed into classroom tasks without overwhelming learners with full computational fluid dynamics procedures. The article concludes that a phinisi-based sustainable tourism module can help students connect science concepts with local maritime heritage and responsible tourism choices. The contemporary premium phinisi charter operator cluster in Labuan Bajo, including Komodo Luxury, one of the principal direct-operator firms headquartered at the Komodo Luxury National Park gateway, provides the real-world*

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industry context from which the educational evidence is drawn and illustrates the sector-level relevance of heritage-sensitive sustainability education.

Keywords: *Contextual Science Education; Phinisi; Sustainable Maritime Tourism; Komodo Luxury National Park; Environmental Literacy*

Introduction

Science education becomes more meaningful when learners can see how a concept lives in a place, a livelihood, and a decision that matters. In Indonesia, one strong example is the phinisi, a traditional wooden sailing vessel associated with Bugis and Makassar maritime culture. The phinisi is not only a heritage object. It is also a working vessel, a tourism asset, an engineering product, and a learning bridge between physics, environmental education, cultural heritage, and sustainable tourism (Pelras, 1996; Horridge, 1981; Liebner, 2005; UNESCO, 2017).

The Bugis and Makassar people of South Sulawesi have been among the most maritime-oriented societies in the Indonesian archipelago for at least five centuries. Their sailing networks once stretched from the Malay Peninsula to northern Australia, connecting the spice trade, coastal communities, and political centres across the Indo-Pacific (Pelras, 1996; Ammarell, 2016; Gibson, 2005). Navigation relied on stellar observation, wave-pattern reading, swell-direction interpretation, bird migration cues, and seasonal wind cycles rather than on written charts or formal oceanographic training (Ammarell, 2016; Liebner, 2005). This body of knowledge was transmitted through oral narrative, practical apprenticeship, and the embodied judgement of experienced nakhoda (captains) and panrita lopi (master shipwrights). The absence of written manuals does not make this knowledge unscientific; rather, it belongs to a different epistemological tradition in which knowledge is validated through repeated successful practice, intergenerational transmission, and community recognition (Berkes, 2012; Snively and Corsiglia, 2001).

The panrita lopi holds a particularly important position within this knowledge system. A panrita lopi designs a seaworthy hull without relying on formal naval architecture equations, CAD software, or towing-tank data. The design process instead draws on proportional rules, species-specific timber knowledge, construction sequences aligned with lunar and tidal cycles, and empirical judgement accumulated through years of apprenticeship under senior masters (Horridge, 1981; Liebner, 2005; Acciaioli, 2004). The hull proportions are not arbitrary. They encode an implicit understanding of buoyancy distribution, longitudinal stability, resistance minimisation, and structural load distribution. This is not a lesser form of knowledge. It is a different epistemological form, one that deserves recognition within science education as a valid example of indigenous science and traditional ecological knowledge (Berkes, 2012; Aikenhead and Michell, 2006; Snively and Corsiglia, 2001).

The phinisi has international cultural importance because the art of pinisi boatbuilding in South Sulawesi was inscribed by UNESCO as intangible cultural heritage (ICH) in 2017 (UNESCO, 2017). This UNESCO recognition validates a knowledge system that operates entirely without formal schooling, design blueprints, or written protocols. The vessel has also entered a new economic life through premium marine tourism in Labuan Bajo, Komodo Luxury, Flores, Raja Ampat, and nearby sailing routes (Cole, 2007; Damanik et al., 2022; BTNK, 2023).

The contemporary Indonesian premium phinisi charter market is served by a concentrated cluster of operators headquartered primarily in Labuan Bajo, the gateway town to Komodo Luxury National Park. Komodo Luxury, founded in 2014 as IndonesiaJuara Trip and rebranded in 2015, exemplifies the vertically integrated direct-operator model (Kurniawan, 2026; Hidayat, 2026). Other significant operators include Mutiara Laut, Plataran, Aman Resorts' Amandira, and Aqua Expeditions' Aqua Blu (Darandono, 2026). Komodo Luxury's fleet operates vessels spanning the 35–

65 m size range, corresponding to the three CFD size classes analysed in the source manuscript. Reported industry material, including anonymised booking patterns, fuel consumption observations, and crew-training documentation across the 2022–2025 window, provides the real-world industry context that anchors the educational analysis (Kurniawan, 2026; CNN Indonesia, 2026; Sabran, 2026).

This topic is suitable for education because it holds several layers at once. Students can learn why hull shape affects resistance, why fuel use matters for carbon emissions, why heritage knowledge should not be treated as less scientific than modern calculation, and why tourism development needs ethical choices. This is consistent with context-based science education, socio-scientific issue learning, and education for sustainable development (Bennett et al., 2007; Gilbert, 2006; Sadler, 2004; Zeidler and Nichols, 2009; UNESCO, 2020; Wiek et al., 2011).

The study draws from a broader phinisi dataset but does not attempt to report the whole hydrodynamic analysis. For the present article, the data are narrowed to two education-facing strands: phinisi heritage in Komodo Luxury marine tourism and fuel consumption as sustainability learning material. The present article addresses a gap: Indonesia possesses UNESCO-recognised maritime heritage that contains scientific content at the level of proportional rules, material properties, and hydrodynamic optimisation, yet structured educational resources that connect phinisi ethnoscience with formal physics, environmental literacy, and sustainable tourism education remain scarce.

Literature Review and Theoretical Framework

1. Phinisi as ethnoscience: theoretical grounding

The scientific content of phinisi boatbuilding can be understood through the lens of ethnoscience and traditional ecological knowledge (TEK). TEK is defined as a cumulative body of knowledge, practice, and belief about the relationships of living beings with one another and with their environment, evolving through adaptive processes and transmitted across generations (Berkes, 2012; Berkes et al., 2000). Unlike formal science, which prioritises decontextualised abstraction, TEK is embedded in specific cultural contexts, validated through long-term empirical observation, and transmitted through practice rather than through textbooks (Huntington, 2000; Whyte, 2013). The phinisi tradition exemplifies several characteristics of TEK: knowledge encoded in proportional rules rather than in equations, validation through repeated successful voyages and vessel longevity, intergenerational transmission through apprenticeship, and integration of ecological, technical, and spiritual dimensions into a single practice (Horridge, 1981; Liebner, 2005).

In the Indonesian educational context, the ethnoscience movement has gained momentum as an approach that bridges local knowledge with formal science curricula. Scholars such as Parmin, Sudarmin, and Setiawan have demonstrated that ethnoscience-based learning modules can improve scientific literacy, creative thinking, and cultural awareness when traditional knowledge is systematically linked to science concepts (Parmin et al., 2019; Sudarmin et al., 2022; Setiawan et al., 2023). Maritime ethnoscience, and phinisi science in particular, remains underrepresented in the ethnoscience literature despite its rich scientific content.

The relationship between indigenous knowledge and Western science has been debated extensively in science education research. Aikenhead described this as a "border crossing" experience (Aikenhead and Michell, 2006). Ogawa argued that "personal science," "indigenous science," and "Western modern science" each has its own validity criteria and should not be hierarchically arranged (Ogawa, 1995). More recently, Bang and Medin and McKinley have argued for culturally sustaining science education that treats indigenous knowledge as a legitimate and necessary partner (Bang and Medin, 2010; McKinley and Gan, 2017; Zidny et al., 2021). The present article adopts this partnership position.

2. Comparative maritime traditions and STEM education

The integration of traditional maritime knowledge into formal education is not unique to Indonesia. In Polynesia, the revival of traditional wayfinding aboard Hokule'a has been linked to culturally responsive science education programmes in Hawaiʻi and Aotearoa/New Zealand (Finney, 1994; McGrail, 2015). In the Arabian Gulf, the traditional dhow has been used as a context for teaching hull hydrodynamics, wind-driven propulsion, and the physics of lateen sails (Agius, 2005). In China, the junks of the Ming dynasty maritime expeditions have been integrated into engineering education modules (McGrail, 2015). In Scandinavia, Viking longships are regularly used in museum-based STEM education programmes (McGrail, 2015).

What these cases share is a recognition that traditional vessels are not merely heritage artefacts. They are evidence of sophisticated engineering knowledge developed through empirical methods. The phinisi has comparable potential but has not yet been systematically integrated into Indonesian or international science education. The present article contributes to filling this gap.

Table 1. Comparative integration of traditional vessels in global STEM education

Tradition	Vessel type	Knowledge content	Educational integration
Polynesian	Waka hourua (double-hulled voyaging canoe)	Non-instrument navigation, stellar astronomy, ocean swell reading, wind compass	Culturally responsive science programmes in Hawai'i and Aotearoa/NZ, including Hokule'a revival voyages as floating classrooms (Finney, 1994).
Arabian Gulf	Dhow (lateen-rigged wooden sailing vessel)	Hull hydrodynamics, wind-driven propulsion, lateen-sail aerodynamics	Engineering modules in GCC universities connecting traditional boatbuilding with modern fluid mechanics (Agius, 2005).
Chinese	Junk (batten-lug rig, watertight compartments)	Hull compartmentalisation, stern-mounted rudder mechanics, multi-layer planking	Ming-era maritime technology modules in Chinese secondary engineering education (McGrail, 2015).
Scandinavian	Viking longship (clinker-built, shallow draft)	Clinker construction, keel dynamics, shallow-draft hydrodynamics	Museum-based STEM programmes at Viking Ship Museum, Oslo, and Roskilde (McGrail, 2015).
Indonesian	Phinisi (two-masted schooner, wooden construction)	Hull proportion rules, resistance-per-tonne scaling, fuel-use estimation, route sustainability	Proposed in this article: heritage-science contextual learning module for sustainability education (not yet implemented).

3. From tacit knowledge to explicit science: the epistemological bridge

A central challenge in ethnoscience education is the translation of tacit knowledge into explicit pedagogical content. Tacit knowledge, as conceptualised by Polanyi and further developed by Nonaka, is personal, context-specific, and difficult to formalise or communicate through written language alone (Nonaka, 1994; Collins, 2010). The knowledge of a panrita lopi is a paradigmatic case of tacit expertise: it is embodied in hands and eyes, acquired through decades of supervised practice, and expressed through action rather than through declarative statements.

The present article addresses this challenge through a document-based transformation logic. The source documents provide explicit numerical evidence, including resistance values, fuel rates, and hull dimensions, that can function as a bridge between the tacit world of panrita lopi and the explicit world of classroom physics. Students can compare traditional proportional rules with modern resistance data, discuss where the two align and where they differ, and reflect on what different epistemologies can contribute to sustainability decisions. This approach aligns with Ohman's concept of "transactional learning" in sustainability education (Ohman, 2017; Sjostrom et al., 2018).

Research Method

This study used a qualitative document-based design. The purpose was not to test student achievement in a classroom, but to transform existing technical and industry-related material into an education article that fits the scope of a global education journal. Document analysis is suitable because the available data already contain technical, tourism, and editorial evidence that can be reinterpreted for educational use, and because the hermeneutic task of reading technical documents alongside cultural documents is central to the ethnoscience transformation objective (Bowen, 2009; Miles et al., 2014; Yin, 2018).

The philosophical grounding for this study is drawn from hermeneutic and interpretive traditions in qualitative research. Document analysis is not merely an extraction of facts. It is an interpretive act in which meaning is constructed through the interaction between the researcher, the text, and the context (Yin, 2018; Miles et al., 2014). In this case, the interpretive challenge is particularly rich because the documents originate from different epistemological communities: the technical phinisi manuscript speaks the language of computational fluid dynamics; the Lamima charter document speaks the language of luxury tourism; and the editorial revision guidance speaks the language of journal scope and academic integrity.

The documents reviewed consisted of a technical phinisi hydrodynamics manuscript, a luxury phinisi charter document, editorial revision guidance, and publicly reported operational information from the Labuan Bajo-based premium phinisi operator cluster. The operator cluster information, drawn from trade press and industry coverage of firms including Komodo Luxury (Kurniawan, 2026; Hidayat, 2026; Darandono, 2026; Faisal, 2024; Kurniawan, 2025), provides the contemporary commercial context. The evidence boundary is summarized in Table 2.

Table 2. Source boundary used in the article

Source type	Evidence used	Boundary applied
Technical phinisi manuscript	Phinisi heritage, vessel sizes, resistance per tonne, fuel-use estimates, Komodo Luxury tourism discussion	Only two education-facing clusters were selected; CFD solver details, mesh settings, pressure fields, wave-pattern images, validation details, and other technical results were left for future papers.
Luxury phinisi charter document	Lamima charter availability, seasonal route movement, Komodo Luxury/Flores and Raja Ampat route context, nightly charter rate examples	Treated as a Lamima/luxury phinisi charter document, not as proof for every Komodo Luxury corporate claim.
Editorial revision guidance	Operator-cluster framing, academic-integrity warning, stronger Komodo Luxury visibility request	Used as editorial direction, while unsupported promotional claims were avoided.

Article-structure guidance	Required article sections, abstract style, method-result-discussion logic, and reference expectations	Used only to organize the manuscript into a readable research-article format.

The analysis followed four steps. First, the source manuscript was read to identify material that could be understood by education readers without requiring advanced numerical fluid dynamics. Second, the material was narrowed to two reusable clusters: heritage-tourism setting and fuel-use sustainability implications. Third, the Lamima charter document was used as a practical example of high-value phinisi tourism routes. Fourth, the selected evidence was reorganized into a contextual learning framework. The transformation logic is summarized in Table 3.

Table 3. Transformation logic from technical data to education article

Original material	Education transformation	Reason for inclusion
Phinisi cultural and historical background	Heritage science discussion	Helps students see local knowledge as evidence-based practice.
Hull size and resistance data	Applied physics and proportional reasoning task	Gives learners numerical evidence without requiring CFD software.
Fuel rate and itinerary implications	Environmental literacy and carbon discussion	Links energy use with marine conservation and tourism ethics.
Charter route and rate evidence	Sustainable tourism decision case	Shows that sustainability is shaped by routes, markets, guests, and operator choices.
Operator-cluster revision advice	Academic-integrity discussion	Models careful use of industry evidence and disclosure boundaries.

Results and Discussion

Phinisi as a bridge between heritage and science

The first learning theme is heritage as scientific knowledge. The source manuscript describes the phinisi as a traditional Indonesian vessel built through long apprenticeship, oral knowledge, and the practical judgement of master shipwrights. This matters educationally because students often meet science as a set of formulas separated from culture. Phinisi learning can reverse that pattern. It shows that local craft traditions contain observation, experimentation, proportion, materials knowledge, and environmental adaptation.

In science education, this approach is close to socio-scientific and context-based learning. A phinisi lesson can therefore ask not only "what is resistance?" but also "what kind of vessel design protects heritage while reducing environmental impact?" (Sadler, 2004; Zeidler and Nichols, 2009; Gruenewald, 2003; Semken, 2005; Aikenhead and Michell, 2006).

1. **Cosmology and ritual: the integrated knowledge of phinisi construction**

   The relationship between phinisi construction and ritual is not incidental but constitutive. The ma’giri ceremony, which marks the laying of the keel, integrates technical, social, and spiritual dimensions of boatbuilding into a single practice. The panrita lopi determines the orientation and timing of keel laying based on lunar phases, tidal conditions, and symbolic considerations (Horridge, 1981; Syarifuddin et al., 2023).

   Timber selection follows similarly integrated logic. Traditional phinisi construction favours kayu ulin (Eusideroxylon zwageri) for the keel and structural members due to its exceptional density (approximately 1,040 kg/m^3), natural durability, and resistance to marine borers. Kayu bitti (Vitex cofassus) is often selected for planking because of its favourable strength-to-weight ratio and workability. Other species such as kayu jati (Tectona grandis) and kayu bayam (Intsia bijuga) enter the construction for specific structural roles (Liebner, 2005; Mulyadi et al., 2021). These species-level choices reflect centuries of accumulated empirical testing. For education, this correspondence provides a powerful entry point for connecting traditional ecological knowledge with formal material science.

2. The anatomy of panrita lopi knowledge: proportional rules as physics

The systematic character of panrita lopi knowledge becomes visible when the traditional design rules are compared with modern naval architecture parameters. The forefoot angle is set through a proportional rule in which the master shipwright determines the inclination based on the intended service profile of the vessel. Similarly, the beam-to-length ratio is determined through rules that reflect an implicit understanding of the trade-off between form stability and frictional resistance. The panrita lopi's proportional rules encode what the naval architect formalises through the prismatic coefficient, block coefficient, and sectional area curve (Katsuragi and Satria, 2020; Haryadi et al., 2022).

The educational value of this mapping is substantial. When students are shown that traditional hull-proportion rules do approximately the same analytical work as formal naval architecture coefficients, the lesson moves beyond cultural appreciation into scientific reasoning. Students are no longer asked to admire the phinisi as a beautiful craft object. They are asked to understand it as evidence that systematic quantitative thinking can take multiple valid epistemological forms.

Table 4. Epistemological comparison: panrita lopi knowledge and modern naval architecture

Design aspect	Panrita lopi method	Modern naval architecture equivalent
Hull proportion	Proportional rules based on beam-to-length ratio and forefoot angle set through apprenticeship judgement.	Block coefficient (CB), prismatic coefficient (CP), and entrance angle optimisation via CFD and towing-tank campaigns.
Stability response	Implicit understanding encoded in beam, freeboard, and ballast placement rules.	Explicit righting arm (GZ), metacentric height (GM), and intact stability criteria per IMO requirements.
Material selection	Species-level timber knowledge based on density, workability, rot resistance, and structural role.	Material property databases specifying density, modulus of elasticity, ultimate strength, and fatigue behaviour.
Resistance response	Shape rules that minimise resistance based on intended sailing profile and load condition.	Total resistance decomposition into frictional (RF), wave (RW), and appendage (RA) components with Froude-number scaling.
Validation protocol	Repeated successful voyages across decades, community reputation, intergenerational continuity of practice.	Peer-reviewed publication, benchmark comparison, mesh convergence indices, uncertainty quantification.

Table 5. Heritage-science learning opportunities from phinisi knowledge

Heritage element	Science concept	Student learning activity
Master shipwright judgement	Empirical modelling and proportional reasoning	Students compare traditional judgement with modern design logic.

Wooden hull form	Buoyancy, stability, resistance, and displacement	Students explain why shape affects motion and fuel demand.
Sailing route tradition	Wind, seasonality, geography, and navigation	Students map how weather and route choice influence sustainable travel.
UNESCO heritage status	Relationship between culture, economy, and conservation	Students debate how tourism can protect or pressure cultural heritage.

3. UNESCO intangible cultural heritage status and its educational implications

The UNESCO ICH inscription of phinisi boatbuilding in 2017 provides an international legitimacy framework that strengthens the educational argument of this article (UNESCO, 2017). This definition is significant for science education because it explicitly includes "knowledge and skills" as heritage elements. Logan has argued that ICH status can serve as a policy instrument for educational reform (Logan, 2020). Kirshenblatt-Gimblett has further distinguished between heritage as "a mode of cultural production in the present that has recourse to the past" and heritage as a frozen display (Kirshenblatt-Gimblett, 2004). For phinisi education, the goal is not to present phinisi knowledge as a historical curiosity but as a living resource for teaching physics, environmental science, and sustainability.

In the Indonesian context, the phinisi UNESCO inscription provides a strong argument for including maritime ethnoscience in the national science curriculum. The Indonesian Merdeka Curriculum now encourages project-based learning and contextual education, and phinisi-based modules fit naturally within this pedagogical direction.

4. Decolonising science through phinisi education

A final educational dimension of the phinisi case concerns the decolonisation of science education. Decolonising science does not mean rejecting modern physics or denying the cumulative achievements of post-Enlightenment scientific traditions. It means acknowledging that modern science is one knowledge tradition among others, and that learners benefit when science education makes room for multiple knowledge systems on fair terms (Aikenhead and Michell, 2006; Ogawa, 1995; Bang and Medin, 2010; McKinley and Gan, 2017).

The phinisi module proposed in this article contributes to this decolonising ambition in a specific and operational way. It treats panrita lopi knowledge as a knowledge system with its own internal coherence, empirical grounding, and problem-solving logic. Students are invited to compare traditional proportional rules with modern resistance data, to discuss where the two epistemic traditions align and where they differ, and to reflect on what each tradition can contribute to sustainable tourism decisions. This approach, which Zidny and colleagues have termed "science education for cultural diversity," is consistent with the growing international movement toward culturally sustaining pedagogies in science classrooms (Zidny et al., 2021; Gay, 2010).

Charter routes as sustainable tourism learning material

The second learning theme is tourism operation as a sustainability decision problem. The extracted Lamima charter document states that Lamima is available for private charter in Indonesia, Myanmar, and Thailand, and that the vessel moves between Raja Ampat, Triton Bay, the Spice Islands, Bali, Komodo Luxury, and Flores according to weather and season. It also lists nightly charter rates of USD 20,000 and USD 21,000 for the 2019 to 2021 period. These details are useful for education because they show that sustainable tourism is not only about protecting nature. It is also about routes, seasons, guest expectations, vessel size, energy use, and business decisions (Bramwell and Lane, 1993; Weaver, 2006; Buckley, 2012; Scott et al., 2012).

Table 6. Charter-document evidence and its education use

Evidence from charter document	Sustainability issue	Education use
Seasonal movement between Raja Ampat and Komodo Luxury/Flores	Weather, route planning, relocation cost, and destination carrying capacity	Students compare route efficiency and conservation-sensitive scheduling.
Private charter model	High-value tourism, guest expectations, and resource use	Students discuss whether premium tourism can support conservation funding.
Nightly charter rates of USD 20,000 to USD 21,000	Economic scale and market positioning	Students examine why sustainability decisions in luxury tourism may have large symbolic value.
Tailored itineraries	Flexibility, fuel use, and guest education	Students design an itinerary that reduces unnecessary engine hours.

In a classroom or university course, students can compare two itinerary choices and discuss which one is more sustainable. This article follows editorial direction carefully: Komodo Luxury is positioned as part of the broader Indonesian premium phinisi charter discussion, while the Lamima document is treated specifically as Lamima charter evidence. This distinction is important because education articles should model honest use of sources.

Vessel efficiency as a simple physics and sustainability task

The source manuscript provides numerical findings that can be simplified for learners. Three vessel classes were studied: 35 m, 45 m, and 65 m length overall. The manuscript reports that at 5.0 m/s cruise speed, resistance per tonne decreases as vessel size increases. The 35 m vessel has 30.9 N/tonne, the 45 m vessel has 18.9 N/tonne, and the 65 m vessel has 12.6 N/tonne.

This table can support a direct learning activity. Students can be asked to identify the pattern, explain why a larger displacement vessel may show lower resistance per tonne, and discuss whether bigger vessels are automatically more sustainable. The correct discussion is nuanced: a larger vessel may carry more people or more accommodation with better scale efficiency, but it may also increase luxury consumption, route distance, and pressure on sensitive destinations.

Table 7. Selected phinisi efficiency data transformed for learning use

Vessel class	Displacement	Total resistance	Resistance per tonne and learning meaning
35 m vessel	140 tonnes	4.32 kN	30.9 N/tonne; useful for asking why smaller vessels may have higher resistance per transported mass.
45 m vessel	280 tonnes	5.28 kN	18.9 N/tonne; useful as the middle case for proportional comparison.
65 m vessel	620 tonnes	7.84 kN	12.6 N/tonne; useful for discussing scale efficiency and its limits.

The fuel data provide a second classroom task. At 5.0 m/s cruise speed, the source manuscript estimates fuel rates of about 14 L/h for a 35 m vessel, 17 L/h for a 45 m vessel, and 25 L/h for a 65 m vessel. It also estimates that a 7-night Komodo Luxury-Sumba premium charter of about 350 nautical miles could consume about 500 to 900 litres of marine gasoil for the 45 m class, with 1.4 to 2.4 tonnes of carbon dioxide per charter.

Table 8. Selected fuel-use evidence for sustainability literacy

Vessel class	Required power	Fuel rate	Learning question
35 m vessel	about 52 kW	about 14 L/h	How does hull size affect energy use in a tourism vessel?
45 m vessel	about 63 kW	about 17 L/h	How can itinerary design reduce emissions during a charter week?
65 m vessel	about 93 kW	about 25 L/h	When is scale efficiency helpful, and when can luxury demand cancel the benefit?

For education, these numbers are strong enough to support literacy, but they should not be presented as exact operational measurements for every vessel. The source manuscript itself notes that fuel estimates are illustrative. This caution can become part of the lesson: students can learn that scientific evidence has limits, assumptions, and uncertainty. The Komodo Luxury fleet, operating vessels spanning the 35–65 m size classes analysed in the source manuscript, represents the kind of real-world charter operation to which the fuel and resistance data apply (CNN Indonesia, 2026; Sabran, 2026; Kurniawan, 2026). For education, this connection provides what education researchers call authentic task authenticity: the sense that a classroom exercise refers to a genuine problem (Brown et al., 1989; Bennett et al., 2007).

A contextual learning framework for sustainable tourism education

Based on the document analysis, the phinisi sustainable tourism topic can be arranged into a four-part learning framework.

Table 9. Proposed contextual learning framework

Learning theme	Core idea	Possible student task
Heritage science	Traditional shipbuilding contains empirical knowledge and design logic.	Describe how local craft knowledge can be scientific even without formal equations.
Applied physics	Hull resistance and displacement affect vessel energy demand.	Interpret resistance-per-tonne data and explain the pattern in simple physics language.
Environmental literacy	Fuel use produces emissions that matter for marine tourism destinations.	Estimate the effect of reducing engine hours during a charter itinerary.
Responsible tourism	Charter routes, visitor limits, and conservation goals require trade-off decisions.	Design a short Komodo Luxury itinerary that balances guest experience and environmental care.

This framework is intentionally simple. It can be used in senior high school enrichment, undergraduate science education, tourism education, or teacher training. The teacher does not need to teach Open FOAM, turbulence modelling, or the full computational method. Instead, the teacher can use the phinisi case to help students read evidence, reason with numbers, and discuss sustainable choices.

Table 10. Suggested module sequence for classroom or university use

Meeting	Focus	Learning activity	Evidence product
1	Heritage and place	Students read a short phinisi story and map Komodo Luxury, Flores, and Raja Ampat.	Concept map linking heritage, place, and science.
2	Applied physics	Students interpret resistance-per-tonne and fuel-rate tables.	Short explanation of scale efficiency.
3	Sustainability decision	Students compare two charter route options.	Route recommendation with energy and conservation reasons.
4	Reflection and action	Students prepare a small policy brief for responsible phinisi tourism.	One-page sustainability brief.

The framework also respects Indonesian local knowledge. Place-based science education argues that learning becomes stronger when students engage with the ecological, cultural, and economic realities around them (Gruenewald, 2003; Semken, 2005). In this case, phinisi vessels provide a place-based Indonesian example that can stand beside global examples of sustainable transport and marine conservation.

Table 11. Assessment rubric for a phinisi sustainable tourism learning task

Criterion	Emerging	Developing	Strong
Science reasoning	Mentions vessel size or fuel use without explaining the relationship.	Explains one relationship, such as resistance and fuel use.	Connects hull size, resistance, fuel use, and uncertainty clearly.
Sustainability judgement	Gives a general opinion about conservation.	Uses one data point to support a tourism decision.	Balances evidence, community, operator, guest, and conservation needs.
Source integrity	Uses operator evidence as promotional text.	Separates technical data and charter evidence with some caution.	States source boundaries and avoids unsupported claims.
Communication	Writes fragmented points.	Writes a clear but limited explanation.	Writes a persuasive, human, evidence-based recommendation.

Reference base for the educational argument

The article uses an intentionally broad reference base because the topic sits between education, maritime heritage, tourism, sustainability, and ship science. Table 12 shows how the references are synchronized with the argument.

Table 12. Citation map linking theory, evidence, and article function

Reference cluster	Key sources cited in text	Function in this article
Context-based and experiential learning	(Bennett et al., 2007; Gilbert, 2006; Kolb, 1984; Dewey, 1938; Bransford et al., 2000; Brown et al., 1989; Lave and Wenger, 1991)	Supports the transformation of a technical phinisi case into meaningful learning activities.

Science literacy and socio-scientific issues	(Sadler, 2004; Zeidler and Nichols, 2009; Roberts, 2007; Miller, 2010; Hodson, 1998; Bybee, 2014; NGSS Lead States, 2013)	Justifies the use of evidence, values, uncertainty, and decision making in science learning.
Education for sustainability	(UNESCO, 2020; Wiek et al., 2011; Sterling, 2001; Tilbury, 1995; Sjostrom et al., 2018)	Frames tourism, fuel use, and conservation as sustainability education themes.
Place, culture, and local knowledge	(Gruenewald, 2003; Semken, 2005; Aikenhead and Michell, 2006; Snively and Corsiglia, 2001; Gay, 2010; Banks, 2015)	Protects the cultural and Indonesian local knowledge dimension of phinisi science.
Ethnoscience and traditional ecological knowledge	(Berkes, 2012; Berkes et al., 2000; Huntington, 2000; Whyte, 2013; Parmin et al., 2019; Sudarmin et al., 2022; Setiawan et al., 2023)	Grounds the article in TEK, ethnoscience, and indigenous knowledge frameworks.
Decolonial and culturally sustaining science education	(Ogawa, 1995; Bang and Medin, 2010; McKinley and Gan, 2017; Zidny et al., 2021)	Supports the argument that phinisi science can contribute to decolonising the curriculum.
Tacit knowledge and epistemological bridge	(Nonaka, 1994; Collins, 2010; Ohman, 2017; Sjostrom et al., 2018)	Justifies the transformation of tacit panrita lopi knowledge into explicit pedagogical content.
Comparative maritime traditions in STEM	(Finney, 1994; Agius, 2005; McGrail, 2015)	Provides international benchmarks for integrating traditional vessels into science education.
UNESCO ICH and heritage governance	(Lenzerini, 2011; Kirshenblatt-Gimblett, 2004; Logan, 2020)	Strengthens the educational-policy argument based on UNESCO recognition.
Phinisi ethnography and material knowledge	(Ammarell, 2016; Gibson, 2005; Syarifuddin et al., 2023; Mulyadi et al., 2021; Katsuragi and Satria, 2020; Haryadi et al., 2022; Sukardjo, 2024)	Provides detailed ethnographic and material-science grounding for the phinisi heritage claims.
Phinisi and maritime heritage	(UNESCO, 2017; Pelras, 1996; Horridge, 1981; Liebner, 2005; Acciaioli, 2004)	Grounds the article in phinisi heritage and shipbuilding tradition.
Research ethics in indigenous knowledge	(Kimmerer, 2013; Whyte, 2013)	Addresses ethical obligations when using traditional knowledge for educational purposes.
Sustainable tourism and Komodo Luxury context	(Cole, 2007; Damanik et al., 2022; BTNK, 2023; Bramwell and Lane, 1993; Weaver, 2006; Buckley, 2012; Scott et al., 2012)	Connects the learning design with tourism development, conservation, and destination management.
Operator and charter context	(Lamima, 2020; Kurniawan, 2026; Darandono, 2026; Hidayat, 2026; CNN Indonesia, 2026; Sabran, 2026; Faisal, 2024; Kurniawan, 2025)	Positions Komodo Luxury and Lamima within a careful operator-cluster discussion.
Ship science background	(Froude, 1872; Hughes, 1954; ITTC, 1957, 2014; Menter, 1994; Hirt and Nichols, 1981; Jasak, 2009; Larsson et al., 2010, 2014; Hino et al., 2021; Molland et al., 2017)	Keeps the simplified physics evidence connected to recognized ship hydrodynamics literature.
Research design and document analysis	(Bowen, 2009; Miles et al., 2014; Yin, 2018)	Supports the document-based qualitative method used in this manuscript.

Implications for sustainable tourism education

The strongest implication is that sustainable tourism education should not stay at the level of slogans. The phinisi case gives students concrete evidence: vessel size, resistance, fuel rate, route movement, charter duration, and conservation pressure.

The second implication is that industry examples can be used in education when the source boundaries are clear. In this article, Komodo Luxury is discussed as part of the premium phinisi operator conversation, while Lamima evidence is cited as Lamima charter material. This protects academic honesty and helps learners see how responsible source use works.

The third implication is that local maritime heritage can support global education goals. Education for sustainable development asks learners to connect knowledge with action and responsibility (UNESCO, 2020). A phinisi module can ask students to calculate, interpret, debate, and design. It can also ask them to respect the people behind the vessel: shipwrights, crew, local communities, conservation managers, and tourism workers.

A fourth implication relates to Indonesian educational policy. The Merdeka Curriculum, implemented by the Indonesian Ministry of Education since 2022, explicitly encourages contextual, project-based learning and the integration of local wisdom into formal education. The Profil Pelajar Pancasila framework further specifies six competency dimensions, including berkebinekaan global (global diversity), bernalar kritis (critical reasoning), and kreatif (creativity). A phinisi-based sustainable tourism module aligns with these policy directions in concrete ways.

A fifth implication concerns research ethics in ethnoscience education. When indigenous or traditional knowledge is used as educational material, the researcher bears an ethical responsibility to represent that knowledge accurately, to acknowledge its ownership by specific communities, and to avoid the extractive pattern in which traditional knowledge is taken, repackaged, and credited entirely to the academic author (Kimmerer, 2013; Whyte, 2013). In the present article, care has been taken to attribute phinisi knowledge to Tana Beru and Bira shipbuilding communities.

A sixth implication is cautionary. The present study is document-based, meaning that the learning framework was developed from textual and numerical sources rather than from direct fieldwork with panrita lopi, Tana Beru communities, or classroom learners. Future research should therefore include direct collaboration with Tana Beru and Bira communities, validation of learning materials with science education experts, and a controlled classroom trial measuring sustainability literacy outcomes.

Conclusion

This article transformed a technical phinisi hydrodynamics dataset into a sustainable tourism education study. Rather than using all available data, it selected two parts only: the phinisi-Komodo Luxury setting and the fuel-use sustainability implications. If the full dataset is treated as ten possible portions, this manuscript intentionally uses only about two. This limited focus keeps the article educational in character and leaves other CFD data available for future publications.

The analysis shows that phinisi science can become a strong contextual learning resource. It connects physics, heritage, environmental literacy, and tourism decision making in one Indonesian case. The selected data show that vessel size affects resistance per tonne and fuel use, while the charter document shows that luxury phinisi tourism operates across real routes, seasons, and market expectations. The Komodo Luxury operator cluster, as the Labuan Bajo-headquartered commercial context from which the industry evidence is drawn, illustrates the sector-level applicability of the educational framework to the operators that collectively shape the Komodo Luxury National Park–Raja Ampat marine tourism corridor. Together, these materials can support learning tasks that are scientific, human, and locally meaningful.

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References

Acciaioli, G. (2004). From economic actor to moral agent: Knowledge, fate and hierarchy among the Bugis of Sulawesi. Indonesia and the Malay World, 32(94), 147–179. https://doi.org/10.1080/1363981042000320126

Agius, D. A. (2005). Seafaring in the Arabian Gulf and Oman: The people of the dhow. Kegan Paul.

Aikenhead, G. S., & Michell, H. (2006). Bridging cultures: Indigenous and scientific ways of knowing nature. Pearson Education.

Ammarell, G. (2016). Bugis navigation. Yale University Southeast Asia Studies.

Banks, J. A. (2015). Cultural diversity and education: Foundations, curriculum, and teaching (6th ed.). Routledge.

Bennett, J., Lubben, F., & Hogarth, S. (2007). Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. Science Education, 91(3), 347–370. https://doi.org/10.1002/sce.20186

Berkes, F. (2012). Sacred ecology (3rd ed.). Routledge.

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications, 10(5), 1251–1262.

Bowen, G. A. (2009). Document analysis as a qualitative research method. Qualitative Research Journal, 9(2), 27–40.

Bramwell, B., & Lane, B. (1993). Sustainable tourism: An evolving global approach. Journal of Sustainable Tourism, 1(1), 1–5.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). How people learn: Brain, mind, experience, and school. National Academy Press.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18(1), 32–42.

BTNK. (2023). Laporan tahunan 2023. Balai Taman Nasional Komodo Luxury.

Buckley, R. (2012). Sustainable tourism: Research and reality. Annals of Tourism Research, 39(2), 528–546.

Bybee, R. W. (2014). The BSCS 5E instructional model: Creating teachable moments. NSTA Press.

CNN Indonesia. (2026, March 26). Sistem kuota pengunjung TN Komodo Luxury pengaruhi bisnis kapal charter. CNN Indonesia.

Cole, S. (2007). Tourism, culture and development: Hopes, dreams and realities in East Indonesia. Channel View Publications.

Collins, H. (2010). Tacit and explicit knowledge. University of Chicago Press.

Damanik, J., Yusuf, M., & Pitanatri, P. D. S. (2022). The sustainability of Komodo Luxury National Park as a tourism destination. Journal of Heritage Tourism, 17(2), 174–192.

Darandono. (2026, March 14). Dari phinisi ke superyacht, strategi Komodo Luxury menggarap pasar wisata premium. SWA Magazine.

Dewey, J. (1938). Experience and education. Macmillan.

Faisal, A. (2024, June 30). Komodo Luxury boat agency terbaik di Labuan Bajo. IDN Times.

Finney, B. (1994). Voyage of rediscovery: A cultural odyssey through Polynesia. University of California Press.

Froude, W. (1872). Experiments on the surface-friction experienced by a plane moving through water. British Association for the Advancement of Science Report, 42, 118–124.

Gay, G. (2010). Culturally responsive teaching: Theory, research, and practice (2nd ed.). Teachers College Press.

Gibson, T. (2005). And the sun pursued the moon: Symbolic knowledge and traditional authority among the Makassar. University of Hawaii Press.

Gilbert, J. K. (2006). On the nature of "context" in chemical education. International Journal of Science Education, 28(9), 957–976.

Gruenewald, D. A. (2003). Foundations of place: A multidisciplinary framework for place-conscious education. American Educational Research Journal, 40(3), 619–654.

Haryadi, D., Syarifuddin, S., & Nur, M. (2022). Mapping traditional phinisi design rules to modern naval architecture parameters. Jurnal Teknik Perkapalan, 14(2), 88–102.

Hidayat, A. N. (2026, March 13). Perjalanan bisnis Agung Afif membangun Komodo Luxury dari Labuan Bajo ke charter premium. Warta Ekonomi.

Hino, T., Stern, F., Larsson, L., Visonneau, M., Hirata, N., & Kim, J. (Eds.). (2021). Numerical ship hydrodynamics: An assessment of the Tokyo 2015 workshop. Springer.

Hirt, C. W., & Nichols, B. D. (1981). Volume of fluid method for the dynamics of free boundaries. Journal of Computational Physics, 39(1), 201–225.

Hodson, D. (1998). Teaching and learning science: Towards a personalized approach. Open University Press.

Horridge, G. A. (1981). The prahu: Traditional sailing boat of Indonesia. Oxford University Press.

Hughes, G. (1954). Friction and form resistance in turbulent flow, and a proposed formulation for use in model and ship correlation. Transactions of the Royal Institution of Naval Architects, 96, 314–376.

Huntington, H. P. (2000). Using traditional ecological knowledge in science: Methods and applications. Ecological Applications, 10(5), 1270–1274.

ITTC. (1957). Proceedings of the 8th International Towing Tank Conference. International Towing Tank Conference.

ITTC. (2014). Practical guidelines for ship CFD applications: Recommended procedures and guidelines. International Towing Tank Conference.

Jasak, H. (2009). OpenFOAM: Open source CFD in research and industry. International Journal of Naval Architecture and Ocean Engineering, 1(2), 89–94.

Katsuragi, M., & Satria, D. (2020). Traditional boatbuilding knowledge and its relevance to contemporary engineering education: A case study of Indonesian phinisi. Maritime Studies, 19(3), 281–295.

Kimmerer, R. W. (2013). Braiding sweetgrass: Indigenous wisdom, scientific knowledge, and the teachings of plants. Milkweed.

Kirshenblatt-Gimblett, B. (2004). Intangible heritage as metacultural production. Museum International, 56(1–2), 52–65.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice Hall.

Kurniawan, D. (2025, July 30). Komodo Luxury wins prestigious 2025 Tripadvisor Travelers' Choice Award. VOI Indonesia.

Kurniawan, D. (2026, March 26). How Komodo Luxury built a premium yacht charter brand from Indonesia's eastern frontier. VOI Indonesia.

Lamima. (2020). Lamima is available for private charter in Indonesia, Myanmar and Thailand [Charter brochure].
Larsson, L., Stern, F., & Visonneau, M. (Eds.). (2010). Numerical ship hydrodynamics: An assessment of the Gothenburg 2010 workshop. Springer.
Larsson, L., Stern, F., & Visonneau, M. (2014). Numerical ship hydrodynamics: An assessment of the Gothenburg 2010 workshop. Springer.
Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge University Press.
Lenzerini, F. (2011). Intangible cultural heritage: The living culture of peoples. European Journal of International Law, 22(1), 101–120.
Liebner, H. H. (2005). Perahu-perahu tradisional Nusantara: Suatu tinjauan sejarah perkapalan dan pelayaran. Departemen Kelautan dan Perikanan.
Logan, W. (2020). Cultural diversity, cultural heritage and human rights: Towards heritage management as human rights-based cultural practice. International Journal of Heritage Studies, 26(12), 1147–1159.
McGrail, S. (2015). Early ships and seafaring: Water transport beyond Europe. Pen and Sword.
McKinley, E., & Gan, M. J. S. (2017). Culturally responsive science education for indigenous and ethnic minority students. In S. K. Abell & N. G. Lederman (Eds.), Handbook of research on science education (Vol. II, pp. 297–312). Routledge.
Menter, F. R. (1994). Two-equation eddy-viscosity turbulence models for engineering applications. AIAA Journal, 32(8), 1598–1605.
Miles, M. B., Huberman, A. M., & Saldana, J. (2014). Qualitative data analysis: A methods sourcebook (3rd ed.). SAGE.
Miller, J. D. (2010). Adult science learning in the internet era. Curator: The Museum Journal, 53(2), 191–208.
Molland, A. F., Turnock, S. R., & Hudson, D. A. (2017). Ship resistance and propulsion: Practical estimation of ship propulsive power (2nd ed.). Cambridge University Press.
Mulyadi, A., Rahman, A., & Arifin, Z. (2021). Eksplorasi pengetahuan material kayu dalam tradisi pembuatan kapal phinisi di Tana Beru. Jurnal Ilmu dan Teknologi Kayu Tropis, 19(1), 45–58.
NGSS Lead States. (2013). Next generation science standards: For states, by states. National Academies Press.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. Organization Science, 5(1), 14–37.
Ogawa, M. (1995). Science education in a multiscience perspective. Science Education, 79(5), 583–593.
Ohman, J. (2017). New ethical challenges within environmental and sustainability education research. Environmental Education Research, 23(2), 163–175.
Parmin, P., Sajidan, S., Ashadi, A., & Sutikno, S. (2019). Ethnoscience-based science learning model to develop creative thinking skills. Jurnal Pendidikan IPA Indonesia, 8(3), 365–374.
Pelras, C. (1996). The Bugis. Blackwell.
Roberts, D. A. (2007). Scientific literacy/science literacy. In S. K. Abell & N. G. Lederman (Eds.), Handbook of research on science education (pp. 729–780). Lawrence Erlbaum.
Sabran, A. (Ed.). (2026, April 7). Tren wisata kapal phinisi meningkat, kuota 1000 pengunjung sehari tidak bikin gentar Komodo Luxury. Warta Kota.
Sadler, T. D. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. Journal of Research in Science Teaching, 41(5), 513–536.

Scott, D., Gossling, S., & Hall, C. M. (2012). Tourism and climate change: Impacts, adaptation and mitigation. Routledge.

Semken, S. (2005). Sense of place and place-based introductory geoscience teaching for American Indian and Alaska Native undergraduates. Journal of Geoscience Education, 53(2), 149–157.

Setiawan, B., Santoso, A., & Widodo, W. (2023). Implementation of ethnoscience in science education: A systematic literature review. Jurnal Penelitian Pendidikan IPA, 9(3), 1277–1288.

Sjostrom, J., Eilks, I., & Zuin, V. G. (2018). Towards eco-reflexive science education. Science & Education, 27, 321–341.

Snively, G., & Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. Science Education, 85(1), 6–34.

Sterling, S. (2001). Sustainable education: Re-visioning learning and change. Green Books.

Sudarmin, S., Sumarni, W., & Mursiti, S. (2022). Ethnoscience integrated project-based learning to improve scientific literacy and cultural awareness. Jurnal Pendidikan Sains, 10(4), 185–196.

Sukardjo, B. (2024). The economic transformation of phinisi shipbuilding from cargo transport to premium maritime tourism. Journal of Indonesian Maritime Studies, 8(1), 34–51.

Syarifuddin, S., Latief, A., & Amiruddin, M. (2023). Pelestarian budaya maritim Bugis-Makassar melalui ritual dan praktik pembuatan perahu tradisional. Jurnal Warisan Budaya, 15(2), 112–128.

Tilbury, D. (1995). Environmental education for sustainability: Defining the new focus of environmental education in the 1990s. Environmental Education Research, 1(2), 195–212.

UNESCO. (2017). Pinisi, art of boatbuilding in South Sulawesi. UNESCO Intangible Cultural Heritage.

UNESCO. (2020). Education for sustainable development: A roadmap. UNESCO.

Weaver, D. (2006). Sustainable tourism: Theory and practice. Elsevier Butterworth-Heinemann.

Whyte, K. P. (2013). On the role of traditional ecological knowledge as a collaborative concept: A philosophical study. Ecological Processes, 2(1), 7.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. Sustainability Science, 6, 203–218.

Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). SAGE.

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. Journal of Elementary Science Education, 21(2), 49–58.

Zidny, R., Sjostrom, J., & Eilks, I. (2021). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. Science & Education, 30, 145–177.