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Preservice Science Teachers as Mediators of Indigenous Artisanal Knowledge: A Community-Based Ethnoscience Project in Central Lombok

[1]Faizul Bayani, [2]Hulyadi, [1]Meilynda Pomeistia, [1]Sudirman, [1]Rahman, [1]Thauhidayatul Hidayah, [1]Dina Hardianti, [1]Temi Ainul Safitri, [2]Gargazi

[1]Bachelor of Science in Natural Sciences Education at Qamarul Huda Badaruddin Bagu University, Indonesia
[2]Chemistry Education Department, Faculty of Technology and Applied Science, Mandalika University of Education, Indonesia
*Correspoding author email: faizulbayani0@gmail.com

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Abstract

This qualitative single-case ethnoscience study explored how preservice science teachers reconstructed indigenous knowledge from local artisanal practices into potential school science learning resources. Conducted in an Ethnoscience course in the Science Education Study Program at Universitas Qamarul Huda Badaruddin Bagu, Central Lombok, the project adopted an ethnoscience-oriented project-based practicum (EthnoPjBL) in which one intact class collaborated with artisans involved in knife forging, clay brick and roof-tile production, herbal medicine and jamu kunyit asam preparation, palm-sugar and sweet tuak processing, and plastic and bamboo weaving. Data from participant observation, field notes, interviews, structured analysis tables, student scientific report drafts, concept maps, reflective worksheets, and course documents were analysed through thematic coding, constant comparison, and concept map interpretation. The findings show that preservice teachers identified dense clusters of phenomena, for example heat transfer, phase change, mixtures, plant physiology, microbial processes, and structural mechanics, mapped these onto canonical concepts and junior and senior secondary curriculum topics, and produced curriculum-linked representations that support contextualised and integrated science learning while developing epistemological awareness, ethical sensitivity, and capacity to pedagogically mobilise indigenous knowledge.

Keywords: ethnoscience; indigenous knowledge; preservice science teachers; EthnoPjBL; culturally responsive science education

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INTRODUCTION

Science education in many parts of the world has long been criticised for presenting scientific knowledge as abstract, universal, and detached from learners' sociocultural worlds. School science is frequently organised around decontextualised concepts and algorithmic problem solving, with limited reference to local environments, livelihoods, and cultural practices. Such approaches risk reinforcing the idea that legitimate science originates only from laboratories and textbooks, while everyday experiences and community practices remain epistemically invisible. In response, curriculum reforms and research initiatives have increasingly called for contextualised science learning that promotes scientific literacy, higher-order thinking, and the ability to apply concepts to real-world situations.

Within this broader movement, indigenous and local knowledge systems have gained attention as rich, yet often underutilised, resources for science education. Indigenous knowledge is built up over generations through close observation of local ecosystems, experimentation with materials and technologies, and collective reflection within specific cultural and historical contexts. It regulates agricultural cycles, resource management, food processing, health practices, and artisanal craftsmanship. Studies in anthropology and ethnoscience show that such systems embody sophisticated forms of categorisation, prediction, and causal reasoning that are highly adapted to local conditions (Lightner et al., 2021; Majumdar & Chatterjee, 2021). When recognised as legitimate ways of knowing, these systems can provide powerful entry points for students to learn school science through familiar, meaningful contexts while affirming cultural identity.

In science education research, ethnoscience is increasingly conceptualised as both a methodological stance and an empirical field concerned with reconstructing indigenous and local knowledge into forms usable in school science. From this perspective, ethnoscience foregrounds cultural relevance, interdisciplinarity, and community epistemologies (Ellen, 2018; Diastuti & Ahmadi, 2024; Selamat & Priyanka, 2023; Hasibuan et al., 2023). As a curricular framework, it promotes the systematic mapping of local practices onto canonical concepts in biology, chemistry, and physics, the alignment of these mappings with policy initiatives such as Kurikulum Merdeka, and teacher-mediated contextualisation through culturally responsive materials and resources (Slikkerveer & Gellaerts, 2024; Murwitaningsih & Maesaroh, 2023; Anazifa & Hadi, 2017; Hardiansyah et al., 2024). Ethnoscience thus goes beyond inserting local examples into existing syllabi toward redesigning learning trajectories so that community practices, artefacts, and epistemologies become generative anchors for science learning.

Empirical studies across subject domains report that ethnoscience-based designs, implemented through multimedia, mind-mapping videos, learning modules, e-learning platforms, and project- or problem-based pedagogies, yield improvements in students' scientific literacy, critical thinking, learning motivation, and broader 21st-century competencies, while also strengthening cultural identity and environmental stewardship (Sholahuddin & Admoko, 2021; Widiyawati et al., 2023; Prabowo et al., 2024; Sholahuddın et al., 2022; Warliani et al., 2024; Yasir et al., 2022; Suryani et al., 2022; Munira et al., 2024; Haryanto & Kencanawati, 2023; Nurhasnah et al., 2022; Prayogi et al., 2023). Subject-specific cases demonstrate chemistry learning gains, for example in distillation and phytochemicals, and physics gains through traditional games, local environmental practices, and community technologies, while also indicating persistent gaps in teachers' content knowledge and pedagogical repertoire that require targeted training and resources.

A growing number of studies has implemented ethnoscience-based learning with school students, using local games, food processing, handicrafts, and environmental practices as contexts for teaching concepts in physics, chemistry, and biology (Dewi et al., 2019; Hariyono et al., 2023; Saminan et al., 2024). Ethnoscience has also been combined with blended and mobile learning strategies, demonstrating that culturally grounded content can be integrated into contemporary instructional technologies (Irfandi et al., 2023; Subali et al., 2023). Taken together, this literature indicates that ethnoscience can enrich science education across different levels and modalities and can be operationalised through diverse media and pedagogical models.

Despite this potential, the relationship between indigenous knowledge and school science remains complex and contested. School science has historically privileged Western scientific rationality, often marginalising or delegitimising non-Western ways of knowing. This asymmetry can lead to epistemic injustice, where community knowledge is treated as folklore rather than as a source of valid insight. Research on ethnoscience in teacher education documents persistent deficits in both prospective and in-service teachers' ethnoscience knowledge and the limited availability of culturally relevant materials, even though teachers generally express favourable attitudes toward integrating local knowledge into their practice (Shofiyah et al., 2020; Ningrat et al., 2024; Yulia, 2025). Teacher education therefore has a crucial role in preparing future teachers who are not only competent in scientific content but also able to recognise, interpret, and pedagogically mobilise indigenous knowledge.

One central challenge lies in supporting preservice teachers to move beyond treating local practices as superficial cultural "decoration" towards engaging with them as sites of systematic inquiry. Ethnoscience-oriented teacher education must create opportunities for preservice teachers to interact directly with knowledge holders in their communities, document practices carefully, and analyse them through the lens of science curricula. Controlled and developmental studies indicate that embedding ethnoscience in teacher education through validated e-modules, blended e-learning environments, and structured project practicums can improve preservice teachers' scientific literacy, critical thinking, and 21st-century competencies (Mahbubah et al., 2025; Sumarni et al., 2025). Such experiences need to be accompanied by explicit reflection on epistemological issues, including how to negotiate tensions between indigenous explanations and scientific models and how to teach science in ways that are both culturally responsive and critically rigorous.

Project- and community-based ethnoscience models have been proposed as particularly suitable pedagogical approaches in teacher education because they engage students in extended, authentic tasks that require inquiry, collaboration, and product creation. STEMPjBL, CoESTEAMPjBL, and other community-partnership models link local artisans and practices to STEM tasks, thereby promoting creativity, collaboration, and entrepreneurship alongside conceptual understanding (Putri et al., 2025; Sumarni et al., 2025; Hidayah et al., 2024; Wahyudi et al., 2023). Digital technologies and e-learning environments can further support such projects by providing access to references, multimedia documentation tools, and virtual simulations, while still centring field-based engagement with communities (Irfandi et al., 2023; Subali et al., 2023). These approaches align with broader efforts to cultivate higher-order thinking and problem solving in authentic contexts (Bayani et al., 2023).

At the same time, studies of implementation at scale highlight resource constraints, time limitations, and infrastructural challenges that can hinder the sustained integration of ethnoscience in schools and teacher education institutions. These challenges point to the need for curricular embedding, sustained professional development, and long-term community partnerships (Shofiyah et al., 2020; Ningrat et al., 2024; Yulia, 2025; Hardiansyah et al., 2024). Most existing ethnoscience interventions still position preservice teachers as recipients or implementers of materials designed by researchers, rather than as active investigators and mediators between community knowledge and school science. Consequently, there remains limited empirical work that documents in detail how preservice science teachers themselves engage in ethnoscience exploration and how they reconstruct indigenous knowledge into potential learning resources.

The present study addresses this gap through an ethnoscience project embedded in an Ethnoscience course for preservice science teachers at Universitas Qamarul Huda Badaruddin Bagu in Central Lombok, Indonesia. Within this course, student groups collaborated with local artisans engaged in practices such as knife forging, brick and roof-tile production, herbal medicine preparation, jamu kunyit asam making, palm-sugar and sweet tuak production, and weaving of bags, bamboo food trays, and bird cages. Guided by course materials and structured worksheets, the students documented artisans' practices, identified scientific phenomena, mapped these onto formal concepts and curriculum topics, and developed initial ideas for science learning activities. They also produced concept maps and reflective writings that articulated their emerging understanding of ethnoscience and culturally responsive pedagogy.

The aim of this paper is to characterise how preservice science teachers reconstructed indigenous knowledge from Central Lombok artisans into potential school science learning resources and to examine the pedagogical and epistemological implications of this process. Specifically, the study analyses (1) the ethnoscientific characteristics of the artisanal practices explored, (2) the scientific phenomena and school science concepts identified by the students, (3) the ways in which students transformed field-based narratives into scientific explanations and curriculum-linked concept maps, and (4) the forms of pedagogical and epistemological reflection that emerged. By foregrounding preservice teachers as ethnoscience explorers and mediators, the study offers a detailed account of a community-based ethnoscience project in teacher education and proposes a model that can inform science teacher education programmes in similar contexts.

METHOD

Research design

This study employed a qualitative, single-case ethnoscience design with a descriptive and interpretive orientation and a case study strategy. The ethnoscience perspective was adopted to foreground indigenous knowledge embedded in community practices as a legitimate and analytically rich source for science education and to trace how this knowledge is reconstructed for school science by preservice teachers (Dewi et al., 2019; Hariyono et al., 2023; Saminan et al., 2024). In line with ethnoscience methodology, the design combined elements of qualitative case study and ethnographic techniques, such as prolonged engagement with community knowledge holders, participant observation, and iterative interviewing, in order to document local practices and examine preservice teachers' pedagogical enactments

(Sammel, 2020). The "case" was defined as one iteration of the Ethnoscience course offered in the Science Education Study Program at Universitas Qamarul Huda Badaruddin Bagu, Central Lombok, during an odd academic semester.

The qualitative single-case design was chosen because the research questions focused on characterising processes, representations, and reflections rather than testing interventions or measuring predefined outcomes. Ethnoscience-oriented studies have frequently used descriptive and interpretive designs to capture the complexity of local knowledge and its transformation in educational settings (Dewi et al., 2019; Kurniawan et al., 2019; Jufrida et al., 2024). In this study, description was understood as a systematic, theory-informed portrayal of how indigenous knowledge and scientific knowledge were related through course activities and how preservice teachers enacted ethnoscience-based pedagogies in a community-engaged practicum, rather than as a simple listing of activities (He & Bagwell, 2022; Meidl et al., 2018).

Participants and setting

The participants were preservice science teachers enrolled in the Ethnoscience course in the Science Education Study Program, Faculty of Teacher Training and Education (FKIP), Universitas Qamarul Huda Badaruddin Bagu, Central Lombok, Indonesia. One intact class was involved; the exact number of students can be specified according to institutional records. Purposive sampling was applied at two levels. First, an intact class was selected as a cohort of preservice teachers who were formally enrolled in an ethnoscience-oriented course. Second, community knowledge holders (artisans) who possessed specialised indigenous expertise and were willing to collaborate were selected (He & Bagwell, 2022; Meidl et al., 2018). Students were organised into small groups of three to five members, and each group selected one local artisanal practice as the focus of its ethnoscience project.

The Ethnoscience course is a compulsory course in the science education curriculum and spans 16 weekly meetings. It is designed to introduce basic concepts of indigenous knowledge and ethnoscience, methods of ethnoscience exploration, and strategies for transforming field findings into school science learning resources. The course adopts a project-based learning (PjBL) model in which groups engage in extended inquiry around authentic community practices and gradually produce a series of artefacts, including field notes, analysis tables, scientific reports, concept maps, and reflective writings. Such ethno-project-based approaches are consistent with community-engaged practicum models such as CoESTEAMPjBL and CSTEMPjBL, which link local artisans and practices to STEM tasks and have been shown to foster scientific literacy, pedagogical content knowledge (PCK), collaboration, creativity, and culturally responsive enactment (Medriati et al., 2023; "PreService STEM Teachers and Their Enactment of CommunitySTEMProject Based Learning (CSTEMPBL)", 2021; Saal et al., 2019; Simpson & Patterson, 2018).

For the purposes of this study, we focused on a cluster of four meetings where field exploration and reconstruction activities were concentrated. Week 7 introduced methods of field data analysis and preliminary coding of ethnoscience findings. In Week 8, students continued field engagement and documentation as needed. Week 9 was devoted to drafting scientific report sections based on field data, and Week 10 was devoted to completing integration worksheets that linked indigenous practices to scientific concepts, curriculum content, and potential learning activities, including the construction of concept maps and reflective commentaries. This sequence parallels community-engaged, service-learning designs in which preservice teachers move from community immersion to co-designed products, guided reflection, and feedback from mentors and community partners (He & Bagwell, 2022; Meidl et al., 2018).

Artisanal practices and practicum structure

The local context of Central Lombok provides a rich diversity of small-scale artisanal industries and traditional practices that are closely interwoven with community life. Based on course documentation, the student groups chose to work with artisans engaged in the following practices: traditional knife forging (pandai besi); production of clay roof tiles and bricks; preparation of traditional herbal medicines; production of jamu kunyit asam; palm sugar processing from nira aren; production of sweet tuak (a non-alcoholic sap drink consumed locally); weaving of plastic rope bags; weaving of bamboo food trays (ingke); craftsmanship of bamboo bird cages; and, in some groups, construction of conical hats (caping).

These practices were selected according to criteria of accessibility, willingness of artisans to collaborate, and perceived richness of scientific phenomena. The selection process aligns with ethnoscience research that emphasises collaboration with knowledge holders and the need to respect community priorities and constraints (Lightner et al., 2021; Majumdar & Chatterjee, 2021). Pedagogically, the practicum was designed to map each practice to canonical concepts in physics, chemistry, and biology, similar to community-engaged ethnoscience interventions that work with local practices such as seaweed bioenergy, eucalyptus distillation, kolecer games, and keris craft (Medriati et al., 2023; "PreService STEM Teachers and Their Enactment of CommunitySTEMProject Based Learning (CSTEMPBL)", 2021). Each group negotiated visit schedules and documentation modes with the artisans, while the course lecturer and community partners acted as mentors to support ethical reciprocity and culturally responsive engagement (Saal et al., 2019; Simpson & Patterson, 2018).

Data sources

Data for this study were drawn from multiple artefacts and interactional records generated by students, lecturers, and community partners during the course. First, field observation sheets and field notes produced during visits to artisans served as primary records of practices in situ. These included textual descriptions, sketches of tools and workspaces, and initial identification of salient stages and phenomena, collected through participant observation (Sammel, 2020). Second, semi-structured interviews and, in some groups, focus group discussions with artisans documented their explanatory models, rationales for particular procedures, and reflections on intergenerational knowledge transmission (He & Bagwell, 2022; Meidl et al., 2018).

Third, structured analysis tables developed for Week 7 guided students to reorganise their field data into columns representing practice stages, tools and materials, observed physical or biological changes, local terms or concepts, and tentative links to scientific phenomena. These tables functioned as an intermediate step between narrative field notes and more abstract scientific representations. Fourth, draft scientific reports prepared in Week 9 followed a simplified IMRD (Introduction–Methods–Results–Discussion) structure and required students to re-express parts of their field findings in scientific language, supported by basic literature references related to metallurgy, ceramics, phytochemistry, food science, or material science, depending on the practice under study.

Fifth, Week 10 learning media worksheets (LKM 10.1, LKM 10.2, LKM 10.3) constituted a major data source for this research. LKM 10.1 required students to systematically map each stage of the artisan practice to empirical phenomena and to junior and senior high school science curriculum concepts. LKM 10.2 guided students in constructing concept maps that linked four layers, namely local practice, phenomena, scientific concepts, and curriculum topics or competencies. LKM 10.3 elicited reflective commentary on the integration of ethnoscience and science education, including perceived opportunities, challenges, and implications for future teaching. These artefacts are consistent with qualitative ethnoscience case work with preservice teachers, which typically uses concept maps, student-produced artefacts such as e-modules or mind-mapping videos, lesson plans, reflection worksheets, community narratives, and field notes as primary data sources (Kearney & Maher, 2019; Coddington, 2020).

In addition, course design documents, including the Ethnoscience syllabus, lecturer slides on ethnoscience exploration, and materials on indigenous versus scientific knowledge, provided contextual information about the intended pedagogical and epistemological framing of the project. Where available, outputs from e-module trials, digital concept-mapping tools, and other project products were also collected as part of the data corpus, in line with authentic assessment and portfolio-based approaches in community-engaged teacher education (Saal et al., 2019; Simpson & Patterson, 2018).

Data analysis

Data were analysed qualitatively through iterative thematic analysis and constant comparison, with particular attention to the processes of knowledge transformation from indigenous to scientific and pedagogical forms. The analytic strategy integrated artefact analysis, coding of interview and observation records, and interpretation of concept maps and reflective texts, in line with established practices in ethnoscience-based teacher education research (Kearney & Maher, 2019; Coddington, 2020).

In the first phase, field notes, analysis tables, and report drafts were subjected to open coding in order to identify units of meaning related to (a) stages of artisan practices, (b) material inputs and tools, (c) observable physical, chemical, or biological changes, and (d) local terminologies and explanatory statements. Codes were assigned at the level of practice stage and phenomenon, producing descriptors such as “heating metal to red hot”, “kneading wet clay”, “evaporation of sap water”, “risk of fermentation”, or “bamboo flexibility”. This phase foregrounded the internal structure of each artisanal practice and the forms of tacit and explicit knowledge articulated by artisans.

In the second phase, codes were grouped axially into broader categories organised by science domains (physics, chemistry, biology, environmental or earth science) and by cross-cutting themes such as “heat and phase changes”, “material strength and elasticity”, “mixtures and solutions”, “bioprocesses and fermentation”, “human physiology”, and “waste and sustainability”. This categorisation sought to make explicit how ethnoscientific knowledge intersected with standard school science domains, in line with previous ethnoscience-based curriculum studies (Dewi et al., 2019; Hariyono et al., 2023; Saminan et al., 2024).

In the third phase, LKM 10.1 and LKM 10.2 were examined to analyse how students mapped empirical phenomena onto specific science topics and learning outcomes in the junior and senior high school curriculum. We documented which topics were most frequently selected, how they were distributed across grade levels and domains, and where patterns of overrepresentation or gaps appeared. Concept maps were inspected for their structural complexity, the clarity of distinctions between phenomena and concepts, and the presence of cross-links connecting different practices or domains. These analyses were informed by frameworks for concept map interpretation and authentic assessment of PCK and epistemic shifts in community-engaged STEM practicum settings (Kearney & Maher, 2019; Saal et al., 2019; Simpson & Patterson, 2018).

In the fourth phase, draft scientific reports and concept maps were analysed to trace the strategies by which students re-expressed indigenous knowledge in scientific terms. We identified instances where local explanations were preserved, reinterpreted, or replaced, examined how scientific vocabulary and analogies were used, and noted examples of explicit comparison between indigenous categories and research-based models. Particular attention was given to shifts from narrative description to analytical explanation and to the ways in which curriculum terminology was introduced. Finally, reflective responses in LKM 10.3 were coded for indications of pedagogical insight, such as recognising the motivational potential of local contexts and designing contextual learning activities, epistemological awareness, such as acknowledging multiple ways of knowing and identifying tensions between tradition and science, and perceived challenges, such as limited scientific background and difficulty in balancing respect and critique. Themes emerging from reflections were compared with patterns identified in the other data sources in order to build an integrated account of the project's pedagogical and epistemological effects.

Throughout these phases, constant comparison across groups and data types was used to refine categories and to ensure that interpretations were grounded in the empirical corpus (He & Bagwell, 2022; Meidl et al., 2018). Member-checking conversations with the course instructor and, where feasible, feedback from selected artisans were used to test the plausibility of interpretations and to surface alternative readings of the practices and classroom implications.

Trustworthiness and ethical considerations

Trustworthiness was addressed through prolonged engagement, methodological triangulation, reflexive discussion among researchers, and member checking. Multiple types of student artefacts were analysed for each group, which enabled cross-verification of observations, analyses, and reflections. Preliminary coding schemes and thematic interpretations were discussed within the research team and with the course lecturer in order to check for consistency and to clarify course-specific terminology and expectations. Where possible, interpretations of particular practices were compared with relevant literature on metallurgy, ceramics, herbal medicine, food processing, and material science to support their plausibility.

Ethical considerations centred on respectful engagement with artisans as knowledge holders and on reciprocity with communities. Students sought negotiated consent to conduct observations, interviews, and documentation, and they were advised to avoid recording sensitive information or portraying practices in ways that could harm the reputation or livelihood of artisans. In line with service-learning and civic-engagement literature, ethical practice foregrounded benefit sharing, co-design of learning activities, and protection of artisanal knowledge (Meidl et al., 2018; Saal et al., 2019; He & Bagwell, 2022; Simpson & Patterson, 2018). Practically, this included sharing documentation products with artisans, discussing potential uses of materials in local schools, and inviting feedback on how the community wished to be represented. The research was embedded in routine teaching activities of the Ethnoscience course and followed institutional norms for ethical conduct in educational settings, while co-designed assessments, capacity-building discussions, and transparent dissemination were used to mitigate access barriers and safeguard reciprocity with communities.

Figure 1 provides a visual overview of this methodological "staircase," beginning with the adoption of a qualitative single-case ethnoscience design and the selection of participants and setting, proceeding through the organisation of artisanal practicum activities, the generation of multiple qualitative data sources, and iterative thematic analysis, and culminating in procedures to ensure trustworthiness, address ethical considerations, and derive final integrated interpretations of the research.

RESULTS

Overview of ethnoscience mapping outcomes

Analysis of students' Week 10 artefacts, particularly LKM 10.1 (tables of phenomena and concepts), LKM 10.2 (concept maps), and LKM 10.3 (reflective commentaries), shows that the preservice science teachers were able to identify a wide range of scientific phenomena embedded in the eleven artisanal practices explored and to relate these phenomena to formal science concepts and school curriculum topics. Across practices, students consistently recognised that artisans' procedures involved systematic manipulation of materials, control of conditions such as temperature and moisture, and empirical testing of quality, even when these were not expressed in formal scientific language. The ideal profiles in the lecturer's assessment guide were largely achieved by the strongest groups and approximated by others, indicating that the ethnoscience project was effective in making the scientific dimensions of local practices visible to preservice teachers.

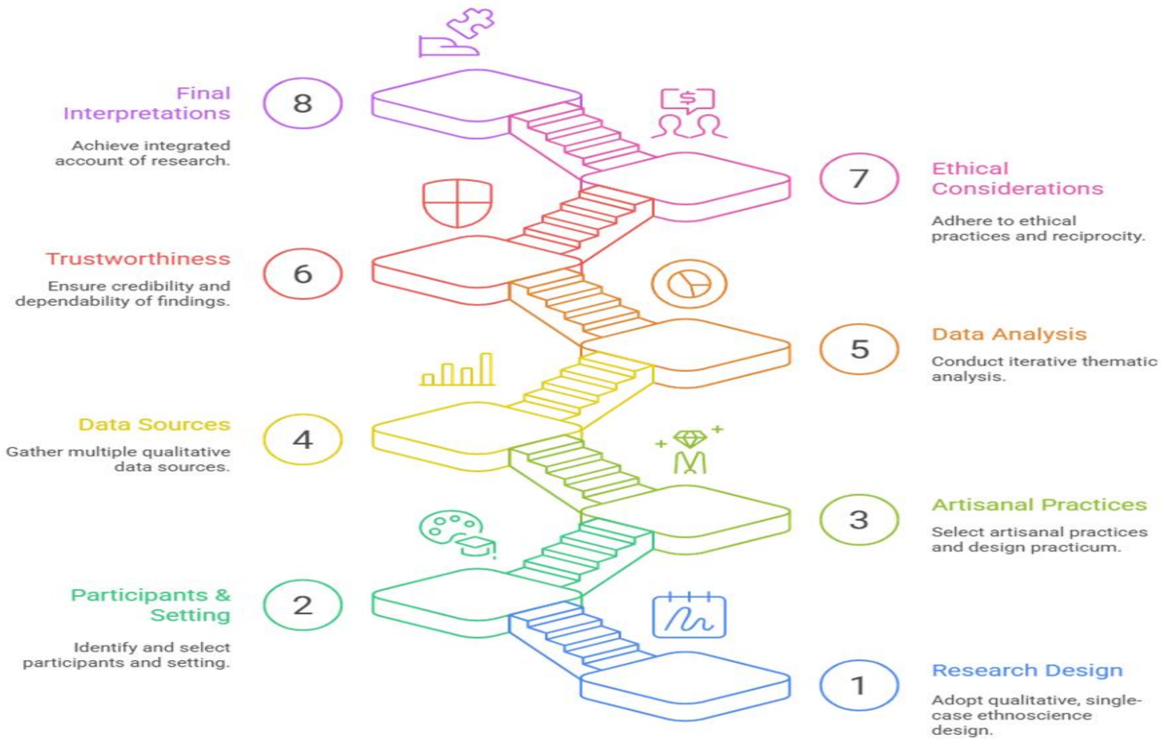

Figure 1. Stepwise representation of the ethnoscience-based research methodology

Ethnoscientific phenomena and science concepts across artisanal practices

Table 1 summarises the main scientific phenomena, disciplinary domains, and exemplar curriculum topics identified across the eleven artisanal practices. Rather than treating each practice as a single illustration of one concept, students' LKM 10.1 tables typically identified multiple phenomena and concepts at successive stages of the practice.

Table 1. Summary of scientific phenomena and school science topics identified across artisanal practices

Local artisanal practice	Dominant phenomena identified	Main science domains	Example school science topics
Traditional knife forging (pandai besi)	Heating of metal until red hot; thermal expansion and softening; plastic deformation by hammering; rapid cooling (quenching); friction and heat during sharpening; corrosion and protection by oil	Physics, chemistry, environmental science	Heat and temperature; heat transfer; forces and pressure; changes in material properties; oxidation and corrosion
Clay roof tile (dure) production	Formation of plastic clay–water mixture; sun drying and evaporation; firing in kilns and sintering; distribution of heat in stacked tiles	Physics, chemistry, earth science	Properties of soil; evaporation and the water cycle; heat transfer by conduction and convection; physical and chemical changes of matter
Brick production	Influence of soil composition on brick quality; drying and evaporation; high-temperature firing and colour change; sound-based testing of density and cracks	Physics, chemistry, earth science	Composition of soil; states of matter and change; oxidation; sound and material structure
Herbal medicine preparation	Use of multiple plant parts; drying of plant materials; extraction in water; dosing and frequency of consumption; dietary restrictions	Chemistry, biology, health science	Mixtures and solutions; natural chemical compounds; human digestive and circulatory systems; nutrition and health
Jamu kunyit asam production	Washing and cleaning of ingredients; grating to increase surface area; boiling and extraction;	Physics, chemistry, biology	Microorganisms and hygiene; surface area and rate of dissolution; heat transfer; separation of

	filtration; consumption for stamina		mixtures; digestive system
Palm sugar processing	Sap collection from aren flowers; evaporation of water during prolonged boiling; concentration of sugar and caramelisation; cooling and solidification in moulds	Physics, chemistry, biology	Plant structure and transport; evaporation and boiling; solutions and concentration; thermal decomposition and caramelisation; phase changes
Sweet tuak production	Collection of fresh sap; susceptibility to microbial fermentation; influence of temperature on fermentation rate; consumption as energy drink	Chemistry, biology, environmental science	Microorganisms and food; fermentation; temperature and reaction rate; nutrition and metabolism
Woven plastic rope bags	Stretching and bending of plastic strips; strength of woven patterns; distribution of forces; reuse of plastic waste	Physics, environmental science	Mechanical properties of materials; forces and tension; structure and stability; recycling and plastic waste
Ingke (woven food trays)	Circular woven patterns; rotational symmetry and geometric repetition; ability to support loads; use of recycled materials	Physics, mathematics, environmental science	Geometry and symmetry; forces and pressure; recycling and environmental pollution
Bamboo bird cages	Selection of bamboo with appropriate age and moisture content; splitting and thinning; assembly into curved frame; light but strong structure	Biology, physics, engineering science	Plant anatomy and tissue structure; properties of materials; forces and frameworks; simple structural design
Bamboo conical hats (caping)	Selection and cutting of bamboo; splitting into strips; weaving diamond patterns; forming a cone; reinforcement with circular frames; shading and ventilation	Biology, physics, mathematics	Structure of bamboo; physical and geometric properties of conical shapes; force distribution in woven structures; solar radiation and heat transfer

The table indicates that all practices involve multiple domains, with physics and chemistry dominant in thermal and mechanical processes (forging, brick and roof tile production, palm sugar making), biology and health central in plant-based practices (herbal medicine, jamu, sap processing), and environmental and mathematical ideas embedded in weaving and structure-related practices. Students' mapping confirms that ethnoscientific practices are inherently interdisciplinary and can support integrated science teaching. These findings resonate with case analyses showing that other local crafts and technologies instantiate canonical phenomena that can be translated into school science targets, such as eucalyptus oil distillation as a context for teaching separation methods, phase change, and density (Hardiansyah et al., 2024), kolecer traditional games as embodiments of mechanics and motion (Sholahuddin & Admoko, 2021), and natural dyeing processes as models for reconstructing material chemistry and process concepts for classroom use (Sholihah et al., 2024).

Distribution of curriculum topics and domains

Analysis of LKM 10.1 and LKM 10.2 showed that students most frequently linked artisanal practices to junior secondary topics on heat and its transfer, states of matter and changes, forces and motion, mixtures and separation, and human body systems. These topics appeared across several practices. For instance, heat and temperature were identified in forging, roof tile and brick firing, jamu boiling, and palm sugar processing. Mixtures and separation were recognised in herbal medicine preparation, jamu filtration, and the handling of sap. Environmental topics such as waste management, recycling, and local environmental impact were associated particularly with woven plastic products and with fuel use in kilns, although less consistently than core physical and chemical concepts.

Concept maps provided a visual representation of these distributions. Many maps located the local practice at the centre, with first-level branches representing empirical phenomena (for example "metal turns red and soft", "sap volume decreases when boiled", "plastic ropes are stretched but do not break"), second-level branches representing underlying concepts (for example "heat transfer", "evaporation", "elasticity of polymers"), and third-level branches indicating curriculum topics and grade levels. In more elaborate maps, cross-links were drawn between nodes associated with different practices but similar concepts, for example connecting heat-related phenomena in forging and palm sugar boiling, or mixture-related phenomena in jamu and herbal medicine. These patterns suggest that the project encouraged students to see recurring concepts across diverse everyday contexts rather than treating each practice as isolated.

Viewed through a curriculum design lens, these mappings represent an important step beyond the fragmented use of local examples that often characterises early stages of ethnoscience integration. Research on place-based and "both-ways" approaches highlights that effective ethnoscience curriculum work requires a staged progression from fragmented, incidental inclusion towards connected, sequenced, and ultimately integrated units in which local practices are central organisers of content rather than peripheral illustrations (Handayani et al., 2018). Bibliometric and case reviews similarly document that many existing initiatives remain at the level of sporadic integration and recommend community co-design and structured teacher development to secure epistemic justice and sustained enactment (Gunawan & Indrawan, 2025; Rioux & Smith, 2019). The patterns in this study indicate that the Ethnoscience course began to move preservice teachers along this continuum, although fuller integration would require more systematic programme-level design.

Quality and patterns of concept maps

The lecturer's guide for Week 10 work described characteristics of high-quality concept maps for each practice, including the presence of four layers (practice, phenomena, concepts, curriculum), clear linking phrases, and explicit recognition of both physical and chemical or biological aspects. Comparison of student maps with these criteria indicated considerable variation in sophistication. Some groups produced relatively simple radial maps with only a few nodes and generic links (for example "related to heat", "related to mixtures"), whereas others constructed more hierarchically organised maps with multiple levels and meaningful linking phrases such as "heating causes expansion of metal", "woven pattern distributes forces evenly", or "cone shape increases shaded area and allows air circulation".

Overall, the strongest maps were associated with practices in which phenomena are visually salient and familiar (forging, roof tile and brick making, jamu production). Maps for herbal medicine and sweet tuak tended to be less detailed, reflecting students' uncertainty about biochemical processes and health effects. In addition, some maps initially conflated phenomena with concepts, labelling nodes simply as "evaporation" or "friction" without describing what is observed. Through iterative feedback, students were encouraged to differentiate between descriptive statements (for example "water vapour rises from boiling sap") and conceptual labels ("evaporation"), leading to clearer and more analytically useful representations.

These patterns are consistent with research showing that concept mapping can help preservice science teachers externalise and reorganise links between indigenous or artisanal practices and canonical science, thereby strengthening pedagogical content knowledge and curriculum design capacities (Chen, 2019; Beaudreau, 2018). Collaborative concept map construction and guided reflection have been found to enhance preservice teachers' pedagogical awareness and scientific literacy by making their implicit assumptions and understandings visible and open to critique (Chen, 2019; Beaudreau, 2018). At the same time, studies indicate that variability in preservice teachers' epistemological beliefs, ranging from more naïve, absolutist stances to more sophisticated, evaluativist positions, can create tensions when mediating between Western science and local knowledge and can influence how teachers conceptualise both learning and assessment (Tessema et al., 2024; Munfaridah et al., 2023; Ningrat et al., 2024). The heterogeneity observed in the concept maps and reflections in this study can be interpreted partly through this lens.

Patterns in reflective commentaries

Reflective responses in LKM 10.3 revealed several recurring themes. Many students reported that the ethnoscience project changed their perception of local practices, which they had previously taken for granted, by making visible that "science is already present in the village". They described increased appreciation for artisans' expertise and recognised that these practices could be used as engaging contexts for teaching topics such as heat, mixtures, and environmental issues. Several groups explicitly mentioned potential lesson ideas, such as analysing videos of forging to identify evidence of heat transfer, conducting simple experiments on evaporation using palm sugar syrup, or inviting artisans to co-teach selected sessions.

At the same time, students highlighted challenges in translating indigenous explanations into scientific terms. In herbal medicine and sweet tuak, for instance, artisans' explanations drew on humoral or balance-based models and on local categories of "hot" and "cooling" foods. Students struggled to decide how far such explanations could be accommodated within scientific discussions of metabolism, inflammation, or fermentation, and they expressed concern about contradicting community beliefs or making overconfident health claims without research evidence. These reflections indicate emerging epistemological awareness: students recognised that indigenous and scientific knowledge systems may use different categories and that respectful dialogue requires careful framing. This is in line with findings that preservice teachers' epistemological beliefs are closely related to their conceptions of assessment and to their comfort with negotiating multiple knowledge systems, and that purposeful mediating strategies such as reflective practices and community-engaged learning are needed to support epistemic justice in curriculum enactment (Tessema et al., 2024; Munfaridah et al., 2023; Ningrat et al., 2024).

Another recurrent theme was the difficulty of identifying appropriate curriculum levels and competencies for complex practices. Some groups tended to overestimate what junior secondary students could grasp, proposing to teach microstructural changes in metal or detailed carbohydrate chemistry, whereas others underestimated possibilities, limiting activities to superficial observation. Through class discussions, students began to calibrate their proposals, aligning them more closely with existing curriculum documents while still attempting to preserve the richness of artisanal practices.

DISCUSSION

Artisanal practices as rich contexts for integrated science learning

The results demonstrate that artisanal practices in Central Lombok embody dense clusters of phenomena that cut across physics, chemistry, biology, and environmental science. This confirms ethnoscience studies which argue that indigenous knowledge systems are not merely collections of isolated facts but integrated frameworks for understanding and acting in local environments (Lightner et al., 2021; Majumdar & Chatterjee, 2021). By systematically identifying heat transfer, phase changes, mixture behaviour, plant physiology, microbial processes, and structural mechanics within these practices, preservice teachers showed that everyday activities such as forging a knife, boiling sap, or weaving plastic bags can be reconsidered as enactments of scientific principles.

These findings parallel other ethnoscience case studies in which local crafts such as eucalyptus oil distillation, traditional games, and natural dyeing techniques have been reconstructed as rich contexts for teaching core chemical and physical concepts, including separation and phase change, mechanics and motion, and material chemistry (Hardiansyah et al., 2024; Sholahuddin & Admoko, 2021; Sholihah et al., 2024). From a curriculum perspective, the mapping work in this study illustrates the potential of ethnoscience to support integrated or thematic units that transcend disciplinary boundaries. Instead of teaching heat, mixtures, and environmental impact as separate topics, teachers could design sequences in which a single practice such as palm sugar making provides the narrative thread, with each lesson focusing on a different layer (for example physical changes during boiling, chemical changes during caramelisation, biological processes in the palm tree, and environmental implications of fuel use). Such approaches align with calls for contextualised, interdisciplinary science learning that builds students' capacity to connect concepts with real-world situations (Dewi et al., 2019; Hariyono et al., 2023; Saminan et al., 2024; Handayani et al., 2018).

Preservice teachers as mediators between indigenous and scientific knowledge

The project positioned preservice teachers not as recipients of predesigned ethnoscience materials but as active mediators between community knowledge and school science. Their progression from narrative field notes to structured tables, scientific report drafts, concept maps, and reflective essays reveals the epistemic work involved in this mediation. Students had to listen carefully to artisans' procedural knowledge and explanations, identify empirical regularities, select relevant scientific concepts, and align these with curriculum topics and grade levels. This process echoes findings that teachers' ethnoscience knowledge significantly shapes their ability to design contextual lessons and to move beyond tokenistic inclusion of local content (Kurniawan et al., 2019; Jufrida et al., 2024; Gunawan & Indrawan, 2025; Rioux & Smith, 2019).

The challenges students reported, especially in the domains of herbal medicine and fermentation, indicate that mediation is not a simple matter of translating local beliefs into scientific language. Instead, it requires critical reflection on where categories overlap, where they diverge, and how to handle differences without disrespecting community perspectives. By grappling with tensions between humoral explanations and biomedical models, or between traditional understandings of tuak and scientific concerns about fermentation and alcohol, students began to develop the epistemological sensitivity needed for culturally responsive yet evidence-informed teaching. This is consistent with research showing that preservice teachers' epistemological beliefs and assessment conceptions can either constrain or enable nuanced mediation between Western science and local knowledge, and that explicit reflective and community-engaged experiences are needed to foster more sophisticated, justice-oriented stances (Tessema et al., 2024; Munfaridah et al., 2023; Ningrat et al., 2024).

Curriculum design, EthnoPjBL, and digital mediation

The patterns observed in concept maps and reflections suggest that the project-based structure of the Ethnoscience course, combined with structured tools such as LKM 10.1–10.3, provided an effective scaffold for curriculum design. Students moved from broad recognition of "science in local practices" towards more precise articulation of which concepts could be taught, at which levels, and through which activities. This resonates with research on ethnoscience-based and RESTEM-inspired digital learning environments, which shows that carefully designed tasks can help students integrate local contexts with formal concepts and twenty-first-century skills (Subali et al., 2023; Wahyudi et al., 2023; Bayani et al., 2023).

More broadly, recent work on EthnoPjBL, understood here as ethnoscience framed explicitly as project-based learning and delivered through blended or digital modalities, indicates that integrating e-modules, learning management systems, and mobile learning into culturally grounded projects can promote critical thinking, creativity, collaboration, communication, and digital literacy (Rahmat et al., 2025; Herayanti et al., 2025). Empirical studies demonstrate that EthnoPjBL and online PjBL designs lead to measurable gains in scientific process skills and literacy, with e-materials and learning management system scaffolds supporting project enactment, formative assessment, and peer collaboration (Husna & Asrizal, 2025; Herlinawati & Suhartini, 2025). The Ethnoscience course in this study did not employ a fully learning management system-mediated model, but the use of digital tools for documentation, concept mapping, and language support indicates the feasibility of such integrations.

At the same time, implementation research cautions that teacher readiness and infrastructural limitations can constrain the scalability of EthnoPjBL, highlighting the necessity of sustained professional development and community co-design (Rahmat et al., 2025; Herayanti et al., 2025; Husna & Asrizal, 2025; Herlinawati & Suhartini, 2025). The findings in this study underscore this point. While preservice teachers were able to generate promising contextual lesson ideas, some still struggled with content depth, assessment design, and ethical engagement with communities, suggesting that longer-term, programme-wide support is required.

The use of concept mapping in particular appears to have supported higher-order thinking by requiring students to organise and interrelate ideas rather than listing them. However, the variation in map quality indicates that explicit instruction in concept mapping techniques, including the distinction between phenomena and concepts and the use of linking phrases, is important. Integrating digital concept mapping tools or e-learning platforms may further enhance students' ability to visualise complex relationships and to revise their representations iteratively (Chen, 2019; Beaudreau, 2018).

Epistemological tensions and opportunities for critical reflection

Students' reflections highlight epistemological tensions that are often underemphasised in ethnoscience discourse. While many studies celebrate the motivational and cultural benefits of integrating local knowledge, fewer address the difficulties teachers face when local explanations conflict with scientific evidence or when the efficacy of remedies is uncertain (Majumdar & Chatterjee, 2021). In this project, preservice teachers confronted these issues directly, particularly in relation to health claims and fermentation. Their concerns about making unsupported claims or offending community beliefs reveal both ethical sensitivity and the need for structured discussion of epistemic criteria in teacher education.

These tensions can be reframed as productive learning opportunities. By comparing indigenous and scientific explanations, teachers can guide students to examine how different knowledge systems construct evidence, causality, and authority, without reducing the discussion to a simple hierarchy in which science always corrects tradition. In line with broader discussions of epistemic justice, the goal is not to romanticise indigenous knowledge but to recognise its empirical and cultural validity while also teaching critical evaluation (Rioux & Smith, 2019; Gunawan & Indrawan, 2025). The ethnoscience project created initial spaces for such reflection. Future iterations could strengthen this component through dedicated sessions on epistemology, assessment, and dialogue strategies, building on insights from research on preservice teachers' epistemological beliefs and assessment conceptions (Tessema et al., 2024; Munfaridah et al., 2023; Ningrat et al., 2024).

Implications for ethnoscience-based teacher education

The findings from this case study contribute to the growing literature on ethnoscience in science teacher education by providing a detailed account of how preservice teachers engage in community-based exploration and knowledge reconstruction. The combination of fieldwork with artisans, structured analytic tools, concept mapping, and reflective writing appears to foster multiple dimensions of professional competence, including sensitivity to local contexts, conceptual understanding of science content, curriculum design skills, and epistemological awareness. These outcomes align with the aims of ethnoscience-oriented chemistry and physics education reported in earlier studies and with broader evidence that EthnoPjBL and community-engaged STEM projects can enhance scientific literacy and twenty-first-century competencies (Dewi et al., 2019; Saminan et al., 2024; Rahmat et al., 2025; Herayanti et al., 2025; Husna & Asrizal, 2025; Herlinawati & Suhartini, 2025).

At the same time, the study points to areas for further development. Some students' mappings remained superficial, suggesting the need for stronger integration of content courses and ethnoscience projects so that preservice teachers have sufficient conceptual resources to interpret complex phenomena. In addition, more explicit guidance on collaborating with community members, handling ethical issues, and using digital tools critically would strengthen the project's impact. Implementation studies emphasise that scaling ethnoscience-based and community-engaged practicum models requires curricular embedding, mentor support, sustained training, and ethical reciprocity with communities (He & Bagwell, 2022; Meidl et al., 2018; Saal et al., 2019; Simpson & Patterson, 2018; Gunawan & Indrawan, 2025; Yulia, 2025). Longitudinal research that follows participants into their teaching careers would help to determine how far these ethnoscience experiences translate into sustained classroom practice and into students' scientific literacy, twenty-first-century competencies, and appreciation of cultural heritage.

Overall, the ethnoscience project examined in this study illustrates how local artisanal practices can serve as powerful pedagogical spaces for reconstructing indigenous knowledge into school science and for cultivating preservice teachers who are able to bridge communities and classrooms in thoughtful, contextually grounded ways. It also demonstrates how EthnoPjBL logics can be realised within a university course, while indicating the institutional support and community partnerships needed to move from promising single-case examples towards more systemic change in science teacher education.

CONCLUSION

This study has examined a qualitative, community-engaged ethnoscience project with preservice science teachers enrolled in an Ethnoscience course at a university in Central Lombok. The project focused on how indigenous knowledge embedded in local artisanal practices, including metal forging, brick and roof-tile production, herbal medicine preparation, jamu kunyit asam, palm sugar and sweet tuak processing, and bamboo and plastic weaving, was reconstructed into potential school science learning resources that are aligned with junior and senior secondary curriculum topics. By tracing preservice teachers' work with field notes, analysis tables, scientific report drafts, concept maps, and reflective commentaries, the study documented how community practices can be transformed into structured representations of scientific phenomena and concepts that are usable in formal science education.

The findings show that, when supported by an EthnoPjBL design, local artisanal practices provide rich, interdisciplinary contexts for integrated science learning. Preservice teachers were able to identify clusters of phenomena that span physics, chemistry, biology, environmental science, and mathematics, and to map these phenomena onto curriculum concepts such as heat and its transfer, phase changes, mixtures and separation, plant physiology, microbial processes, material strength, geometry, and environmental sustainability. Concept mapping and structured worksheets helped them to make these links explicit and to move beyond fragmented or incidental use of local examples toward more connected and curricular mappings. At the same time, their reflections revealed challenges in determining appropriate levels of abstraction, selecting feasible learning activities, and negotiating tensions between indigenous explanatory frameworks and research-based scientific models.

Methodologically, the study illustrates the value of combining community fieldwork with systematic artefact analysis in ethnoscience-based teacher education. Working with artisans as knowledge holders, preservice teachers engaged in documentation, interpretation, and curricular reconstruction of indigenous practices, which strengthened their pedagogical content knowledge, their awareness of scientific phenomena in everyday life, and their appreciation of epistemological issues. The use of project-based structures and tools such as analysis tables, concept maps, and reflective worksheets provided a scaffold for preservice teachers to develop more coherent understandings of how local practices, scientific concepts, and curriculum expectations can be linked in teachable ways.

Overall, the ethnoscience project reported in this paper suggests that community-based, EthnoPjBL-oriented courses can contribute meaningfully to the preparation of science teachers who are able to recognise, respect, and pedagogically mobilise indigenous knowledge in their local contexts. Such experiences have the potential to enhance future teachers' capacity to design contextualised lessons, to foster students' scientific literacy and higher-order thinking, and to support the preservation and critical appreciation of cultural heritage and environmental stewardship. To realise this potential more fully, ethnoscience-based initiatives need to be embedded more systematically at programme level, supported by sustained collaboration between universities, schools, and communities, and accompanied by ongoing professional development that addresses content knowledge, digital mediation, ethical engagement, and epistemological reflection.

RECOMMENDATIONS

Based on the findings and conclusions of this study, several recommendations are proposed for science teacher education programmes, schools, and future research. First, ethnoscience-based and EthnoPjBL-oriented activities should be embedded more systematically in preservice science teacher curricula rather than positioned as isolated course experiences. Programmes can integrate community-engaged ethnoscience projects with content courses in physics, chemistry, biology, and environmental science, so that preservice teachers develop sufficient conceptual depth to interpret complex artisanal practices and to design accurate, curriculum-aligned learning activities.

Second, universities and schools are encouraged to strengthen structured partnerships with local communities and artisans as knowledge holders. These partnerships should be grounded in mutual respect, clear communication, and shared benefits. Joint planning of ethnoscience projects, co-teaching opportunities, and dissemination of learning materials that highlight local practices can enhance both educational relevance and community recognition. Institutional support is needed to provide time, resources, and ethical guidelines for sustained collaboration.

Third, science teacher educators should provide explicit guidance and training on epistemological and ethical issues that arise when mediating between indigenous and scientific knowledge. Course components that address how different knowledge systems construct evidence and explanation, how to handle tensions between local beliefs and research-based models, and how to design assessments that value multiple ways of knowing can help preservice teachers adopt more reflective and justice-oriented stances.

Fourth, the use of digital tools and learning management systems to support EthnoPjBL should be expanded and critically developed. E-modules, digital concept-mapping tools, and online platforms for documenting fieldwork and sharing artefacts can help preservice teachers organise their ideas, collaborate with peers, and receive feedback. At the same time, teacher education programmes need to ensure that digital mediation does not replace direct engagement with communities but rather complements and enriches it.

Finally, further research is recommended to examine the longer-term impact of ethnoscience-based experiences on preservice teachers' classroom practice once they begin teaching. Longitudinal and comparative studies that follow cohorts into their professional careers, investigate student learning outcomes, and explore variations across different cultural and regional contexts would provide a stronger evidence base for scaling up ethnoscience-informed teacher education and for informing policy and curriculum development in science education.

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