

INPLASY

Indigenous mathematical knowledge: A scoping review on its conceptualization

INPLASY2025110045

doi: 10.37766/inplasy2025.11.0045

Received: 16 November 2025

Published: 16 November 2025

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ADMINISTRATIVE INFORMATION**Support** - FONDECYT INICIACIÓN 1124155.**Review Stage at time of this submission** - Preliminary searches.**Conflicts of interest** - None declared.**INPLASY registration number:** INPLASY2025110045

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 16 November 2025 and was last updated on 16 November 2025.

INTRODUCTION

Review question / Objective What definitions and conceptual frameworks regarding indigenous mathematical knowledge are reported in academic literature published in English, Spanish, and Portuguese?

What definitions and conceptual frameworks regarding indigenous mathematical knowledge are reported in academic literature published in English, Spanish, and Portuguese?

The aim of this scoping review is to systematically map and analyze conceptualizations of indigenous mathematical knowledge found in academic literature, in order to identify the main forms of understanding, characterization, theoretical approaches, contexts of use, geographical distribution, and temporal evolution.

Criteria PCC:

- Population: Indigenous peoples and native communities in relation to mathematical practices and knowledge.

- Concept: Definitions, conceptual frameworks, forms of understanding, and characterizations of indigenous mathematical knowledge.
- Context: Academic literature published in English, Spanish, and Portuguese, without geographical or temporal restrictions.

Background Indigenous mathematical knowledge constitutes a set of practices, reasoning, and systems of numerical, spatial, or logical relations that emerge from the lifeways, languages, territories, and worldviews of indigenous peoples (Nutti, 2013; Robinson et al., 2023). It manifests in activities such as weaving, agriculture, navigation, commerce, territorial orientation, and ritual planning (Kabuye, 2024). Unlike Western school mathematics, which is presented as universal and decontextualized, this knowledge is situated, relational, often oral, holistic, and dynamic, inseparable from spiritual, ecological, and social domains.

Historically, ethnomathematics has been the central framework for studying this phenomenon.

Introduced by D'Ambrosio (1985) and conceptualized by Ascher (1991), ethnomathematics challenged the notion of a single school mathematics and made visible diverse mathematical practices in non-Western contexts. However, the field has evolved considerably. While ethnomathematics remains relevant, recent scholars warn that certain applications tend to document practices without questioning power structures conditioning recognition as legitimate knowledge (Appelbaum et al., 2022). Beyond this specific approach, broader theoretical perspectives have emerged, such as indigenous epistemologies, offering a comprehensive framework promoting fundamental reconfiguration of teaching, learning, and valuing knowledge (Walsh et al., 2018). These perspectives align with decolonial approaches emphasizing epistemic pluralism and recognizing indigenous peoples' active resistance and memory as fundamental components of knowledge production (Nahuelpan, 2016), capturing dimensions beyond purely mathematical toward holistic conceptions integrating cosmological, spiritual, and relational indigenous wisdom.

Internationally, diverse initiatives illustrate commitment to integrating indigenous mathematical knowledge in education. Robinson et al. (2023) in Canada documents how mathematics can be grounded in Mi'kmaq language structures; Nutti (2013) in Norway integrates Sámi knowledge in curriculum; and in Latin America, scholars like Quintriqueo and Arias-Ortega (2019) advance overcoming systematic exclusion by conceiving alternative forms of teaching-learning mathematics from own territories and cultures. These initiatives reflect growing academic recognition that mathematics education must incorporate multiple ways of knowing and being.

Academic production on indigenous mathematical knowledge has grown steadily since the mid-2010s. Recent bibliometric analyses show significant growth particularly from 2014 onward, consolidating as an active and expanding field (Tamur et al., 2023; Turmuzi et al., 2024; Rusli et al., 2023). This literature is heterogeneous in scope and approaches: narrative reviews focused on pedagogical applications, bibliometric studies analyzing quantitative trends, book chapters addressing specific aspects, and primarily qualitative empirical investigations (ethnographic, phenomenological) in geographically varied contexts (Gula & Jojo, 2024; Setiaputra et al., 2025). These bibliometric works also warn of need for theoretical integration and expanded geographic coverage.

Despite this growing and diverse production, literature lacks systematic analysis examining

theoretical conceptualizations' evolution as a whole. Existing reviews present fragmented approaches, frequently limited to ethnomathematics as sole interpretive framework, without rigorous methodological synthesis enabling identification of coherent patterns, conceptual divergences, or theoretical integration capturing indigenous perspectives more broadly (Rosa & Orey, 2015). The specialized literature indicates considerable diversity in ethnomathematics' operational definitions and intercultural education applications, reflecting absence of consensus on systematically integrating these knowledges in formal educational contexts (D'Ambrosio & Rosa, 2017). This situation necessitates a synthesis effort consolidating knowledge about how the academic community has defined and interpreted indigenous mathematical knowledge—beyond ethnomathematics—as a systematic object of study.

Rationale In recent decades, there has been growing interest in indigenous knowledge systems (IKS), which are gaining prominence in debates on epistemic justice and the need to decolonize knowledge (Odora, 2021). This recognition is particularly urgent in the context of mathematics, where traditional education has been criticized for perpetuating Western paradigms of knowledge construction that may not align with the cultural contexts of students from indigenous, minority, or historically marginalized communities (Luzano, 2025).

However, there is no comprehensive review that specifically analyzes how indigenous mathematical knowledge has been understood and conceptualized in the academic literature. Existing reviews have focused mainly on pedagogical applications of ethnomathematics (D'Ambrosio, 2019) or on specific case studies of particular peoples, but they lack a systematic synthesis that examines cross-cutting theoretical conceptualizations.

The preliminary search identified narrative reviews on ethnomathematics that focus on educational applications but not on theoretical conceptualizations, bibliometric studies that analyze quantitative trends but not conceptual epistemic content, and book chapters that address specific aspects but without systematic methodology.

This identifies some specific gaps in knowledge: conceptual fragmentation, existing studies present scattered conceptualizations without a coherent synthesis that allows patterns and divergences to be identified; absence of evolutionary analysis, there is no systematic analysis of how these

conceptualizations have evolved over time; lack of global representativeness, existing reviews tend to focus on specific regions without a global perspective; and limited theoretical integration, there is little articulation between different theoretical frameworks used to conceptualize this knowledge.

This scope review is necessary because the texts analyzed demonstrate that the field requires a reconciliation between Indigenous Peoples and their Knowledge (IPK) and colonial institutions that can only be achieved through a progressive interface that begins with a fundamental commitment to mutual collaboration. Without a systematic understanding of how this knowledge has been conceptualized, this reconciliation process lacks a solid foundation (Wolf et al., 2025). Therefore, this review is necessary to: (1) overcome existing conceptual fragmentation; (2) identify consensus and divergences in conceptualizations; (3) highlight the cultural and geographical diversity represented; (4) provide a solid basis for future research and intercultural educational policies; and (5) contribute to debates on epistemic justice and the decolonization of knowledge. On the other hand, it is relevant to different audiences as it can provide: researchers with a solid conceptual basis for future research; educators with a frame of reference for the inclusion of indigenous knowledge in the school curriculum; education policymakers with evidence for the development of intercultural public policies; and indigenous communities with academic recognition of their knowledge systems.

METHODS

Strategy of data synthesis A systematic search was conducted in various academic databases: Web of Science (WoS), Scopus, ERIC (Education Resources Information Center), Google Scholar, Scielo Chile and Scielo Brazil. The following search equation was used in Web of Science, Scopus, and ERIC:

"indigenous knowledge" AND (mathematics OR "mathematical knowledge") AND (definition OR conceptualization OR understanding)

On Google Scholar, the strategy was:

intitle:"indigenous knowledge" intitle:(mathematics OR "mathematical knowledge") (definition OR conceptualization OR understanding) -ethnomathematics

In Scielo Brazil, the expression was used:

educação matemática indígena

And in Scielo Chile, the search was applied:

conocimiento matemático indígena

Qualitative thematic analysis

Methodological framework: inductive thematic analysis to identify patterns in conceptualizations

Units of analysis: definitions, identified characteristics of indigenous mathematical knowledge, and contexts of application

Synthesis strategy: constant comparison between conceptualizations, construction of conceptual taxonomies

Quantitative descriptive analysis

Temporal variables: distribution of publications by decade, identification of periods of greatest scientific production

Geographical variables: frequencies and percentages by continent, country, and specific indigenous communities studied

Methodological variables: proportion of qualitative, quantitative, and mixed studies; predominant types of design

Statistical measures: absolute and relative frequencies, measures of central tendency for continuous variables such as years of publication

Managing heterogeneity

Conceptual heterogeneity: grouping by similar theoretical frameworks (ethnomathematics, indigenous epistemologies, intercultural education)

Contextual heterogeneity: stratification by geographic regions and specific indigenous communities

Methodological heterogeneity: separate analysis by study type when methodologically appropriate.

Eligibility criteria Includes works in English, Spanish, and Portuguese, with no time restrictions. Excludes works that do not focus on indigenous mathematical knowledge or that lack a clear definition or conceptual framework.

Inclusion criteria:

Based on study characteristics:

1. Language: Publications in Spanish, English, or Portuguese

2. Time frame: No publication date restrictions

3. Methodological design: Theoretical, conceptual, empirical qualitative, quantitative, or mixed studies

Content-based:

1. Thematic focus: Studies that conceptualize, define, or theorize about indigenous mathematical knowledge

2. Mathematical dimension: Research that specifically addresses curricular or extracurricular mathematical aspects (not necessarily related to school mathematics) of indigenous knowledge

3. Population: Studies involving peoples, communities, or individuals identified as indigenous or native

Criterios de exclusión:

Based on publication type:

1. Grey literature (theses, technical reports, government documents)

2. Opinion pieces, editorials, letters to the editor

Content-based:

1. Research focused solely on pedagogical applications without addressing theoretical conceptualization
2. Studies that address only Western mathematics applied in indigenous contexts
3. Research that treats indigenous mathematical knowledge as errors or approximations of Western mathematics
4. Duplicate studies or preliminary versions of research already included

Criteria application process:

The criteria were applied sequentially: first by title and abstract (initial screening), then by full text (final evaluation). Three reviewers worked independently applying these criteria, resolving discrepancies by consensus in team meetings. Rayyan QCRI software was used to facilitate the blind selection process and the management of agreements between reviewers.

Source of evidence screening and selection**Stage 1 - Title and Abstract Screening:**

Three independent reviewers will screen all retrieved titles and abstracts using Rayyan QCRI software. Each reviewer independently evaluates each record as "Include," "Exclude," or "Unclear" based on eligibility criteria. Screening is conducted blind to reduce bias. Initial screening focuses on identifying studies mentioning indigenous knowledge and mathematical practices.

Stage 2 - Full Text Review:

Studies approved in Stage 1 proceed to full-text review. The same three reviewers independently assess complete articles against full eligibility criteria (PCC framework):

- Population: Does it address indigenous peoples/communities and their mathematical knowledge?
- Concept: Does it provide definitions, conceptual frameworks, or theoretical characterizations of indigenous mathematical knowledge?
- Context: Published in English, Spanish, or Portuguese academic literature?
- Additional criteria: Recognizes indigenous knowledge as valid; avoids exclusively pedagogical applications without theoretical grounding.

Disagreement Resolution:

- Level 1: Any discrepancies are discussed in team meetings. Disagreements are resolved consensus.
- Level 2: Patterns in disagreements trigger criteria refinement and retrospective application if necessary.

Documentation: For each study, Rayyan tracks:

- Individual reviewer decisions
- Agreement/disagreement between reviewers
- Resolution method for discrepancies
- Final inclusion decision with justification

Quality Assurance:

- Blinding: Reviewer identities protected throughout process
- Standardization: All reviewers complete pre-screening training with 20-30 practice records and discussion of borderline cases
- Parallel workflow: Reviewers work simultaneously to ensure independence
- PRISMA flow diagram showing: initial records identified, records after deduplication, records screened, records excluded, full texts assessed, full texts excluded with reasons, studies included.
- Timeline: 2-3 months for screening and selection process
- Software: Rayyan QCRI (web-based systematic review software)
- Team: 3 independent reviewers.

Data management Storage and Access

All data will be stored in secure, password-protected digital databases:

- Primary storage: Rayyan QCRI software for study screening and selection data
- Secondary storage: Collaborative spreadsheet on institutional encrypted server for data extraction
- Access: Limited to 3 research team members with login credentials
- Version control: All versions are tracked with automatic backup

Data Security

- All personal information of researchers encrypted
- Study data de-identified (no author personal information stored)
- Institutional firewall protection
- Regular automated backups (daily)
- No cloud storage of sensitive information without additional encryption

Confidentiality

- Only aggregated data will be reported (no individual study data exposed)
- Raw data retained for 5 years post-publication for audit purposes
- Data deletion protocol: secure deletion after retention period

Responsibilities

- Primary Data Manager: Dayans Estrada Parra
- Secondary Responsibility: Eugenio Chandía Muñoz.

Reporting results / Analysis of the evidence**Analytical Approach**

For this scoping review, results will be analyzed using a qualitative thematic synthesis combined with quantitative descriptive analysis. The analysis aims to identify patterns, themes, and conceptual frameworks in how indigenous mathematical knowledge has been defined and theorized in academic literature.

Thematic Analysis Process

Data will be coded and analyzed around the following dimensions:

Conceptual Themes:

- Definitions and conceptualizations of indigenous mathematical knowledge provided
- Characteristics emphasized (situated, relational, oral, holistic, dynamic)
- Relationships to other knowledge domains (spiritual, ecological, social)

Theoretical Lenses:

- Primary theoretical frameworks used (ethnomathematics, indigenous epistemologies, decolonial approaches, other)
- Evolution of theoretical perspectives over time
- Debates or divergences in conceptualization

Contextual Patterns:

- Indigenous peoples and communities studied
- Geographic distribution and representation gaps
- Educational contexts addressed (formal, non-formal, revitalization efforts)

Methodological Approaches:

- Research methodologies employed
- Study designs and their relationship to findings

Heterogeneity Management

Given the expected heterogeneity of studies (diverse methodologies, contexts, populations), results will be presented narratively rather than through meta-analysis. Heterogeneity will be documented and discussed as an essential characteristic of the field, reflecting the diversity of indigenous mathematical knowledge systems.

Quality Considerations

Although scoping reviews do not typically employ formal quality assessment, this review will document:

- Methodological rigor of included studies
- Clarity of conceptual definitions provided
- Degree of indigenous community involvement in research

Synthesis Output

Results will synthesize findings to create:

- Conceptual map of how indigenous mathematical knowledge has been theorized
- Timeline of conceptual evolution
- Geographic and cultural representation analysis
- Identified gaps and areas requiring further research.

Presentation of the results Overview of Presentation Strategy

At protocol development, the review team has planned the following approach to presentation of results, recognizing that scoping reviews require diverse formats to effectively communicate mapping and conceptual synthesis.

Primary Outputs

1. Narrative Summary (Written)

A comprehensive narrative synthesis describing:

- Evolution of conceptualizations of indigenous mathematical knowledge across the reviewed literature
- Major theoretical frameworks identified and their temporal development
- Consensus areas and conceptual divergences in how researchers define and understand indigenous mathematical knowledge
- Regional and cultural variations in conceptualization

2. Conceptual Mapping Table

A matrix presenting:

- Study characteristics (author, year, country, indigenous people)
- Definition/conceptualization provided
- Theoretical lens employed (ethnomathematics, indigenous epistemology, decolonial, etc.)
- Methodological approach
- Key characteristics emphasized (situated, relational, oral, holistic, etc.)

3. Geographical Representation Map

- Visual representation of geographic distribution of studies

- Identification of regions with high and low research representation

- Highlighting gaps in coverage (particularly in Africa, Asia, indigenous communities in developed nations)

4. Temporal Evolution Chart

- Timeline showing:
- Publication trends over time
- Evolution of theoretical frameworks used
- Shifts in definitional approaches
- Growth of the field since mid-2010s

5. Conceptual Framework Diagram

- Visual representation of relationships between different theoretical approaches
- How ethnomathematics relates to indigenous epistemologies and decolonial perspectives
- Integration of conceptual dimensions identified

Supplementary Outputs

Research Gap Analysis Table:

- Identified gaps in research by geography, indigenous peoples, educational contexts
- Recommendations for future research directions

Quality Assessment Narrative:

- Summary of methodological rigor across included studies
- Discussion of indigenous community involvement in research

Dissemination Formats

Results will be presented in multiple formats to reach diverse audiences:

- Academic journals: Multidisciplinary and education-focused publications
- Conference presentations: International and regional conferences

- Policy briefs: For education policymakers considering intercultural curriculum development
- Community dissemination: Accessible summaries for indigenous education networks and communities
- Interactive visualization: Digital platform allowing users to explore the conceptual map and geographic distribution

Planned Figures and Tables

1. PRISMA flow diagram (study selection process)
2. Characteristics of included studies table
3. Conceptual frameworks comparison table
4. Geographic distribution map
5. Temporal evolution timeline
6. Theoretical perspectives network diagram.

Language restriction English, Spanish, and Portuguese are included.

Country(ies) involved Chile.

Other relevant information Complete references will be included and any additional interests or contributions by the working team will be documented. Ethical protocols for data review and validation will be respected.

Keywords Indigenous Education; Mathematics Education; Traditional Knowledge; Cultural Knowledge; Indigenous Knowledge Systems; Educational Methods; Cross Cultural Education.

Dissemination plans Results will be published in multidisciplinary indexed journals, presented at international conferences, and shared within intercultural education networks.

Contributions of each author

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