International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 10, pp. 348-371, October 2025
https://doi.org/10.26803/ijlter.24.10.16
Received Jul 25, 2025; Revised Sept 3, 2025; Accepted Sept 18, 2025

Mathematical Literacy in Feminist Indigenous Knowledges: A Qualitative Study of Women's Practices in Soweto, South Africa

Titilope Rachael Opesemowo*
Centre for Education Rights and Transformation,
University of Johannesburg,
South Africa

Abstract. This study is grounded in ethnomathematics, which examines how mathematical ideas emerge from cultural practices and knowledge systems. Using this lens, the study explores the intersection of mathematical literacy and feminist indigenous knowledges among women in South Africa, focusing on how mathematical reasoning is embedded in cultural, environmental, spiritual, and economic practices. Drawing from oral histories and narratives of indigenous healers, farmers, and traders, the study highlights how counting, measuring. Sequencing and estimation are sustained outside formal education systems. The study employed a qualitative and narrative-based design rooted in indigenous feminist methodologies, emphasising relationships, storytelling, and lived experiences. This method ensures diverse opinions and experiences regarding mathematical literacy and feminist indigenous knowledge. The study population consisted of all South African indigenous women. Indigenous women in Soweto, a community with a long-lasting background of indigenous practices, mostly those actively involved in communal farming, trading, and traditional healing, form the sample for the study. Six women above fifty years participated in the study, who were functionally illiterate, and four had a basic education. Findings reveal that indigenous women apply complex mathematical reasoning through embodied activities such as cooking, healing, farming, trading, and organizing community rituals. Practices include using moon cycles for planting, hand and calabash measurements in food preparation, rhythmic dance patterning, and mental arithmetic in market transactions and saving groups. These practices reflect advanced understandings of ratio, volume, time, and spatial logic forms of mathematical literacy passed down through generations. Participants expressed concern that formal education systems, grounded in Eurocentric epistemologies, marginalise indigenous knowledge and undermine intergenerational transmission.

*Corresponding author: Titilope Rachael Opesemowo; *topesemowo@uj.ac.za*

Keywords: Mathematical Literacy; Feminist Indigenous Knowledge; Indigenous Measurement Systems; Ethnomathematics; Indigenous women; Decolonial Education; South Africa.

1. Introduction

The purpose of colonial educational systems was to replace Indigenous knowledge systems with Eurocentric models. This was done to integrate Indigenous populations into European culture and values and exert control and influence over them. Colonial powers believed that by promoting Eurocentric education, they could weaken Indigenous identities and traditions, ultimately solidifying their domination over Indigenous peoples. The depiction of mathematics as a universal and objective discipline has historically marginalised indigenous mathematical practices, which are often dismissed as primitive. This perspective overlooks the rich epistemologies rooted in indigenous knowledge systems, which integrate lived experiences and cultural context into mathematical understanding. Historical evidence shows that indigenous people possess sophisticated mathematical knowledge, challenging the misconceptions of their skills as rudimentary (Xu & Ball, 2024).

Integrating indigenous mathematical practices into formal education has been historically ignored, leading to a disconnection between cultural heritage and academic curricula. Indigenous communities have long utilised mathematical thinking in various activities, yet colonial education systems have often marginalised these practices. Indigenous artisans employ concepts of symmetry and geometry as seen in traditional basket making among women in rural communities in South Africa, which can be linked to school mathematics curricula (Shimwandi et. al., 2024). Calendar systems and spatial reasoning are integral to agricultural practices, demonstrating a sophisticated understanding of time and space in indigenous cultures (Nursyahidah et. al., 2024). Also, indigenous architecture reveals principles of shape, scale, and balance, emphasising the mathematical knowledge rooted in community design (Xu & Ball, 2024). These practices, however, were neither recorded nor included in the colonial curriculum.

As a result, formal mathematics education turned into a weapon for assimilation, disregarding indigenous mathematics' contextual significance and prohibiting pupils from using their cultural heritage. Postcolonial curricula, which hold Western Knowledge hierarchies, have often perpetuated the colonial pattern. Even though South Africa's educational reforms have recognised the need for diversity, indigenous knowledge is still not fully recognised in mathematical curricula and teacher preparation. In formal educational discourse, knowledge holders (such as indigenous women farmers, healers, weavers, etc.) are deprived of legitimacy and space, which perpetuates epistemic injustice.

Indigenous learners often experience alienation in school mathematics due to a disconnection between the curriculum and their cultural realities. Silva et al. (2017) state that the curriculum usually fails to include indigenous mathematical knowledge rooted in community life and artistic practices. Furthermore,

mathematics is predominantly taught in English or Afrikaans, sidelining indigenous languages that contain essential mathematical vocabulary (Jorgensen, 2018), and the marginalisation of indigenous ways of reasoning in mathematics education risks eroding traditional knowledge systems (Nelson-Barber, 2023).

Mathematical literacy is an essential skill that extends traditional classroom learning, enabling individuals to apply mathematical concepts to real-world situations. It encompasses the capability to understand, interpret, and use mathematics from several perspectives, such as financial management, problem-solving, and critical thinking. It is vital for everyday activities such as budgeting, farming, and trading, where mathematical concepts are applied to make informed decisions (Serin, 2023). This skill is essential for navigating the complexities of modern life, as it allows individuals to make informed decisions and engage with quantitative information effectively.

Mathematical literacy involves formulating, applying, and interpreting mathematical concepts, which are vital for rational decision-making (Setiowati et. al., 2024). In essence, mathematical literacy empowers individuals to think critically, to solve problems efficiently, and ultimately, to thrive in a society driven by data and numbers. By understanding mathematical concepts, individuals are better equipped to make informed decisions in several aspects of their lives, from managing personal finances to interpreting statistical information. Mathematical literacy also fosters a sense of logical reasoning and critical thinking, essential abilities that are highly valued in today's fast-paced and technology-driven world.

In the South African education system, mathematical literacy is an official subject at the secondary level, aimed at empowering students to engage critically with numbers in their daily lives. However, it has often been taught through Western paradigms, marginalising indigenous forms of mathematical expression, and it has led to a lack of cultural relevance and understanding for many students, particularly those from indigenous backgrounds.

In this study, mathematical literacy has a broader and culturally enhanced meaning. It includes the informal, intuitive, and deeply contextual mathematical practices embedded in the daily lives of indigenous women, such as calculating prices and profit margins in trading, measuring land and understanding seasonal cycles in farming, creating geometric patterns in weaving or beadwork, and managing quantities in healing practices. These forms of mathematical understanding are rarely recognised in formal education but are fundamental to community survival and knowledge transmission.

Feminist Indigenous Knowledges (FIK) is a framework that emphasises the critical role of women in conserving and transmitting indigenous knowledge systems. The systems are deeply embedded in cultural traditions and are characterised by their relational, experiential, and sustainable nature. FIK is grounded in lived experience rather than abstract theories. It is often passed down through oral traditions, storytelling, and practical engagement with the environment, crucial for maintaining cultural identity and continuity (Bruchac

n.d.). The sustainability and intergenerational knowledge transfer are central to FIK., indigenous communities prioritise the continuity of their cultural practices and knowledge systems to ensure resilience and adaptability across generations. FIK is vital for the survival and identity of indigenous communities and offers valuable insights into broader societal challenges. However, the persistent epistemic exclusion and inequality, particularly in STEM disciplines, is underscored by the urgency to reimagine and decolonise educational knowledge systems in South Africa. This resonates with the findings of Govender & Naidoo (2023) that the dominance of European hegemony in education limits the representation of diverse epistemologies, particularly in STEM fields. Therefore, a radical shift in epistemological frameworks is essential to dismantle the "pedagogy of big lies" and promote African-centred knowledge production (Heleta, 2018).

The integration of feminist indigenous knowledge systems into mathematical literacy in South Africa remains underexplored, particularly in the context of women's contributions through daily practices such as healing, trading, and farming. These activities often involve complex mathematical reasoning not traditionally recognised in mainstream education. These women, as cultural custodians, have employed advanced mathematical reasoning in the context of land use, calendrical systems, measurement and trade for generations.

The absence of such contributions from formal syllabi suggests a continued legacy of colonial knowledge hierarchies, in which African ways of knowing are undervalued or dismissed. This study challenges the colonial as well as patriarchal systems that have silenced indigenous women's voices, devalued their knowledge as unscientific and excluded their contributions from formal educational practices. By aligning feminist theory with indigenous knowledge, the study draws attention to the intersection of ender, knowledge, and decolonisation where indigenous women are not only knowledge holders but also agents of innovation and social transformation.

Additionally, it responds to this gap by investigating how mathematical literacy is expressed within feminist indigenous knowledge systems among South African women in Soweto. In response to these gaps, the study investigates how mathematical literacy is expressed within feminist indigenous knowledge systems among South African women in rural communities, highlighting the contributions of indigenous women to knowledge systems that incorporate mathematical reasoning outside the Western academic framework.

The specific objectives are: to investigate stories, practices, or traditions passed down from women in Soweto that reflect how indigenous women have historically used knowledge related to counting, patterns, or organizing in everyday life, ceremonies, or cultural practices; to assess how women in this region utilise mathematical concepts in daily life and traditional practices and to investigate how formal education systems or external institutions have affected the expression of mathematical literacies rooted their indigenous knowledge systems.

1.1 Research Questions

The study seeks to answer the following questions.

1. How do women in Soweto narrate and transmit stories, practices, or traditions that reflect indigenous ways of using counting, patterns, and organisation in everyday life, ceremonies, and cultural practices?
2. In what ways do women's daily practices and traditional roles demonstrate indigenous forms of mathematical literacy that challenge or expand Western academic definitions of mathematics?
3. How have formal education systems or external institutions affected the expression of mathematical literacies rooted in feminist indigenous knowledge?

2. Literature Review

2.1 Feminist Indigenous Knowledge and Identity

Feminist Indigenous Knowledge (FIK) represents indigenous women's unique perspectives and practices, highlighting their deep connections to land, community, and ecological systems. This knowledge system challenges Western epistemologies by appreciating oral traditions, embodied wisdom, and communal ethics, which are often overlooked in a colonial context. Colonial frameworks usually undermine indigenous epistemologies, framing them as mere cultural opinions rather than legitimate knowledge systems (Gareau & Swain, 2024), and this marginalisation affects the acknowledgement of women's contributions, necessitating a re-evaluation of indigenous knowledge within a decolonial context (Gareau & Swain, 2024). FIK is rooted in the interconnectedness of human and non-human relationships, emphasising a holistic worldview that contrasts with Western individualism (Baskin, n.d.).

The knowledge actively resists colonial and patriarchal narratives that seek to undermine indigenous identities and practices. (McGuire-Adams, 2020). Feminist Indigenous scholars emphasise the critical roles of indigenous women as knowledge keepers, storytellers, nurturers, and activists, ascertaining their authority in various domains of life. This perspective highlights the gender specific nature of indigenous knowledge, where women are central to health, education, and environmental stewardship. Women are often responsible for health and food production, reflecting their integral role in sustaining community lifeways (Gareau & Swain, 2024). According to Forster (2019), their involvement in environmental stewardship is linked to traditional practices and spiritual beliefs, essential for maintaining ecological balance.

Women's roles in African contexts, particularly in South Africa, demonstrate the dynamic nature of FIK. These roles encompass a rich tapestry of applied knowledge in various fields, including agriculture, medicine, and trade, which are not merely cultural traditions but adaptive systems that respond to contemporary challenges. Women's roles as healers, farmers, and traders integrate mathematics, astronomy, botany, and ecology, showcasing a sophisticated understanding of their environment (Emeagwali, 2020; Wiafe, 2023). This synthesis of knowledge is transmitted through oral narratives and practices, highlighting the innovative spirit of women as they navigate changing social realities. This resonates with

Shivani et al., (2022) that knowledge is passed down through storytelling and performance, ensuring cultural continuity while allowing for adaptation to new circumstances. FIK is context-specific, generative, and adaptive rather than static or nostalgic.

Indigenous feminist frameworks emphasise the profound connection between identity, land, language, and spirituality, highlight32ing women's roles as custodians of knowledge and culture. This relationship is not merely symbolic; it is foundational to the understanding of indigenous identities. Land is viewed as a living entity, integral to indigenous knowledge systems, encompassing history, medicine, and cosmology (Die & Karanja, 2022). According to McGuire-Adams, (2020), language serves as a vessel for cultural expression and identity, deeply intertwined with land and spirituality.

Memory also plays a vital role in sustaining feminist indigenous identities. Intergenerational transmission through songs, proverbs, rituals, and apprenticeship ensures cultural continuity and coherence. Memory and artistic practices, such as songs and rituals, facilitate the transmission of knowledge across generations, ensuring cultural continuity (Anderson, 2023). Conversely, while indigenous feminist frameworks highlight the importance of these connections, Western epistemologies often overlook or undervalue them, leading to a disconnection from these vital knowledge systems.

FIK and identity serve as transformative epistemic tools that challenge and reshape educational and research paradigms. These knowledges are deeply embedded in holistic, situated, and liberatory frameworks that repel colonial narratives and offer alternative ways of understanding the world. Indigenous women, through their assertion of identity, memory, and practice, provide a vision of knowledge that is both inclusive and empowering. This approach not only promotes cultural pride and resistance but also redefines the parameters of knowledge production and dissemination.

2.2 Ethnomathematics and Everyday Mathematical Practices

Ethnomathematics is an interdisciplinary field that looks at the interplay between mathematics and culture, emphasising the culturally situated nature of mathematical practices. It explores how mathematical practices are embedded in cultural activities such as architecture, weaving, and farming, which are often overlooked in traditional mathematics education (Jacob, 2021). It challenges the dominance of Western mathematical paradigms by recognising the mathematical reasoning inherent in the daily activities of diverse cultural groups.

Ethnomathematics broadens the definition of mathematical activity and affirms the validity of culturally rooted practices as forms of mathematical literacy. It highlights six fundamental mathematical activities present in all cultures: counting, locating, measuring, designing, playing, and explaining, thereby broadening the scope of what is considered mathematical literacy (Jacob, 2021). This perspective is particularly significant in decolonising mathematics education and acknowledging diverse epistemologies, especially in African and Indigenous

contexts. However, ethnomathematics offers a valuable perspective on the cultural dimensions of mathematics, but it faces challenges in gaining recognition within the broader scientific community.

Mathematical practices in various African contexts are intricately linked to daily life, manifesting in arts, games, and agricultural activities. Women in rural South Africa utilise estimation and proportional reasoning in farming, such as calculating the right number of seeds based on land area (Gerdes, 2000). Informal mathematical operations, like calculating prices and profit margins, are used daily in local markets, demonstrating practical applications of mathematics (Gerdes, 2011). These practices illustrate how mathematical reasoning is not merely academic but a vital part of cultural expression and survival. Decolonising education, particularly mathematics, involves integrating local context and languages to promote epistemic justice and enhance learner engagement.

Despite policy intentions, challenges such as inadequate teacher training and assessments favouring Western standards hinder effective implementation. Silver et. al., (2023) state that the slow adoption of decolonial practices in education is attributed to systemic barriers, including teacher preparedness and entrenched assessment methods. Teaching mathematics through local contexts fosters relevance and engagement, as seen in studies that link traditional practices to mathematical concepts (Shimwandi et al., 2024). It can bridge cultural knowledge and formal education. Yet, its integration remains limited (Silver et al., 2023). Recognising women's knowledge in mathematical practices can shift the discourse towards a more inclusive and relational understanding of mathematics (Pereira & Godoy, 2023).

Ethnomathematics offers a critical foundation for understanding how mathematical literacy is practiced, lived, and passed down outside formal institutions. It validates diverse forms of reasoning and invites a rethinking of who is considered mathematically literate. In the African context, particularly in South Africa, everyday mathematical practices rooted in indigenous knowledge, often led by women, provide a rich yet underexplored resource for curriculum development, educational inclusion, and epistemic justice.

2.3 The Relationship between Feminist Indigenous Knowledge (FIK), Ethnomathematics, and Mathematical Literacy

The intersection of FIK, ethnomathematics, and mathematical literacy provides women's theoretical and epistemic agency as knowledge bearers, innovators, and custodians of practices such as healing, farming, and trading, which embed mathematical reasoning in everyday life. FIK provides a lens to understand how women's knowledge of cultural practices is often overlooked. Ethnomathematics bridges cultural practices with mathematical concepts, revealing the mathematical reasoning in daily life (Mollah & Kanu, 2024; Umbara et. Al., 2023).

Ethnomathematics frames these practices as legitimate mathematical systems that emerge from cultural contexts rather than formal schooling, thereby challenging Eurocentric definitions of mathematics. Mathematical literacy, meanwhile, focuses on the capacity to apply mathematical reasoning in solving real-life

problems, aligning with how indigenous women use measurement, estimation, and proportion in socially and economically meaningful ways (dos Santos & Madruga, 2024). The study demonstrates that indigenous women's knowledge is mathematical and literate in ways that bridge culture, gender, and sustainability. FIK provides the gendered and cultural lens, ethnomathematics legitimises the practices as mathematics, and mathematical literacy underscores their applicability and problem-solving potential. The overlaps show how women's cultural practices (FIK) are mathematical (ethnomathematics) and build everyday literacies (mathematical literacy). At the same time, the intersection of all three represents an integrated framework where mathematics is lived, practiced, and transmitted.

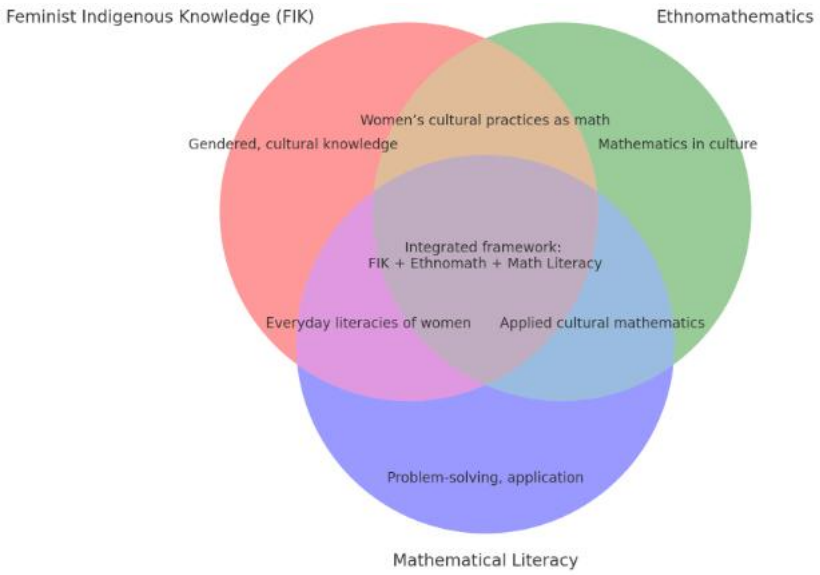

Figure 1: Conceptual model mapping the relationship between FIK, Ethnomathetics and Mathematical Literacy.

Existing research highlights that indigenous communities transmit mathematical knowledge through oral traditions, storytelling, rituals, and embedded practices rather than formal schooling (Mogege, 2017; Nursyahidat et al., 2024; Owens, 2012). These studies underscore the importance of exploring women's narratives in Soweto to uncover how mathematical reasoning is embedded in domestic, economic, and ceremonial activities, which are often overlooked by Western-centric curricula.

Conversely, Western-oriented schooling and formal institutions have been shown to marginalise indigenous mathematical practices, devaluing experiential knowledge and disrupting intergenerational transmission (Xu & Ball, 2024; Murthy, 2013; Borthakur & Singh, 2021). These studies indicate that formal education often privileges abstract, textbook-based knowledge over community-grounded numeracy, creating epistemic dissonance and limiting the visibility and continuity of indigenous knowledge systems. By examining Soweto women's experiences, the present study responds to this gap, investigating how feminist indigenous mathematical literacies are expressed, applied, and affected by

educational and institutional structures, thereby contributing to decolonial and ethnomathematical scholarship.

3. Methodology

3.1. Research Design

The study employed a qualitative and narrative-based design rooted in indigenous feminist methodologies, emphasising relationships, storytelling, and lived experiences. The design was adopted because it aligns with this study's epistemological orientation and the cultural context of feminist indigenous knowledge systems. It aimed at uncovering how Indigenous women's practices embody mathematical literacy within everyday contexts such as healing, farming, and trading. This method ensures diverse opinions and experiences regarding mathematical literacy and feminist indigenous knowledge.

3.2 Population and Sample

The study population consisted of all South African indigenous women. Indigenous women in Soweto, a community with long-lasting backgrounds of indigenous practices, mostly those actively involved in communal farming, trading, and traditional healing, form the study sample. Six women above fifty years participated in the study; two were functionally illiterate, and four had a basic education. Engaging with women in indigenous communities requires building trust, reciprocity, and respect for cultural protocols. Working with six participants made it possible to sustain these ethical commitments and ensure that each woman's contribution was valued and carefully documented. Given the scope of the research, focusing on six women allowed for detailed thematic analysis, prolonged engagement, and careful interpretation without overwhelming the study with unmanageable amounts of qualitative data.

3.3. Research Instrument

A discussion guide for focus group discussions was developed to help lead group discussions, support group discussions, and maintain reliability in data collection. The women were asked to share any stories, practices, or traditions passed down from women in their family and community that involve counting, measuring, or recognising patterns. They were asked to describe a typical day in their work and to reflect on the connection between what they do and what is taught in school, such as "mathematics," among others. The discussion guide was developed to get in-depth answers from the participants about the mathematical literacies ingrained in their indigenous knowledge.

The three main elements that complemented the study's aims were the guide's focus. It investigated how indigenous women have historically applied knowledge about counting, patterns, or organizing in daily life, ceremonies or cultural practices. Second, it explored how mathematical ideas are used in cultural, environmental and economic practices of the indigenous women who work as farmers, healers and traders. It also investigated how formal education systems or external institutions have affected the expression of mathematical literacies rooted in their indigenous knowledge systems. The guide encouraged Open-ended answers, enabling the participants to share their personal

experiences. This guaranteed a deep and complex comprehension of women's vital role in preserving indigenous knowledge.

3.4. Data Collection

Data were collected using both focus group discussions and in-depth interviews. Indigenous women who work as farmers, traders, and healers were interviewed on the mathematical literacy ingrained in their indigenous practices. The conversation was in a quiet and comfortable environment (Kwakhayale Ndaba Cultural Village), prompting candid and unhindered communication. The one hour and forty minutes of conversation included an introduction and welcome session, followed by a description of the study's goal in their native languages and English.

Ground rules for courteous and inclusive participation were also provided. The sessions were concluded with a review of the main points covered, a call for further discussion, and statements of appreciation for the participants' time, contributions and light refreshments. The women's voices were recorded to capture the dialogues and interviews, and field notes were taken to document non-verbal cues, related observations, and insights that added depth to the verbal responses.

3.5. Data Analysis

Thematic analysis was used to analyse the data collected. It was conducted following Braun and Clarke's (2006) six-phase framework to ensure a rigorous and systematic process.

1. The researcher reviewed the transcripts and repeatedly listened to the audio recordings to immerse deeply in the participants' narratives. During this stage, initial observations and potential patterns were noted, emphasising on early patterns related to healing, farming, and trading.

2. Relevant textual passages aligned with the research questions were identified and systematically coded (e.g. herb measurement, row counting, mental calculation of process, etc). This process ensured that segments of data capturing meaningful aspects of women's experiences and mathematical practices were highlighted.

3. The codes were grouped into broader categories that captured recurring ideas and relationships across participants' accounts. The step allowed for the development of preliminary themes.

4. The emerging themes were refined by checking them against the coded extracts and the entire dataset. Overlapping or weak themes were revised and merged, and some were removed to enhance coherence and relevance.

5. Each theme was clearly defined, capturing its essence and contribution to answering the research questions. Descriptive labels were assigned to ensure that the themes reflected both participants' voices and the study's analytical focus.

6. Finally, the themes were organized into a coherent narrative demonstrating how mathematical literacy is intertwined with cultural practices, showing evidence of feminist indigenous knowledge in action. The analysis was supported with illustrative quotations from the participants to foreground their perspectives and validate the interpretations.

3.6. Data Validity

Thematic analysis was validated through member checking by sharing emerging themes with participants, allowing them to confirm or clarify interpretations to represent their voices authentically. Also, an audit trail documenting the analytic process was maintained to enhance transparency, alongside reflexive notes to account for the researcher's positionality and potential biases. As an academic, not a member of the Soweto community, I positioned myself as a learner and relied on reflexive journaling throughout the research process, continually questioning my assumptions and interpretations. Member checking was used to ensure that themes reflected women's voices rather than my own beliefs. This ensured the validity and reliability.

3.7. Ethical Consideration

The study was reviewed at first by the Centre for Education Rights and Transformation and then by the Faculty of Education Research Ethics Committee at the University of Johannesburg. In both cases, the study was approved. Informed consent was obtained from all participants while the purpose, procedures and potential outcomes of the study were communicated using culturally appropriate language, ensuring that participants fully understood their role in the research. Participation was entirely voluntary, and the anonymity and confidentiality of the participants were strictly maintained throughout the study.

All research data, including transcripts and recordings, were securely stored in encrypted digital files, accessible only to the researcher. Long-term archiving followed university guidelines, retaining only anonymised data to protect participant identities. Data were handled with utmost care to protect the identities of the participants and the integrity of the knowledge shared. Knowledge identified as sacred, sensitive, or culturally restricted was carefully excluded from public dissemination and handled according to local cultural protocols. These measures ensured ethical stewardship, maintaining research integrity and protecting indigenous knowledge systems.

4. Findings

Results were presented following the order in which the research questions were raised. Themes were employed to organize perspectives, experiences and insights on mathematical literacy in feminist indigenous knowledges.

4.1. Stories, practices, or traditions from women in your community related to counting, patterns or organizing.

The study's findings shed light on the complexity and richness of feminist indigenous knowledge systems, particularly in practices of counting, pattern

recognition, and organisation passed down by women in South African communities.

Theme One: Stories and Practices

Women have conserved mathematical knowledge systems outside the formal educational system through oral traditions, rituals, embodied activities, and storytelling. Participants' stories emphasise cultural discipline and mathematical reasoning rooted in common practices like cooking, dancing, healing, and planning events. The first participant pointed out that knowledge was traditionally passed on not through formal schooling, but through active participation in domestic, economic, and sacred places.

"*Thank you, my child. It is an honor, you see, in our history as African women, we were never far from knowledge. Long before these Western schools, our grandmothers taught us with their hands, eyes and hearts. We learned through doing in the fields, the kitchen, the market and even in the sacred healing space*" This embodied learning contradicts Eurocentric knowledge systems that support communal teaching and lived experience as effective and successful teaching methods. Traditional healing practices began as a significant site of indigenous mathematical reasoning. "We were never far from knowledge" serves as a decolonial corrective to the assumption that mathematical knowledge only starts within formal schooling. The second participant described how knowledge of body patterns, moon cycles, and herbal combinations involved careful observation, categorisation, and precision.

"*As a woman rooted in the soils of Soweto, and one who carries the knowledge of our foremothers as a traditional healer, even in healing, we use patterns from how we read the body signs to how we align plants with the moon's phases*". Using lunar cycles to align healing processes and rituals also highlights indigenous systems of time reckoning and natural logic, where knowledge of sequences, intervals, and alignment plays a key role in decision-making and ritual efficacy. Songs and dances, especially those led by women during communal ceremonies, served as cultural expressions and instructional tools in mathematical sequencing. "*Women's songs and dances often involve clapping, stomping, and chanting in patterns that reflect rhythm and mathematical sequence*.

Traditional dances, such as those in the Venda culture, incorporate specific rhythmic patterns, like a 5-beat cycle, which teach girls about sequencing and counting (Nursyahidah et al., 2024).
"*It is not just a dance,* "*says one elder,* "*it is how we teach them discipline, balance, and how to move with others like counting silently with the heart*"

These practices cultivate cognitive and physical discipline in young girls, teaching them pattern, balance, and synchronisation skills closely related to early numeracy and mathematical abstraction. The fourth participant provided vivid examples of how women estimate quantities without using modern measuring tools. "*Women measure quantities of grain, maize, and water without modern tools, often by hand, bowl size, or feel. Knowing how many hands or cups of sorghum feed a household. We adjust recipes based on the number of people or ceremonies.* Using calabashes and

grinding bowls to measure ingredients reflects an intuitive understanding of volume, ratio, and time (Alonso, 2019). The recipe for the funeral [bogobe] requires three calabashes of water per two grinding bowls of millet and shows how standardized orally transmitted measures function as accurate and reliable systems within indigenous communities.

The role of women in organizing ceremonies around indigenous calendars and lunar phases was highlighted in the fifth participant's narrative. "*Across all indigenous groups, women often organize key life ceremonies, births, marriages, and funerals based on indigenous calendars and lunar cycles. Women distribute food and clothes based on household sizes or community expectations. During an initiation celebration, elder women count seven days after the new moon to begin preparing the initiates' special garments and food. The elder in charge instructs the other. On day five, we start steaming the pumpkin; on day seven, the rain will come, and so must our fire.* Such practices are not random but embedded in long-term observation, historical memory, and ecological knowledge and passed down through generations.

4.2. How do indigenous people apply mathematical concepts in cultural, environmental and economic practices

This study revealed that indigenous women apply mathematical reasoning in deeply rooted and culturally situated ways, often without formal schooling or modern measuring tools.

Theme Two: Indigenous Application of Mathematical Concepts

Their practices span across healing, farming, trading, and communal life, where counting, estimating, measuring, timing, and calculating are fundamental to sustaining livelihoods and nurturing community well-being. The first and second participants draw attention to the sacred dimensions of indigenous knowledge. "*I am a part of a long line of women who carry indigenous knowledge like a flame glowing in the darkness. My healing wisdom is divine and not from the classroom. My history, our people's history, is one of survival and preservation. My days begin with examining plants, continue interpreting dreams or ancestral signs, and end in prayer to the creator*". (The participant went into a trance and couldn't speak further)

2nd Participant: *There is a kind of indigenous mathematics in the cycles of nature and in the precision, we use when mixing and dosing herbal remedies. We observe nature and interpret signs (stars, animals, plants). We don't use rulers but divine wisdom. You know, one pinch of this plant, two fingers of that root, and a handful of this bark. These are precisions rooted in practice. Ohhhh… life is found in the breath of nature, in the spirit of our people, and in the hands of women. It is measurement, proportion and estimation. In our work, a treatment may need three crushed seeds taken before the first rooster crows, which is also mathematics rooted in the rhythm of life*.

The concept of indigenous mathematics is deeply intertwined with the natural world and traditional practices, particularly in the context of herbal remedies. This form of mathematics is not merely theoretical; it is practical and rooted in the rhythms of life, showcasing a sophisticated understanding of measurement and proportion without using conventional tools.

"I grow vegetables, herbs and medicinal plants for subsistence and small-scale income. I measure land using hands, feet, and sticks and time tasks using the sun's position, day cycles, or traditional stories. Through my mother, I learn from the land by touching it, smelling its dust, and reading how the clouds gather in the sky.

4th participant: I am a woman who tills the land, not just as a place to grow food, but as a sacred life space. Each morning, I rise to feed the chickens. Ah, farming, you must know the rains, the soil, and the moon. You must count your seeds, space your crops properly, and calculate the harvest time. My farming is not just about planting crops, but about feeding families and healing the community. I plant life, hope and knowledge that will never die.

As described by the participants, traditional farming practices embody a rich understanding of environmental mathematics and ethnobotanical knowledge. These practices are not merely about cultivation but also involve a deep connection to the land, passed down through generations. The methods of measuring land and timing tasks reflect ethnomathematical concepts**,** where cultural practices are intertwined with mathematical reasoning (Shaterian, 2023).

For instance, the geometric arrangements of plants and the calculations involved in planting and harvesting demonstrate a sophisticated understanding of spatial relationships and environmental cycles. Participants five and six reflect on economic life, showing that indigenous women are cultural stewards and financial managers. Through oral budgeting traditions and market experience, women use mental arithmetic for pricing, change-making, profit/loss estimation, and seasonal forecasting.

5th participant: I am a trader, a mother and a bearer of indigenous wisdom passed down through generations. Trading, for me, is not just a business; it is a way of life, a way of serving the community, and a practice of sharing hope. Since I was young, following my mother through the streets, I learned that money is not only counted but felt. I learnt from my mother that September means an increase in supply, February means low prices to earn long-term gain, and that was our traditional budgeting.

6th participant: 'I don't use a scale to measure maize and sorghum; the intelligence comes from our ancestors who traded with memory and honor." She further said, *"….and don't forget, we women ran savings groups. That is serious mathematics. Each woman contributes, and every month someone takes the pot. We managed money, interest and community trust without a calculator. The informal saving systems like stokvels require high-level numeracy skills and logic".*

Indigenous women play a crucial role in economic life, functioning as cultural stewards and as adept financial managers. The oral budgeting traditions and market experiences enable them to engage in complex financial activities, demonstrating significant numeracy skills.

4.3. How the formal education systems or external institutions affected the expression of mathematical knowledge rooted in indigenous knowledge.
Based on the environmental and communal experiences, and the Western-centric, textbook-driven models promoted by schools and formal institutions, participants expressed a sense of loss, marginalisation, and devaluation of sacred and practical indigenous numeracy, especially concerning healing, agriculture, trade, and communal life.

Theme Three: Effects of Formal Education on the Expression of Mathematical Knowledge
The interviews reveal not only a displacement of indigenous mathematics but also how the authority of formal education systems has eroded trust in indigenous knowledge and interfered with its generational transfer.

The first participant reflects on how indigenous mathematics once lived in nature's rhythms, spiritual observation, and intuitive practices passed from healer to healer. "*Long ago, we did not count written numbers; our mathematics lived in nature, seasons, and the moon. I learned to measure with my hands, ears, and spirit. When to pick [imbiza] and how many roots to boil. These are calculations passed from healer to healer, but schools call it GUESSWOK. My daughter came home once asking if this is real science, I said, "It is not just real, it is sacred". They teach the child to trust a book over a grandmother's memory. The learning period, where a young girl would study under an elder healer, has been eroded. As a result, there is no room for sacred counting systems to time healing rituals.*"

2nd Participant: Western medicine and education often dismiss traditional healing as superstitious. Schools consider Spiritual knowledge, including numeracy tied to dreams, bones and herbs, invalid. Students trained in schools see us as witch doctors, even though our methods involve generations of careful dosage, timing and pattern recognition. Also, the mathematical precision in dosage calculation (e.g. root lengths, number of leaves, boiling time) is rarely acknowledged in school curricula.

The participants' reflections highlight the profound connection between indigenous mathematics and natural rhythms, emphasising a holistic approach to knowledge that contrasts sharply with conventional educational systems. Despite the rigorous calculations involved in dosage, timing, and diagnostic rituals, traditional numeracy is rendered invisible in curricula. This exclusion reinforces stigma and undermines the cultural and scientific validity of indigenous knowledge, thereby discouraging younger generations from learning or practicing it.

The third participant highlights how school teachings promote mechanised, monoculture farming over traditional, community-based approaches.
3rd participant: "*Indigenous knowledge of planting by moon and soil feel is not seen as scientific. This leads to young people abandoning indigenous techniques favouring chemical fertilisers and monocultures pushed by agricultural extension officers. Also, schools promote large-scale production, while traditional farming was communal and cooperative. My measurements using feet, hands, and moon signs are considered unreliable*". Indigenous practices, such as planting by moon phases and soil

conditions, are dismissed as unscientific, leading to a generational gap in Knowledge transfer (Borthakur & Singh, 2021). Also, the reliance on chemical fertilisers and monocultures has been linked to environmental degradation and loss of biodiversity due to the abandonment of indigenous planting calendars and cooperative systems (Joshi & Singh, 2006).

The fourth participant draws attention to the social and economic exclusion of older women who, despite their mastery of mental calculation and oral accounting, are sidelined in modern economies prioritising literacy and digital literacy. 4th Participant: *Older women who can calculate mentally and remember complex debts are now pushed aside because they cannot read or write.* The transition to cashless payment systems and permit regulations can indeed disadvantage those who are not educated in formal systems, particularly affecting marginalised groups such as indigenous communities. While cashless systems offer convenience and efficiency, they can inadvertently marginalise those without access to digital tools or formal education.

The fifth participant underscores the cultural mismatch between school-taught mathematics and indigenous ethical calculation. "*At school, they say one plus one is two, but in our shops, one handful plus one good heart equals trust. They don't teach that kind of calculation* ". This evokes a qualitative, ethical form of arithmetic rooted in relationships. It directly illustrates colonial epistemic dissonance. Decolonial theorists argue that modern schooling perpetuates epistemic injustice by marginalising non-Western ways of knowing. The cultural mismatch between school-taught mathematics and indigenous ethical calculation highlights a significant gap in educational systems, particularly in South Africa.

This gap is characterised by the under-evaluation of indigenous mathematical practices deeply rooted in ethical, relational, and ecological contexts. These practices emphasise values such as reciprocity, fairness, and community cohesion, contrasting with formal education's quantifiable and individualistic approaches. The findings affirm that decolonial, feminist, and ethnomathematical frameworks are not just abstract lenses but lived realities. They confirm that indigenous women's mathematics is at once intellectual (cognitive reasoning), ethical (rooted in trust), and political (resisting colonial erasures.

5. Discussion

The findings of this study confirm that indigenous women in Soweto conserved mathematical knowledge systems outside of formal schooling through oral traditions, rituals, embodied activities, and storytelling. Oral traditions, rituals, songs, and embodied activities such as cooking, healing, and dancing preserve cultural identity and function as epistemic spaces where mathematical reasoning is cultivated. These practices illustrate that mathematical reasoning is embedded in everyday survival and communal life, positioning women as central agents of knowledge transmission. The declaration from the participants that "we were never far from knowledge" disrupts Eurocentric assumptions that mathematics begins with formal education, instead foregrounding the validity of indigenous systems where practice, experience, and community constitute pedagogy.

Moreover, the findings reveal how women's roles as timekeepers, healers, and organizers embed mathematics within ecological and cosmological frameworks. Using calabashes and grinding bowls to measure food, lunar cycles for rituals, and indigenous calendars for ceremonies demonstrates a sophisticated, systematic, and contextually relevant form of mathematical literacy (dos Santos & Madruga, 2024).

From the perspective of nego-feminism, these examples show mathematics as community-centred, non-hierarchical, and relational, foregrounding women as custodians of intellectual labour. Nego-feminism promotes a relational approach to learning, valuing the contributions of women as custodians of knowledge (Jagire, 2013). Women's roles in these ceremonies are not random but embedded in long-term observation and historical memories. Their leadership in these practices affirms their central role as timekeepers and organizers in community life (Arauf, 2023). Collectively, these findings illustrate how African women's indigenous knowledge is deeply mathematical, structured, and systematic, even though it is seldom recognised within formal education systems. This knowledge is cultural heritage and a form of intellectual labour, honed through practice and passed on through generations.

The exploration of indigenous mathematical practices reveals a profound connection between mathematical literacy and indigenous feminist knowledge systems, particularly among African women. This relationship fosters a concept termed "nego-feminism", which emphasises community-centeredness and pragmatic action in knowledge transfer. This perspective encourages non-hierarchical knowledge transfer, promoting a more inclusive understanding of mathematics. Recognising the mathematical practices of rural women is not merely about inclusion; it is about reframing what counts as mathematics, and who counts as mathematicians (Utete et al., 2017).

The findings further demonstrate that indigenous women engage in mathematical reasoning through everyday practices deeply rooted in cultural and spiritual traditions. It aligns closely with ethnomathematics's foundational work, which argues that mathematical thinking is embedded in cultural practices rather than confined to classrooms. In the same vein, ethnomathematics scholars (Jacob, 2021; Villar Briones et al., 2023) have argued that cultural practices constitute legitimate mathematical systems (not merely primitive precursors to formal math), which supports the women's interpretation of herbal proportions, calendrical timing, and sequencing as sophisticated local mathematising. In healing, farming, and communal life, participants reveal how counting, measuring, estimating, and timing are applied in ways that align with natural cycles and ancestral wisdom.

Their practices embody ethnomathematics, where mathematical concepts are interwined with spirituality, ecological knowledge, and cultural continuity. Beyond subsistence, the findings also highlight the role of indigenous women as traders and financial managers, applying numeracy in oral budgeting traditions, profit and loss calculations and collective savings systems. Mental arithmetic, market forecasting, and rotational savings groups (Stokvels) illustrate the

application of mathematical logic in sustaining livelihoods and community well-being.

According to Lappeman et. al., (2020), rotating savings and credit associations (stokvels) and township trading show that women routinely perform complex mental arithmetic, forecasting, and bookkeeping in market contexts and communal saving schemes. These examples affirm that indigenous mathematics is not abstract, but a living practice embedded in healing, agriculture and trade. The findings affirm that despite limited formal schooling, indigenous women embody advanced mathematical thinking that is experiential, intuitive, and culturally situated, making them custoduans of knowledge systems that sustain families and communities.

According to Mogege, (2017), the use of specific quantities, "one pinch". "Two fingers "or "three crushed seeds before the rooster crows demonstrate the precise dosing based on experiential knowledge, demonstrating an intuitive grasp of ratios and timing These are not random but reveal deep familiarity with ratios and timing, stressing the mathematical logic embedded in healing rituals and natural cycles. The participant notes that September signals increased supply, while February indicates lower prices, reflecting a deep understanding of market cycles (Price, 2024). Indigenous financial practices, particularly those led by women, exemplify a unique integration of mathematics within cultural contexts.

These practices, such as rotational lending groups, highlight how mathematical reasoning is deeply embedded in daily life, emphasising trust, community and environmental awareness. Mogege, (2017) opined that many individuals, despite limited formal education, effectively apply mathematical concepts in daily activities, highlighting the need to recognise this knowledge in academic settings. This affirmed the findings of Owens, (2012) that indigenous mathematics is not separate from life; it is a living practice that informs decision-making in various aspects, including agriculture and trade. Whether in a healer's touch, farmer's hands. Or trader's head, indigenous women engage in precise and purposeful mathematical thinking.

Critical commentators (Monteiro, 2009; Pais, 2011; Pais, 2012) have warned that ethnomathematics as a pedagogical project can be conceptually and politically flawed: there is a risk of romanticising, decontextualising, or instrumentalising indigenous practices when they are extracted and simplified for school lessons without attention to power, context and the sacred status of some knowledge. The findings from the study are strongly supported by ethnomathematics, ethnobotany, and studies of informal finance. It confirms that indigenous women's activities embody systematics mathematical logics, which are socially embedded, experientially learned, and culturally sanctioned.

Furthermore, the findings highlight a critical tension between Western school-taught mathematics and indigenous ethical-mathematical reasoning. Participants consistently reported that the exclusion of indigenous numeracy from formal schooling has led to a sense of loss and marginalisation. This resonates with the

findings of Xu & Ball, (2024), that this marginalisation is evident in the curriculum, which often fails to incorporate indigenous perspectives, leading to a disconnect between students' cultural backgrounds and educational experiences. Natural signs, intuitive measurement, and relational calculation in healing and agriculture reflect a sophisticated understanding of proportions, timing and sequencing, yet such practices are often dismissed as superstitious or unscientific (Xu & Ball, 2024).

Consequently, younger generations are discouraged from learning these skills, and the intergenerational transfer of culturally grounded mathematical knowledge is disrupted, creating a significant gap in the continuity of indigenous epistemologies. The exclusion of these practices contributes to the erosion of intergenerational knowledge transmission, as children are taught to prioritise textbook knowledge over traditional wisdom (Xu & Ball, 2024). The findings challenge the universality of Western mathematical epistemology, showing instead that mathematics can embody a moral economy. It suggests that educational systems should not dismiss such practices but recognise them as complex and legitimate forms of reasoning.

Similarly, older women's expertise in oral accounting and mental arithmetic is marginalised in cashless and digitised economies, highlighting socio-economic exclusion linked to formal education priorities (Lupo-Pasini, 2020). These align with decolonial theory, emphasising that conventional schooling can perpetuate epistemic injustice by privileging Western ways of knowing and devaluing indigenous knowledge systems (Borthakur & Singh, 2021). The study underscores the urgent need for educational policy reforms that validate indigenous numeracy, integrate relational ecological forms of mathematics, and bridge the cultural dissonance between community-based knowledge and formal education. The study adds to the growing decolonial scholarship that calls for reimaging mathematics education to include relational and ethical numeracies.

6. Conclusion

The study illuminates the depth and legitimacy of indigenous women's mathematical knowledge systems in Soweto, South Africa, which are expressed through healing, farming, trading and relational reasoning. It was revealed that women's stories and practices embody unique forms of counting, measuring, and organizing that extend beyond Western academic definitions of Mathematics.

It also showed how these practices are transmitted across generations and how formal education and external institutions have influenced their expression. Also, the study makes a significant theoretical contribution by bridging Feminist indigenous Knowledge and ethnomathematics, showing how women's practices embody mathematical reasoning embedded in cultural, relational, and ecological contexts.

Beyond the educational sphere, the findings carry broader implications for social justice, cultural sustainability, and policy. Recognising women as epistemic agents and innovators highlights the need to restore epistemic justice in schools

and community development, as well as environmental sustainability and economic empowerment initiatives. These indigenous mathematical literacies offer alternative problem-solving frameworks that challenge extractive models of knowledge production. To advance genuine transformation, institutions must move towards inclusive, co-constructed approaches that validate and integrate diverse ways of knowing. In this way, indigenous knowledge can inform curriculum reform and broader societal projects of decolonisation, cultural renewal, and intergenerational dialogue.

7. Recommendations

The study's recommendations were as follows:

1. Educators must recognise literacy and numeracy forms rooted in oral, gestural and rhythmic traditions. These literacies are already embedded in communities and should be leveraged in teaching strategies rather than dismissed as informal or inferior.
2. To ensure sustainability, a wider group of stakeholders, like community elders, cultural custodians, and local women's groups and associations must be involved as co-educators and key transmitters of indigenous numeracies.
3. Teacher education programs should be revised to include training on recognising and incorporating local indigenous knowledge into lesson planning. This includes engaging elders, traditional healers, and cultural custodians as knowledge bearers and co-educators.
4. Curricula should incorporate indigenous knowledge systems, especially those passed on by women, into STEM subjects such as mathematics and science.
5. Policy shifts should support including indigenous knowledge in national curricula and assessments. This may also involve adopting indigenous languages where feasible, as language often encodes particular mathematical and ecological understandings.
6. These systems of knowledge are susceptible to erasure due to their oral nature. The preservation and continuous transmission of these practices to future generations can be ensured by education systems supporting community-based documentation projects that preserve them in textual and digital forms.

8. Potential Barriers to Implementation

Several potential barriers that could hinder implementation include:

1. Resistance from educators and policymakers accustomed to Eurocentric curricula, the risk of misinterpreting or diluting indigenous practices when translated into academic frameworks, and the sacred nature of some knowledge, which cannot be fully shared
2. Teacher education reforms require curriculum redesign, training workshops, and incentives for collaboration with community knowledge holders, which require critical resources.
3. Digital and textual preservation projects require funding, technological infrastructure, and community participation to ensure ethical and accurate documentation

8. Implications of the Study

The study highlights that successfully integrating indigenous mathematical knowledge has implications beyond education. Education provides pathways for developing culturally relevant curricula that reflect local realities. It contributes to cultural sustainability and epistemic justice by recognising women as central custodians of knowledge. This recognition not only enhances community pride but also disrupts historical patterns of marginalisation, contributing to epistemic justice. Economically, indigenous mathematical literacies embedded in farming, trading, and healing have practical applications that support livelihoods, local enterprise and community resilience. Strengthening these practices contributes to sustainable development goals by aligning knowledge systems with environmental stewardship and resource management.

9. Limitations of the Study

Indigenous mathematics techniques are frequently oral and context-based and run the risk of being misinterpreted or diluted when translated into academic terminology and frameworks. The completeness of the data was limited since certain indigenous information is sacred or restricted and was not completely given by participants. However, the study was limited by its sample, which, while allowing for rich, in-depth engagement, restricts the generalizability of the findings. Furthermore, focusing on one community means that diverse indigenous practices in other South African contexts remain unexplored. Future research should expand to include a broader range of communities and comparative studies across regions, while also exploring intergenerational perspectives and the role of men in sustaining or transforming these knowledge systems.

10. Conflict of Interest

No conflict of interest

11. References

Alonso, N. (2019). A first approach to women, tools and operational sequences in traditional manual cereal grinding. *Archaeological and Anthropological Sciences*, *11*(8), 4307–4324. https://doi.org/10.1007/S12520-019-00791-X

Anderson, K. (2023). *Multi-Generational Indigenous Feminisms* (pp. 11–26). Informa. https://doi.org/10.4324/9781003053989-4

Arauf, M. A. (2023). The Existence of Women in the Traditional Rituals of the Jatilawang Bonokeling Community in Banyumas Regency. *International Journal of Social Science and Religion*, 347–366. https://doi.org/10.53639/ijssr.v4i3.187

Baskin, C. (n.d.). *Indigenous Knowledges*. https://doi.org/10.1002/9781405165518.wbeos1713

Borthakur, A., & Singh, P. (2021). *Indigenous Agricultural Knowledge Towards Achieving Sustainable Agriculture* (pp. 401–413). Springer, Cham. https://doi.org/10.1007/978-3-030-63249-6_15

Braun, V., Clarke, V.: Using thematic analysis in psychology. Qual. Res. Psychol. 3(2), 77–101 (2006). https://doi.org/10.1191/1478088706qp063oa

Bruchac, M. (n.d.). *Indigenous Knowledge and Traditional Knowledge*.

Dei, G. J. S., & Karanja, W. W. (2022). *Land as Indigenous Epistemology* (pp. 113–126). https://doi.org/10.1007/978-3-030-84201-7_5

Dos Santos, J. da S., & Madruga, Z. E. de F. (2024). Mathematics teaching and the Culture of the "Rezadeiras" (traditional healers) from the perspective of the global approach of Ethnomodelling. *Revista Latinoamericana de Etnomatemática*, *17*(1), 1–16. https://doi.org/10.22267/relatem.24171.103

Draper-Clarke, L., & Green, C. (2023). African Wisdom Traditions and Healing Practices: Performing the Embodied, Contemplative, and Group-based Elements of African Cosmology, Orality, and Arts Modalities. *Creative Arts in Education and Therapy*. https://doi.org/10.15212/caet/2023/9/14

Emeagwali, G. (2020). *African Indigenous Knowledge Systems and the Legacy of Africa* (pp. 37–55). Springer Science and Business Media LLC. https://doi.org/10.1007/978-3-030-34304-0_3

Forster, M. (2019). *Restoring the Feminine of Indigenous Environmental Thought*. *3*(1), 11. https://doi.org/10.3390/GENEALOGY3010011

Gareau, P. L., & Swain, M. B. (2024). Indigenous Knowledges. *Oxford Research Encyclopedia of Religion*. https://doi.org/10.1093/acrefore/9780199340378.013.1178

Gerdes, P. (2000). *On Mathematical Ideas in Cultural Traditions of Central and Southern Africa* (pp. 313–343). Springer, Dordrecht. https://doi.org/10.1007/978-94-011-4301-1_16

Gerdes, P. (2011). *African Basketry: Interweaving Art and Mathematics in Mozambique*. 9–16. http://archive.bridgesmathart.org/2011/bridges2011-9.pdf

Govender, L., & Naidoo, D. (2023). Decolonial insights for transforming the higher education curriculum in South Africa. *Curriculum Perspectives*. https://doi.org/10.1007/s41297-023-00200-3

Heleta, S. (2018). Decolonising Knowledge in South Africa: Dismantling the 'pedagogy of big lies.' *Ufahamu*, *40*(2). https://doi.org/10.5070/F7402040942

Jacob, G. (2021). Ethnomathematics. International Journal of Advanced Research. https://doi.org/10.21474/ijar01/13409

Jacob, G. (2021). Ethnomathematics. *International Journal of Advanced Research*. https://doi.org/10.21474/ijar01/13409

Jagire, J. (2013). *Indigenous African Knowledges and African Feminism* (pp. 77–89). SensePublishers. https://doi.org/10.1007/978-94-6209-446-8_7

Jorgensen, R. (2018). Building the mathematical capital of marginalised learners of mathematics. *Journal on Mathematics Education*, *50*(6), 987–998. https://doi.org/10.1007/S11858-018-0966-9

Joshi, C. P., & Singh, B. B. (2006). *Indigenous Agricultural Knowledge in Kumaon hills of Uttaranchal*. http://nopr.niscair.res.in/bitstream/123456789/6793/1/IJTK%205%281%29%20%282006%29%2019-24.pdf

Lappeman, J., Litkie, J., Bramdaw, S., & Quibell, A. (2020). Exploring retail orientated rotating savings and credit associations: festive season 'stokvels' in South Africa. The International Review of Retail, Distribution and Consumer Research, 30(3), 331–358. https://doi.org/10.1080/09593969.2019.1667853

Lupo-Pasini, F. (2020). *Is it a wonderful life? cashless societies and monetary exclusion.* https://dro.dur.ac.uk/30666/

McGuire-Adams, T. (2020). *Indigenous Feminist Theory and Embodied Settler Colonialism* (pp. 31–44). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-56806-1_2

Mogege, M. (2017). Conceitos Matemáticos de Anciãos da Comunidade Explorando a Conexão entre Contextos Etnomatemáticos e práticas de aula. *ETD: Educação Temática Digital*, *19*(3), 667–686. https://doi.org/10.20396/ETD.V19I3.8648368

Mollah, A. T., & Kanu, A. R. (2024). Folk Mathematics in Everyday Life. International Journal for Multidimensional Research Perspective (IJMRP), 2(9), 19–26. https://doi.org/10.61877/ijmrp.v2i9.187

Monteiro, A. (2009). Algumas reflexões sobre a perspectiva educacional da Etnomatemática [Some reflections on the Ethnomathematics educational perspective]. 12(22), 9–32. https://doi.org/10.20396/ZET.V12I22.864697

Murthy, A. (2013). Mathematics of nature and nature of mathematics. *Research Papers in Economics*. http://www.voiceofresearch.org/Doc/Jun-2013/Jun-2013_2.pdf

Nelson-Barber, S. (2023). Infusing Mainstream STEM Education with Indigenous Culture, Language and Values. *Scientia*. https://doi.org/10.33548/scientia875

Nursyahidah, F., & Susilo, B. E. (2024). Eksplorasi etnomatematika pada tradisi adat sesaji rewandha jawa tengah sebagai konteks pembelajaran untuk mendukung kemampuan numerasi siswa. *Proximal*. https://doi.org/10.30605/proximal.v7i2.4121

Owens, K. (2012). *Papua New Guinea Indigenous knowledges about mathematical concepts*. *6*(1), 20–50. https://researchoutput.csu.edu.au/en/publications/papua-new-guinea-indigenous-knowledges-about-mathematical-concept

Pais, A. (2011). Criticisms and contradictions of ethnomathematics. Educational Studies in Mathematics, 76(2), 209–230. https://doi.org/10.1007/S10649-010-9289-7

Pais, A. (2012). A investigação em etnomatemática e os limites da cultura. Reflexão & Ação, [Research in Ethnomathematics and the Limits of Culture. Reflection & Action] 20(2), 32–48. https://doi.org/10.17058/REA.V20I2.3226

Pereira, S. A., & Godoy, E. V. (2023). Decolonialidade na Educação Matemática: uma revisão sistemática de literatura. Decoloniality in Mathematics Education: A Systematic Literature Review][*Amazônia*, *19*(42). https://doi.org/10.18542/amazrecm.v19i42.13383

Price, C. J. (2024). A Review of Engraved on Our Nations: Indigenous Economic Tenacity. *Journal of Aboriginal Economic Development*, *14*(2), 132–133. https://doi.org/10.29173/jaed512

Serin, H. (2023). The Significance of Mathematical Literacy in Today's Society. *International Journal of Social Sciences & Educational Studies*, *10*(2). https://doi.org/10.23918/ijsses.v10i2p396

Setiowati, E. A., Hadi, S., Ulfa, M., Dainuri, A., Sholeh, F., Surur, M., & Munawwir, Z. (2024). Analisis Kemampuan Literasi Matematika Dalam Meningkatkan Kemampuan Berpikir Kritis Siswa. [Analysis of Mathematical Literacy Ability in Improving Students' Critical Thinking Skills]*Jurnal Kajian Penelitian Pendidikan Dan Kebudayaan*, *2*(2), 55–68. https://doi.org/10.59031/jkppk.v2i2.321

Shaterian, M. (2023). *A Comprehensive Update on Traditional Agricultural Knowledge of Farmers in India* (pp. 331–386). https://doi.org/10.1007/978-981-19-6502-9_14

Shimwandi, R., Ngololo, E. N., & Kanandjebo, L. N. (2024). Indigenous Knowledge Content & Mathematics Curriculum. *Jumuga Journal of Education, Oral Studies, and Human Sciences*, *7*(2), 1–15. https://doi.org/10.35544/jjeoshs.v7i2.93

Shivani, S., Aparna, A., & Mishra, S. (2022). Traditional knowledge. *International Journal of Health Sciences (IJHS)*, 1570–1581. https://doi.org/10.53730/ijhs.v6ns5.8916

Silva, A. P. F. da, Gomes, V. M. S., & Capecchi, M. C. V. de M. (2023). Perspectivas da Decolonialidade e Descolonização no Ensino de Matemática: uma Revisão Sistemática da Literatura. Perspectives of Decoloniality and Decolonization in Mathematics Education: A Systematic Literature Review][*Perspectivas Da Educação Matemática*. https://doi.org/10.46312/pem.v16i43.18264

Silva, N. L. da, Couto, M. E. S., & Oliveira, R. de. (2017). A Matemática no currículo das escolas indígenas: um desafio da Educação Matemática. [Mathematics in the curriculum of Indigenous schools: a challenge for Mathematics Education]*Revista Latinoamericana de Etnomatemática*, *10*(3), 149–166. https://dialnet.unirioja.es/servlet/articulo?codigo=7530845

Umbara, U., Prabawanto, S., & Jatisunda, M. G. (2023). Combination of mathematical literacy with ethnomathematics: How to perspective sundanese culture. https://doi.org/10.22460/infinity.v12i2.p393-414

Utete, C. N., Ilukena, A. M., & Sindano, G. (2017). *Exploring how modern sciences impede the development of indigenous knowledge (IK) [Ethno-science and Ethno-mathematics] in the Kavango East region: A case study*. https://repository.unam.edu.na/handle/11070/2130

Villar Briones, S. I., Briones, S. C., & Palmes, M. P. (2023). Linking mathematics and cultural practices of the agta tabangnon in the upland communities of goa, philippines. Ethnomathematics Journal. https://doi.org/10.21831/ej.v4i2.63235

Wiafe, E. (2023). African Indigenous Epistemologies, Traditions, and Practices Before the Arrival of Europeans. *Educational Considerations*, *49*(2). https://doi.org/10.4148/0146-9282.2362

Xu, H., & Ball, R. (2024). Indigenous Mathematics: From Mainstream Misconceptions to Educational Enrichment. *Canadian Journal of Science, Mathematics and Technology Education*. https://doi.org/10.1007/s42330-024-00321-5