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ETHNOMATHEMATICS FROM PAST AND CURRENT USES: A DIDACTIC INFERENCE

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Abstract: Over the past few decades, Ethnomathematics has drawn attention to the existence of culturally embedded mathematical knowledge systems; yet, their systematic pedagogical transfer into formal school mathematics is still limited in many African contexts, including Ethiopia. This study looks at Ethiopian ethnomathematical practices from historical and contemporary cultural activities in order to incorporate them into curriculum-aligned mathematical learning paths. Data was gathered utilizing a qualitative ethnographic approach using document analysis, field observations, artifact analysis, and semi-structured interviews with cultural practitioners and educators from specific Ethiopian communities. Analytical reconstruction was utilized to identify underlying mathematical structures in order to translate indigenous activities onto formal mathematical concepts such as geometry, measurement, slope, optimization, and spatial reasoning. The findings demonstrate how complex and cohesive mathematical ideas are embodied in Ethiopian cultural practices such as terracing, threshing floor design, traditional storage systems, embroidery patterns, and monument construction. These ideas can be carefully transformed into modeling exercises, classroom assignments, and inquiry-based projects. These reconstructions provide culturally relevant meditation methods in addition to enhancing conceptual understanding, leaner engagement, identity affirmation, and epistemic justice. By offering a theoretically informed framework for integrating indigenous knowledge into mathematics curricula and teacher preparation, the study advances socially relevant and culturally sensitive mathematics education in Ethiopia.

Keywords: Ethnomathematics, indigenous knowledge, didactic inference, curriculum integration, mathematics education

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INTRODUCTION

Over the past five decades, ethnomathematics has emerged as a significant field of inquiry that challenges the notion of mathematics as a culturally neutral and universal body of knowledge. Grounded in the pioneering work of D'Ambrosio (1985, 2001), ethnomathematics conceptualizes mathematics as a culturally situated human activity embedded in the practices, technologies, and symbolic systems of diverse communities. Barton (1996), drawing on the contributions of Ascher, Gerdes, and Bishop, further elaborates ethnomathematics as encompassing mathematical ideas developed within identifiable cultural groups and articulated through activities such as counting, measuring, locating, classifying, designing, and relating. These conceptualizations reveal that mathematical knowledge is not only a formal academic construct but also a living cultural practice shaped by historical, social, and epistemological contexts.

A growing body of international scholarship has demonstrated that indigenous practices—such as architectural designs, weaving and embroidery patterns, trade systems, calendrical computations, land measurement techniques, and technological constructions—embody sophisticated mathematical structures (Ascher, 1991; Bishop, 1992; Gerdes, 1994a, 2014). Consequently, scholars have advocated for the integration of ethnomathematics into formal schooling as a means of developing inclusive curricula, strengthening learner identity, enhancing conceptual understanding, and promoting social relevance in mathematics education (D'Ambrosio, 1985; Zaslavsky, 1991b; Bush, 2005; Rosa & Orey, 2010). Reviews of ethnomathematics literature (Barton, 1996; Bishop, 1992; Vithal & Skovsmose, 1997) converge on the view that connecting ethnomathematics to formal mathematics education represents the most critical direction for advancing equitable and meaningful mathematics learning.

Despite sustained theoretical advocacy, the implementation of ethnomathematics within formal education systems remains limited and fragmented. Persistent beliefs that mathematics is culturally neutral continue to shape curricula and classroom practices, resulting in the marginalization of indigenous epistemologies and the dominance of abstract, decontextualized instruction (Gerdes, 1994b; Rosa & Orey, 2010). As a consequence, mathematics learning in many contexts remains disconnected from students' lived experiences, contributing to superficial procedural learning, low motivation, and limited transfer of knowledge to real-life situations (Zaslavsky, 1988; Bush, 2005; Michael & Gladys, 2022).

These challenges are particularly pronounced in African contexts. In Ethiopia—one of Africa's oldest civilizations—rich ethnomathematical traditions are embedded in the Ge'ez numeration system, ecclesiastical calendars, architectural constructions, weaving and embroidery patterns, indigenous engineering, land measurement, and trade practices (Pankhurst, 1992). However, the formal mathematics curriculum remains predominantly Eurocentric, privileging externally constructed knowledge systems while marginalizing local mathematical practices (Bishop, 1992; Matang, 2002; Ditasona, 2018). This curricular orientation positions learners as passive recipients of mathematical knowledge and undermines their cultural identity, epistemic agency, and conceptual engagement (François & Stathopoulou, 2012; Sesanti et al., 2019).

Although contemporary policy discourses increasingly emphasize learner-centered and contextualized pedagogy, there remains a critical lack of systematically documented Ethiopian ethnomathematical practices that are analytically mapped onto formal mathematical concepts and transformed into curriculum-aligned learning sequences, instructional models, and assessment frameworks. Existing studies in Ethiopia and other African contexts have largely focused on descriptive documentation of cultural artifacts rather than on generating didactic inferences—that is, pedagogical reconstructions of indigenous practices into teachable mathematical content (Ogunkunle & George, 2015; Septianawati et al., 2017; Roza et al., 2020). Consequently, teachers lack empirically grounded instructional models, curriculum developers lack validated design frameworks, and empirical evidence regarding the effects of ethnomathematics-based instruction on students' reasoning, problem-solving, and conceptual development remains scarce (Sesanti et al., 2019; Sunzuma & Maharaj, 2020).

This persistent gap between Ethiopia's extensive ethnomathematical heritage and its formal mathematics education system underscores an urgent scholarly and pedagogical need to systematically identify, analyze, and didactically reconstruct indigenous mathematical practices into curriculum-relevant learning trajectories and classroom tasks. Addressing this gap is essential not only for improving conceptual understanding and learner engagement but also for advancing culturally responsive pedagogy, strengthening learner identity and agency, and promoting epistemic justice within Ethiopian mathematics education (D'Ambrosio, 2001; Gerdes, 2014; Rosa & Orey, 2010).

Overview of the Theoretical Foundation

This study is anchored in an integrated theoretical framework that positions ethnomathematics as the epistemological foundation, didactic inference as the mechanism for pedagogical transformation, and sociocultural–constructivist learning together with critical pedagogy as the explanatory and justice-oriented lenses for understanding learning processes and curriculum reform. Each component of this framework is examined in depth in subsequent paragraphs.

Ethnomathematics as a Cultural–Epistemological Framework

D'Ambrosio (1985, 2001) presented ethnomathematics, which views mathematics as a culturally placed body of knowledge created by social groups to solve contextual issues with counting, measuring, locating, designing, playing, and explaining. This is consistent with Bishop's 1988 work, which goes into great depth about the common mathematical practices of cultural societies worldwide, regardless of where they live or what language they speak. More significantly, Weldeana's (2016, 2020) works, which address the maturity and applicability of ethnomathematical practices in Ethiopia to foster crucial mathematical contents embedded in cultural materials of significance, mirror and bolster this sentiment. By acknowledging various mathematical epistemologies based on lived activities, these viewpoints contest the prevailing notions of mathematics as a universal and culturally neutral science (Bishop, 1992; Ascher, 1991; Gerdes, 1994a, 2014). In contrast to casual or incidental encounters, ethnomathematics presents cultural activities as valid sources of mathematical knowledge.

Coherent mathematical frameworks can be methodically examined and pedagogically reproduced in African contexts through indigenous practices including traditional land measuring, weaving algorithms, architectural proportionality, and numeration systems (Gerdes, 1994a; Zaslavsky, 1991a). Localized mathematical epistemologies are further demonstrated in Ethiopia by mathematical concepts incorporated into indigenous architecture, craft practices, church calendars, and the Ge'ez numeration system (Pankhurst, 1992; Gerdes, 2014). The epistemological basis for recognizing, verifying, and recording indigenous mathematical knowledge systems is thus provided by ethnomathematics.

Didactic Inference as a Pedagogical–Transformational Theory

Chevallard's (1991) theory of didactic transposition, which describes how knowledge from social or academic contexts is transformed into teachable school knowledge through institutional and pedagogical procedures, is consistent with the conversion of culturally ingrained knowledge into classroom mathematics. Vithal & Skovsmose (1997) highlight the need for ethnomathematics research to go beyond documenting in favor of pedagogic reconstruction—converting traditional mathematical practices into curriculum-aligned classroom content.

In this study, didactic inference is defined as the methodical process of reconstructing mathematical structures from indigenous practices into formal representations, learning trajectories, instructional tasks, and assessment strategies (Rosa

& Orey, 2010; Sunzuma & Maharaj, 2020). It ensures both curricular legitimacy and epistemic fidelity by operationalizing the shift from knowledge-in-use (cultural practice) to knowledge-for-teaching (school mathematics).

Sociocultural and Constructivist Learning Foundations

Sociocultural learning theory, which holds that language, social interaction, and cultural tools mediate learning, provides the foundation for the pedagogical viability of didactic inference (Vygotsky, 1978). Cultural artifacts support students' conceptual growth by acting as cognitive mediators. According to constructivist epistemology (Piaget, 1970; Fosnot, 2013), students actively create mathematical knowledge by connecting new ideas to preexisting experienced understandings.

While didactic inference organizes these tools into formal learning sequences that enable the transition from intuitive reasoning to abstract mathematical formalism, ethnomathematical practices offer culturally significant mediational tools (François & Stathopoulou, 2012).

Critical Pedagogy and Epistemic Justice

Ethnomathematics is positioned within a justice-oriented pedagogical paradigm that prioritizes learner identity, social relevance, and empowerment in critical mathematics education (Skovsmose, 1994; D'Ambrosio, 2001; Rosa & Orey, 2010), as summarized in Table 1. By establishing students as legitimate mathematical knowers and validating their cultural knowledge, the methodical incorporation of indigenous mathematical knowledge into school curricula through didactic inference advances epistemic fairness (Fricker, 2007; Sesanti et al., 2019).

Table 1. Integrative Theoretical Model

Theoretical Lens	Contribution to the Study
Ethnomathematics Theory (D'Ambrosio, Gerdes, Bishop)	Epistemic source of indigenous mathematical knowledge
Didactic Transposition / ATD (Chevallard; Vithal & Skovsmose)	Mechanism for pedagogical reconstruction
Sociocultural & Constructivist Theory (Vygotsky; Piaget)	Explanation of learning mediation and conceptual development
Critical Mathematics Education (Skovsmose; Rosa & Orey)	Equity, identity, and relevance framing

Ethnomathematics and Mathematics Education

In the "Principles and Standards for School Mathematics" (NCTM, 2000), the National Council of Teachers of Mathematics (NCTM) encourages creative approaches to knowledge and skill development through related themes. "The Need for Mathematics in a Changing World", which emphasizes both content and procedure, is one crucial subject. "Citizens should gain a respect and comprehension of that achievement, including its aesthetic and even recreational features" (NCTM, 2000) highlights the importance of comprehending mathematics as part of cultural legacy.

Paulus Gerdes developed the Zaslavsky-Ascher Model and the D'Ambrosio-Gerdes Model as two approaches for putting these principles into practice in a comprehensive curriculum. While the latter bridges the gap between contemporary sciences and home culture in underdeveloped nations, the former is appropriate for multicultural classrooms in wealthy nations. When combined, these approaches address a range of learning requirements.

The relationship between mathematics and cultural studies is highlighted by research by Bishop (1988), Barton (1996), and Gerdes (2014). Bishop defined six mathematical tasks that are common to all societies: measuring, counting, locating, designing, playing, and explaining. Barton created a system for studying mathematics and culture that emphasizes analytical, mathematizing, descriptive, and archeological activity. By immersing oneself in the culture and comprehending the reasoning behind its forms, Gerdes' method entails discovering and rebuilding hidden mathematics in cultural objects.

According to researchers like Roza et al. (2020), Ogunkunle & George (2015), and Gerdes (2014), ethnomathematics-based curricula promote cultural competence in mathematics education. These courses cover proficiency in motivation, knowledge, skills, and attitudes while integrating real-world exercises, decision-making, and community interactions. Finding mathematical content in cultural items, for instance, improves mathematical and cultural literacy and numeracy.

In conclusion, integrating ethnomathematical perspectives into the curriculum leads to holistic education, promoting a deeper understanding of mathematics through cultural contexts.

Mathematical Literacy:

1. Using mathematical ideas in practical situations is what it means to be mathematically literate.

2. Gaining proficiency in building mathematical models.

Cultural Literacy includes:

a. Learning about culture.
b. Understanding the significance of cultural sensitivity.

Highlights of Mathematical Numeracy:

1) Expertise in mathematics or culturally appropriate tasks.
2) The ability to engage in society in an effective manner.

METHOD

The goal of the current study was to provide a framework for incorporating ethnomathematical activities into formal education in order to improve cultural appreciation and mathematical literacy. In order to promote an inclusive and pertinent mathematics education, the research findings given in this study offered educational resources and curriculum that integrate indigenous mathematical knowledge into classrooms.

Research Design

Using a qualitative research design, this study aims to investigate the mathematical concepts present in a range of ethnomathematical activities from diverse cultural practices. Finding the hidden mathematical ideas in customary cultural practices and artifacts and examining how they relate to formal mathematical education are the goals.

Data Collection Methods

The following methods of gathering data are essential to the methodology:

Ethnographic Fieldwork

This involves take part in cultural immersion to see and record how societies employ ethnomathematical techniques. This can entail going to locations like Konso's terracing, looking at traditional threshing plots within Tigray, and researching storage buildings like the "*Gotera*".

Interviews with Cultural Practitioners

To learn more about how artisans, community leaders, and cultural practitioners comprehend the mathematical concepts in their customs, conduct semi-structured interviews with them.

Archival Research

To learn about the development of mathematical ideas in various cultures, gather historical documents, illustrations, and descriptions of cultural artifacts (such as Aksumite obelisks and theme trays).

Participant Observation

This entails take part in conventional exercises to learn how mathematical ideas like symmetry, area maximization, and gradients are used in practical problem-solving situations.

Data Analysis Technique

The following were the main topics of the analysis:

Thematic Analysis

Finding and classifying recurrent mathematical themes, such as gradients, area maximization, volume measurements, and geometric patterns, is known as thematic analysis.

Content Analysis

Examine the mathematical content of the processes and artifacts to determine how formal mathematical ideas like algebra, geometry, and trignonomety relate to cultural practices.

Comparative Analysis

To identify similarities and differences, compare and contrast the mathematical concepts used in these cultural practices with those taught in regular schools.

We cross-referenced the results from observations, interviews, and historical data to guarantee trustworthiness. In order to confirm the accuracy of the interpretations, member verification will also entail discussing findings with cultural practitioners. Participants gave their informed consent after being fully informed about the study's minimal risk, cultural sensitivity, and correct treatment of intellectual property pertaining to customs and expertise.

RESULTS AND DISCUSSION

This section highlights important Ethiopian ethnomathematical practices that were discovered through participant observation, interviews, anthropological fieldwork, and archival analysis. It also shows how these cultural practices serve as effective instructional contexts for formal mathematics education. Beyond identifying culturally embedded mathematical ideas, the study documented how indigenous practitioners enact systematic, rule-based reasoning in authentic cultural settings. The discussion interprets these findings in relation to existing literature, theoretical frameworks, and implications for mathematics education.

Gradient: The Terracing Technology of the *Konso* People

The *Konso* people of Southern Ethiopia have developed a terracing technology, illustrated in Figure 1, recognized by UNESCO, to combat environmental degradation. Despite debates over its origin, this technology is fundamentally based on the mathematical concept of gradient, defined as the rise-over-run ratio. This technology provides a rich source for classroom projects that encourage critical thinking about environmental preservation through mathematical modeling. Students can explore mathematical relationships by converting this indigenous knowledge into school-taught mathematics, such as creating equations to describe gradients. They can also delve into discussions about preventing soil erosion in mountainous areas by examining how variations in gradient impact environmental outcomes.

Figure 1. *Konso* terracing technology

This typical cultural activity may create a rich context and meaningful idea in the teaching and learning of mathematics. Students could be encouraged to analyze the terracing technology by addressing questions such as:

1. What is terracing, and does it contain embedded mathematical concepts?
2. How is *Konso* terracing related to the concept of gradient?
3. How can this technology and the concept of slope aid in environmental preservation?

Through this exploration, students ought to identify and translate the implicit mathematical content into explicit representations. They also need to immerse themselves in the cultural context to fully understand and generalize the mathematical ideas, enhancing both cultural and mathematical literacy.

Terracing is a mathematically structured system controlled by slope optimization and proportionate reasoning, not just an environmental protection tactic, according to ethnographic fieldwork conducted among the *Konso* people. Terrace walls are installed at regular vertical and horizontal intervals to control water flow and stop soil erosion with the use of water lablel, according to participant observation. “We place each stone after the previous one at the same distance”, a farmer clarified. The terrace collapses if the distance varies. A tool known as “water label” was also used to support this.

The mathematical idea of gradient (rise-over-run) is reflected in these procedural regularities, which can be reconstructed into projects involving slope, linear equations, and environmental modeling in the classroom. By creating equations, analyzing how slope changes impact erosion and water retention, and translating these traditional traditions into explicit mathematical representations, students can improve their mathematical literacy and environmental awareness.

Maximizing Area: The Threshing Plot as an Example

The traditional Tigrayan (and other cultures within Ethiopia) “Threshing Process”, illustrated in Figure 2, involves maximizing the area of a regular polygon and has been practiced for centuries. This activity provides a context-rich mathematical exercise suitable for various educational levels. Students can explore the reasons behind the choice of circular threshing plots and engage in tasks involving inscribing or circumscribing polygons within circles to understand area relationships.

Educators can prompt discussions with questions like:

a. What shape does the traditional threshing plot take?
b. What mathematical concepts are embedded in this cultural practice?
c. How can you plan to maximize the area?

Figure 2. Threshing process

These activities would surely help students develop an intuitive understanding of limits and area maximization. By comparing the areas of polygons and circles, students learn that the circle has the largest area for a given perimeter, a principle rooted in the study of limits and extreme values in mathematics, more explicit in the application of derivatives.

Elders in Tigray built circular threshing floors utilizing rope-based radius estimate and repeated arc alignment, according to field observations of traditional threshing plots. We stretch a rope from the middle, as one elder observed. The harvest will be dispersed and the oxen will not move smoothly if the circle is not precise. This exercise shows how to optimize area and perimeter connections intuitively.

This cultural exercise provides a rich educational setting for teaching derivatives, area maximization, and limits. In order to connect intuitive thinking to formal calculus concepts, classroom activities can include writing polygons inside circles, comparing their areas, and modeling how the circle offers maximum area for a given perimeter. In this situation, Paula Zaslavsky's writings (Zaslavsky, 1991a; 1991b) offer superb illustrations that help bolster this claim.

Capacity and Storage: The Traditional Solo as an Example

The "*Gotera*", a traditional Ethiopian storage method, exemplifies the application of mathematical reasoning to solve practical problems. This artifact involves measuring and optimizing space, particularly volumes and surface areas. Students can engage in tasks that require them to analyze the geometric properties of the *Gotera*, helping them understand the importance of high-quality storage solutions. Figure 3 and Figure 4 represent the local solo and its closest mathematical representation in school mathematics.

Figure 3. The Traditional *Solo*

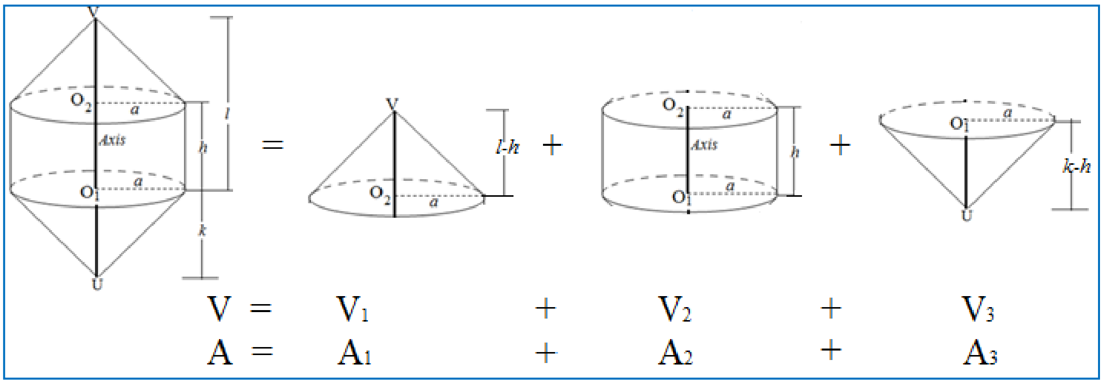

Figure 4. Dissection of a local *Solo* into measures of capacity and surface area of the *Solo*

Educators can guide students with questions such as:

1) How is the *Gotera* constructed, and why does it take its specific form?
2) What mathematical principles justify its shape and quality?

Through this process, students could be helped to develop spatial awareness and geometric reasoning, learning to apply mathematical concepts to optimize practical designs. Participant observation and interviews with local builders revealed that the *Gotera* (traditional grain storage) is constructed using consistent modular measurements to optimize volume and protect stored crops. These practices involve systematic reasoning about surface area, volume, and material efficiency.

Students can reconstruct the *Gotera* into formal geometric solids and analyze its capacity using mathematical formulas, thereby developing spatial visualization and problem-solving skills. This bridges indigenous design practices with school-taught concepts of three-dimensional geometry.

Locating Position: The Compass as an Example

The compass used by the *Aksumite* kingdom for navigation and trade highlights the application of coordinate geometry and trigonometry. This ancient artifact, depicted in Figure 5, shows the principal directions and demonstrates the *Aksumite*'s understanding of spatial relationships.

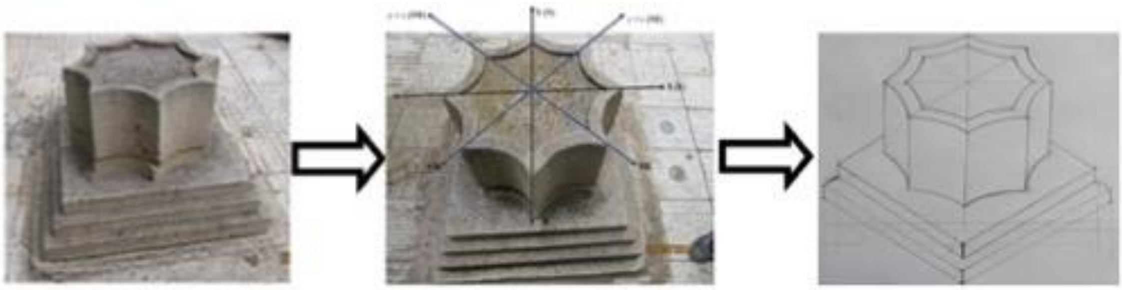

Figure 5. Compass-an ancient navigation tool

Students can explore questions like:

a) How does the *Aksumite* compass compare to modern compasses?

b) What are the geometric properties of the compass, and how can they be analyzed using coordinates and parametric equations?

This activity introduces students to the concepts of bearing, coordinate planes, and geometric measurements, fostering mathematical thinking and understanding.

Archival documents and museum records on *Aksumite* navigation tools demonstrate structured geometric layouts based on directional orientation and angular measurement. These findings confirm that ancient Ethiopian navigators applied principles of coordinate geometry and trigonometry. Students can compare these compasses with modern coordinate systems, analyze angular positions, and apply parametric equations, thus contextualizing abstract coordinate geometry concepts in historical practice.

Measurement of Length: The Construction of the Obelisks as an Example

The *Aksumite* kingdom's construction of massive obelisks, depicted in Figure 6, using a metric system of measurement, exemplifies the application of mathematical precision in engineering. These structures, some over 24 meters tall and weighing 160 tons, demonstrate the importance of accurate measurement and spatial reasoning.

Students can investigate:

(1) How does the *Aksumite* measurement system compare to the modern metric system?

(2) How did precise measurement contribute to the construction of the obelisks?

Through these questions, students learn about the historical application of mathematical principles in architecture and engineering, enhancing their understanding of measurement and its significance.

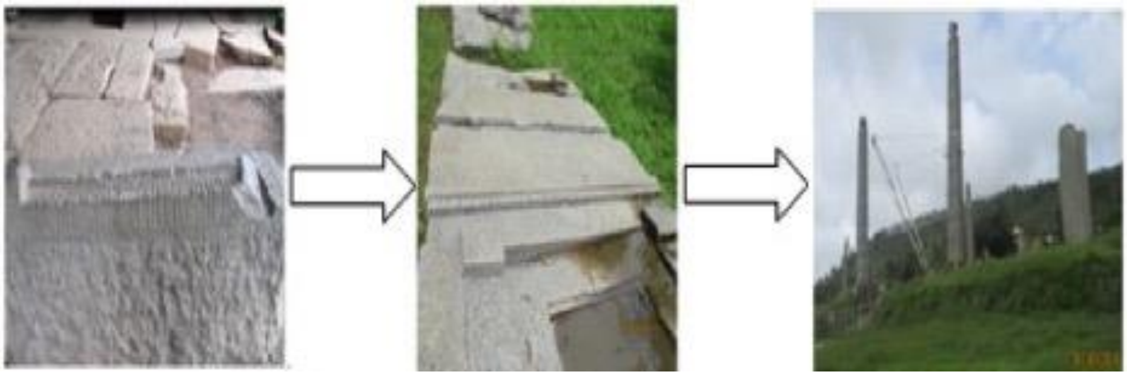

Figure 6. The formation of the imaginative towers

Archival evidence showed that *Aksumite* builders used fixed modular units and proportional design principles in constructing monumental obelisks. An archivist noted, “These manuscripts describe how many stone units must be used for each in building the Obelisks”. Such structured measurement systems provide historical evidence of applied mathematics in engineering. These artifacts can be reconstructed into lessons on measurement systems, scale, ratio, and structural modeling, enhancing students’ understanding of precision and engineering mathematics.

Artistic Works, Angles, and Rotations: The Motif Tray as an Example

Mathematics plays a significant role in cultural artifacts, such as the motif tray in Figure 7, which involves angles, symmetry, and geometric patterns. This artifact provides a platform for students to explore the mathematical concepts embedded in artistic designs, such as central angles in circles and symmetry.

Figure 7. Artistic values in motif trays

In typical mathematics lessons, students can be guided by questions like:

(a) What geometric properties can be identified in the motif tray?

(b) How can angle measurements and patterns be analyzed mathematically?

By reconstructing and analyzing these designs, students enhance their mathematical literacy and cultural appreciation, learning to recognize the mathematical foundations of artistic expressions.

Interviews with artisans revealed that motif trays are designed using repeated angular partitions and rotational symmetry. These designs can be reconstructed into mathematical explorations of central angles, rotations, and tessellation. Students can measure angles, reconstruct rotational patterns, and analyze symmetry groups, thereby strengthening geometric reasoning.

Cross Designs and Symmetry: The Embroidery as an Example

Claudia Zaslavsky's work highlights the mathematical richness in African cultural artifacts, such as embroidery, depicted in Figure 8, which involves patterns, symmetry, and geometric methods. These designs offer an opportunity to integrate multiple mathematical concepts in a cohesive manner, fostering a deeper understanding of their applications.

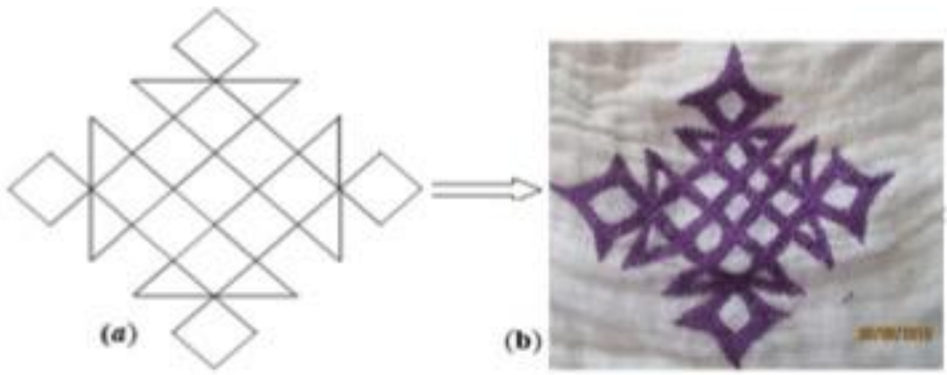

Figure 8. Cross design for embroidery production

Such cultural artifacts of cultural significance can be used as a rich resource in mathematics lessons to supplement the ‘academic’ or ‘school’ popular in today’s education system. In doing so, students can explore:

- What mathematical concepts are present in traditional embroidery mostly prevalent in cultural attires?
- How can patterns and symmetry be analyzed and understood mathematically?

This activity encourages students to appreciate the mathematical beauty in cultural artifacts, enhancing their ability to identify and analyze mathematical concepts in various contexts.

Traditional embroidery patterns were found to be governed by rule-based repetition, proportional spacing, and mirror symmetry. A weaver stated, “We count by definite numbers so that the design stays balanced”. These artifacts offer cohesive contexts for teaching sequences, symmetry, transformation geometry, and pattern generalization. Students can analyze embroidery patterns using coordinate grids and transformation rules, fostering deep conceptual understanding and cultural appreciation.

In summary, the integrated findings demonstrate that Ethiopian ethnomathematical practices constitute coherent and systematically structured mathematical systems. Through didactic reconstruction, these cultural activities can be transformed into curriculum-aligned mathematical tasks that enhance conceptual understanding, engagement, and cultural relevance in mathematics education.

The goal of this study was to determine the pedagogic viability of Ethiopian ethnomathematical practices in formal mathematics education by examining their historical and contemporary applications. The results offer compelling theoretical and empirical proof that indigenous Ethiopian cultural practices form cohesive, complex, and pedagogically potent mathematical knowledge systems. Community members regularly used systematic reasoning involving proportionality, symmetry, modular repetition, optimization, spatial regularity, and algorithmic sequencing in a variety of cultural activities, such as threshing-floor construction, terracing, weaving, embroidery, basketry, architecture, calendrical computation, and monument building. By showing how deeply ingrained mathematical knowledge is in Ethiopian cultural traditions, these practices dispel the myth that mathematics is culturally neutral and validate indigenous knowledge as valid mathematical epistemologies (D'Ambrosio, 1985, 2001; Gerdes, 1994a, 2014; Bishop, 1988, 1992; Rosa & Orey, 2010).

Despite not employing symbolic notation, ethnographic data showed that weavers, farmers, craftspeople, and elders use exact mathematical thinking. Modular pattern repetition in weaving, proportionate sequencing in terracing, and rope-based radius estimation in threshing-floor construction are examples of implicit but methodical geometry, measurement, and optimization expertise. These results support the idea of "hidden mathematics" in African cultural objects proposed by Gerdes (2014) and are consistent with the larger historical acknowledgement of African contributions to the advancement of mathematics worldwide (Ascher, 1988; Zaslavsky, 1991a; 1991b).

This study's methodical use of didactic inference to convert ethnomathematical practices into curriculum-aligned learning pathways is one of its main contributions. Formal mathematical concepts including slope, derivatives, coordinate geometry, spatial measurement, modeling, and optimization were analytically rebuilt from cultural practices. In addition to immediately addressing Vithal & Skovsmose's (1997) request to transition from descriptive documentation to pedagogically structured reconstruction, this procedure operationalizes Chevallard's (1991) didactic transposition theory. The resulting instructional models support Sunzuma & Maharaj's (2020) claim that systematic instructional modeling is necessary for legitimizing ethnomathematics in formal education and validate Rosa & Orey's (2010) claim that ethnomathematics bridges learners' lived experiences with formal mathematics.

In order to facilitate learners' transitions from intuitive reasoning to formal abstraction, the reconstructed activities served as culturally significant mediational aids. Students were able to more effectively hypothesis, generalize, model, and abstract mathematical concepts by modeling familiar tasks including analyzing terracing gradients, optimizing threshing-floor layouts, and deciphering symmetrical needlework designs. These results validate earlier findings that culturally responsive pedagogy improves engagement and conceptual understanding (Bush, 2005; Michael & Gladys, 2022; Sesanti et al., 2019) and support Vygotsky's (1978) sociocultural learning theory and constructivist perspectives on experiential knowledge construction (Piaget, 1970; Fosnot, 2013).

The incorporation of Ethiopian ethnomathematics has important societal ramifications that go beyond cognitive results. By affirming learners' cultural identities and repositioning them as legitimate knowers, acknowledging indigenous mathematical knowledge addresses epistemic oppression. These results support critical frameworks for mathematics education that present mathematics as a tool for learner agency, social relevance, and empowerment (Skovsmose, 1994; D'Ambrosio, 2001; François & Stathopoulou, 2012) and are consistent with Fricker's (2007) concept of epistemic fairness.

By offering empirically supported approaches for incorporating indigenous knowledge into Ethiopian mathematics curricula, the study significantly advances curriculum development. In addition to providing authentic educational materials in line with NCTM (2000) principles that emphasize modeling, practical problem solving, and cultural appreciation, archival and ethnographic evidence of modular and proportional design principles in church and monument construction shows historical continuity in Ethiopian mathematical reasoning. To improve pedagogical topic knowledge, cultural competency, and instructional design capacity, however, sustainable implementation necessitates focused teacher professional development (Matang, 2002; Sunzuma & Maharaj, 2020). Ethnomathematics runs the risk of staying symbolic rather than transformative in the absence of such structural backing.

Lastly, the results place Ethiopian ethnomathematics in the context of larger African and international traditions of culturally grounded mathematics. This study confirms the usefulness of the D'Ambrosio–Gerdes Model and the Zaslavsky–Ascher Model for curriculum creation in multicultural and developing contexts, respectively, in accordance with Gerdes (2014) and Zaslavsky (1991a, 1991b). In order to close resource gaps, improve teacher preparation, promote student pride, and advance culturally sensitive and socially just mathematics education, coordinated research initiatives to integrate culture and mathematics remain essential.

CONCLUSION

In conclusion, this study offers strong proof that Ethiopian ethnomathematical practices are logical, exacting, and useful for teaching formal mathematics. These practices can be developed into curriculum-aligned pedagogical models that improve conceptual understanding, engagement, cultural identity affirmation, and epistemic justice through methodical didactic inference. This will provide a solid basis for reimagining Ethiopian mathematics education as intellectually rigorous, socially responsive, and culturally grounded.

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