IJAAR PUBLISHING®

International Journal of Research in Education and Sustainable Development | ISSN: 2782-7666
Vol. 5, Issue 6 (2025) | www.ijaar.org/ijresd

Ethnomathematics and Child Development: Pattern, Issues and Prospects

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This paper explores ethnomathematics, a field that examines the mathematical ideas and practices embedded in diverse cultures and their connection to child development and education. It emphasizes how cultural contexts shape mathematical understanding and argues for the integration of ethnomathematical approaches into curricula to create more inclusive and equitable learning environments. By connecting mathematics to students lived experiences and cultural backgrounds, ethnomathematics aims to enhance engagement, understanding, and appreciation for the diverse ways mathematics is practiced worldwide. Drawing on theories of enculturation and acculturation, and sociocultural learning the paper discusses various examples of ethnomathematics in different cultures and educational levels. It also underpins ethnomathematics as a tool for equitable learning environment and culturally inclusive education. It concludes by advocating for the integration of ethnomathematical perspectives in early childhood and K–12 education, ensuring that mathematics instruction is inclusive, culturally relevant, and socially just.

Keywords: Ethnomathematics, Culturally Relevant Pedagogy, Mathematics Practices, Social Justice

Ajani, M. O. (2025). Ethnomathematics and Child Development: Pattern, Issues and Prospects. *International Journal of Research in Education and Sustainable Development.* *5*(6), 12-21. DOI: https://doi.org/10.5281/zenodo.15870493

Introduction

Ethnomathematics is a field pioneered by Brazilian mathematician Ubiratan D'Ambrosio, which examines the mathematical ideas embedded in the everyday practices of various cultural groups. It also lies on the borderline between the history of mathematics and anthropology with the evolution of concept of mathematics in a cultural and anthropological framework. The term “ethno” refers to the key components that shape all culturally identifiable group’s identity, such as their language, values, beliefs, cultural customs, symbols, codes, utopias, ways of reasoning, inferring, community, modelling and social class (D'Ambrosio, 1985; D'Ambrosio, 2001, p. 308). Ethnomathematics represents the way that various cultural groups mathematize their own reality because it examines how both mathematical ideas and mathematical practices are processed and used in daily activities. It is described as the art and techniques developed by students from diverse cultural and linguistic backgrounds used to explain, understand, and manage social, cultural, environmental, political, and economic environments (D'Ambrosio 2007).

Ethnomathematics explores how learners from diverse backgrounds engage with mathematical concepts, procedures, and practices to address real-world problems. By connecting culture and mathematics, it examines how different groups interpret, express, and apply mathematical thinking in their daily activities. This approach challenges the idea that mathematics is solely a western, abstract construct. Instead, it emphasizes that diverse mathematical systems have existed across societies and presents mathematics as a dynamic, living practice shaped by human interactions with the world. This aligns with Allan Bishop's theories of enculturation and acculturation as both focus on how cultural contexts shape mathematical understanding. According to Bishop, enculturation refers to the process by which individuals learn the cultural norms and practices of their own community, including its mathematical systems. Acculturation, on the other hand, involves the adaptation of individuals or groups to a different cultural context, which may include learning and incorporating new mathematical practices. These processes highlight the ways in which mathematical knowledge is not only a universal academic discipline but also a deeply cultural phenomenon, shaped by both one's native culture and external influences. By connecting these theories to ethnomathematics, educators can better understand how students' cultural backgrounds influence their approach to mathematical learning and bridge the gap between informal and formal mathematics (Bishop, 1988).

The emergence of ethnomathematics has brought attention to the mathematical practices of Indigenous cultures, African communities, and other non-Western societies, which were previously overlooked or undervalued in traditional mathematical education. In the 1990s, the field expanded as scholars began to incorporate ethnomathematical approaches into educational theory, arguing for a more inclusive and culturally responsive curriculum that would reflect students' diverse backgrounds. The work of Powell and Frankenstein (1997) and other scholars helped solidify the connection between ethnomathematics and pedagogy, emphasizing the importance of integrating cultural knowledge into math instruction to make the subject more relevant and meaningful to all students.

Mathematics involves a wide array of activities like arithmetic, classifying, ordering, reasoning, and modeling**.** Through this perspective, students can recognize math in various aspects of everyday life. An understanding of these concepts allows educators to expand their view of mathematics and teach more effectively in diverse classroom settings**.** By linking math to familiar cultural contexts**,** ethnomathematics provides an effective way to enhance students’ learning and development, particularly in diverse environments. For instance, in

Hawai'i and Sāmoa, Indigenous counting systems—an example of ethnomathematics thrived and were taught to children to meet their immediate social and physical needs to quantify (Furuto, 2014; Henward & Aikau, 2024).Children naturally acquire languages, behaviors, knowledge, skills, and talents in their home settings. However, once they begin formal schooling, their learning often shifts from hands-on, experiential learning to more abstract, classroom-based methods. Ethnomathematics helps bridge this gap, making math education more relevant, engaging, and culturally responsive.

Ethnomathematics, defined by Brazilian mathematician Ubiratan D'Ambrosio, explores the intersections between culture, historical traditions, sociocultural roots, and mathematics. Students frequently seek connections between mathematics and their daily lives, and ethnomathematics addresses this need by answering the age-old question: "What's the relevance?" By demonstrating how math operates in real-world contexts, ethnomathematics helps children see the practical applications of mathematical concepts and reduces the likelihood of developing negative attitudes toward the subject. Powell and Frankenstein (1997) advocate for the study of ethnomathematics, emphasizing its role in highlighting the significance of mathematics throughout human history. According to him, focusing on mathematics within students' cultural contexts allows them to appreciate and recognize their ancestors' contributions to mathematical knowledge. This validation of lived experiences can enhance students' confidence in their mathematical abilities and foster their creative potential.

According to Aikpitanyi & Eraikhuemen (2017), ethnomathematics approach promotes the rights of all people, no matter their sexual orientation, gender, ethnicity, race and socio-economic status. It does this to allow learners to understand issues and problems of diverse society. Ethnomathematics deals with both content and the process of curriculum, classroom, teacher expectations, professional development and relationship among teachers, administrators, students and community. This approach allows students to make connections with historical developments of mathematics and the contributions made by diverse groups and individuals. Exposing students to diverse ways of thinking and practicing mathematics can enhance their interest in learning essential content. By connecting mathematical concepts to future professional contexts, students are better able to understand and apply what they learn, leading to improved performance.

Children are active participants in learning their culture by observing, engaging in, and contributing to community activities. This process is essential for acquiring mathematical knowledge and skills. Through participation in daily practices such as games, household tasks, and traditional work, children naturally integrate mathematical thinking into their experiences (Rogoff, 2003; Abah, 2020). For instance, Nigerian children learn counting and strategic reasoning through games like *I'tche* (a variant of Mancala) and develop measurement skills through traditional market practices like the *Mudu* system (Abah, 2020). This active participation aligns with Vygotskian theories of learning, where children develop cognitive skills through social interactions and cultural contexts (Gauvain & Munroe, 2012). The situative perspective on learning also emphasizes how knowledge is built within meaningful, real-world practices (Bang, 2015). These culturally embedded mathematical activities not only enhance problem-solving skills but also ensure that learning remains relevant and culturally sustaining for children.

Child development is integral to understanding how children learn mathematics within their cultural contexts. This perspective includes acknowledging children's prior experiences, cultural practices, and evolving comprehension of social justice issues. Vygotsky's

sociocultural theory of child development provides a foundational framework for this understanding. According to Vygotsky (1978), children's cognitive development is deeply influenced by social interactions, language, and cultural tools, which shape their learning processes and meaning making. Ethnomathematics aligns with Vygotsky's theory by emphasizing the importance of the sociocultural environment in mathematical learning (D'Ambrosio, 2001). Ethnomathematics recognizes that mathematical knowledge is not universal but context-dependent, reflecting the cultural practices and daily experiences of different communities (Rosa & Orey, 2007). By integrating Vygotsky's principles of mediated learning with ethnomathematical approaches, educators can create learning experiences that are culturally relevant and support children's developing understanding of mathematics and social justice (Gutiérrez, 2013). This approach promotes a more equitable mathematics education by valuing diverse ways of knowing and understanding the world.

Ethnomathematics across Educational Grades

Ethnomathematics can play a significant role in supporting child development and learning across different grade levels. By connecting mathematical instruction to students' cultural experiences and real-world contexts, educators can make learning more meaningful and engaging. Research by Weiland and Poling (2022) highlights the importance of integrating culturally responsive practices in mathematics to foster deeper understanding and participation. Similarly, Witherspoon (2024) emphasizes that recognizing students' cultural identities helps promote equitable learning environments. Desai and Safi (2023) further illustrate how ethnomathematical approaches encourage critical thinking and problem-solving skills by validating diverse mathematical practices and knowledge systems.

Elementary School: At the elementary level, ethnomathematics can help children develop a strong foundation in basic math concepts while also nurturing their cultural awareness and appreciation. For example, incorporating traditional games, stories, using and drawing or art forms that involve mathematical thinking can provide engaging and culturally relevant learning experiences. According to Gauvain, Beebe, and Zhao (2011), considering cultural contributions such as involving experienced cultural members, practices, institutions, and artifacts offers children valuable support and guidance in developing knowledge and thinking skills.

Middle/High School: As children progress to middle and high school, ethnomathematics can help them explore more complex mathematical ideas and connect them to real-world issues. For instance, analyzing data related to their communities, or studying the mathematical principles behind cultural artifacts or practices. Also, examining geometric transformations through culturally relevant tile designs or analyzing school and district data through community walks can provide authentic and engaging learning experiences.

Mathematics is inherently relevant and applicable; teachers can reinforce this by consistently providing examples that highlight its real-world connections. Doing so helps prevent the development of negative perceptions among students.

Ethnomathematics: A Tool for Equitable and Culturally Inclusive Education

Ethnomathematics is a vital tool for promoting more equitable and culturally inclusive learning environments. By recognizing and valuing the diverse ways mathematics is practiced

globally, educators can contribute to a more inclusive and empowering educational experience for all students, as outlined below.

Connecting to Students' Lived Experiences: Ethnomathematics recognizes that learning is most effective when connected to students' lived experiences and cultural backgrounds. This approach can be particularly beneficial for students from marginalized communities who may not see their cultures reflected in traditional math curricula. In their study, Powell and Frankenstein (1997) examined traditional methods used to lay foundations for homes in Mozambique. They discovered that builders use ropes, and bamboo sticks to create a rectangular base, where the diagonals consist of ropes of equal length, and the sides are made of bamboo sticks. This practice reflects the “rectangle axiom,” which states that if the opposite sides of a quadrilateral are congruent and the diagonals are also congruent, the shape is a rectangle. By linking mathematics to students' cultural practices and their funds of knowledge, ethnomathematics makes learning more meaningful, promotes student engagement, enhances understanding, and reinforces cultural identity.

Promoting Mathematical Sense-Making: Ethnomathematics emphasized the importance of mathematical sense-making by engaging students with math concepts in authentic, meaningful contexts. It supports the development of problem-solving, reasoning, and critical thinking skills in children. By this, one can observe and understand how people around the world continue to adapt and apply mathematical concepts. Students should be supported in developing their own mathematical understandings and articulating their reasoning. When their mathematical ideas, experiences, and applications are acknowledged and respected, students receive equal opportunities for access and success (Harvard University Achievement Gap Initiative, 2008; Kyselka, 1987; UCLA Center X, 2008). By exploring how math has been used in different contexts and for different purposes, students develop a more sophisticated understanding of the subject.

Building on Funds of Knowledge: Ethnomathematics draws on students' funds of knowledge, utilizing the rich cultural and linguistic resources they bring to the classroom. Van Es et al. (2022) explored the concept of teachers’ noticing in creating equitable classrooms, linking it to a framework for multidimensional noticing for equity, which is organized around two key constructs: stretch and expanse. Stretch refers to how teachers’ noticing connects with both their own and students’ past and future experiences, while expanse reflects the scope of what teachers consider significant during classroom interactions. Both stretch and expanse have important implications for equity. It is essential to recognize that teachers' noticing is always shaped by broader social and racial discourses that influence both the classroom and society at large. Noticing for equity requires an awareness of how educational systems often marginalize students and an understanding of teachers’ agency to challenge dominant practices, ultimately recognizing students' full cultural identities. This approach fosters a more inclusive and equitable learning environment where all students feel valued and respected.

Preserve children's cultural identities and promotes inclusivity and equity in education

By recognizing and valuing diverse mathematical knowledge systems, ethnomathematics supports the principles of culturally sustaining pedagogies, which focus on teaching and learning for justice in an evolving world (Witherspoon & Stein, 2023). For Indigenous communities, ethnomathematics plays a vital role in decolonizing education by reclaiming and revitalizing traditional mathematical practices and resisting the dominance of Western

knowledge systems (Rogoff et al., 2014; Henward & Aikau, 2024). This approach nurtures a sense of pride and belonging, which positively impacts academic achievement and overall development.

Gutstein (2006) provides two salient examples where middle school students from working-class backgrounds were able to develop an understanding about the distribution of wealth:

> *In the U.S., Bill Gates holds more money than anybody else, but if you divide the wealth by population, Bill would probably have an average amount of money and a homeless [person] would have an average amount of wealth. (Gutstein, 2003, p. 50)*

> Our family makes somewhere in the neighborhood of $40,000. I heard that Michael Jordan makes about $1,000 for every minute he plays. So that means that in 40 minutes he makes our whole family's earnings. While my family works year round for that money. (Gutstein, 2003, p. 50)

These examples illustrate not only students' deep mathematical understanding but also their awareness of identity, race, and social positioning (Dutro, Kazemi, Balf, & Lin, 2008). In the second example, a student contrasts Michael Jordan's wealth with his family's annual income, presenting it in a way that resonates with his classmates. Here, mathematics serves as a tool to analyze power dynamics and resource distribution. Similarly, students from affluent backgrounds should participate in comparable activities to better understand the nuances of resource allocation within a democratic society. Through such exercises, students from diverse socioeconomic backgrounds can gain insights into the cultural wealth and family traditions that different groups contribute to the classroom.

Ethnomathematics and Culturally Relevant Pedagogies in Different Contexts

Ethnomathematics offers opportunities for educational initiatives and new curriculum goals grounded in culturally relevant pedagogies. Guidelines from organizations such as the National Council of Teachers of Mathematics (NCTM, 1991), the Brazilian Ministry of Education and Culture (Brasil, 1997), and the Ministry of Public Education in Costa Rica (2012) emphasize the importance of connecting mathematics to students' sociocultural contexts. When students explore mathematical activities within their own cultural experiences, they understand that mathematical procedures and practices are meaningful, as they are closely tied to their everyday lives (Rosa & Orey, 2007). By integrating principles of culturally relevant pedagogy, curricular activities highlight the significance of mathematics in various sociocultural contexts, drawing on ethnomathematical perspectives to solve problems.

Indigenous Counting System

In Hawai'i and Sāmoa, traditional counting systems were designed to address the social and physical needs of their communities. These systems illustrate how mathematical principles are applied within specific cultural contexts (Henward & Aikau, 2024). Beyond their practicality, they also embody the values and priorities of their respective societies. Mathematical principles in context include base systems, where Indigenous counting methods often incorporate base numbers tied to cultural and environmental elements. For example, the Hawaiian system follows a base-10 structure but organizes numbers according to natural groupings, such as fingers, hands, or lunar cycles. Additionally, counting systems often utilize groupings and aggregation, where items are organized into manageable sets — like tens or twenties to facilitate resource organization and storage.

Tailoring in Liberia

Liberian tailors acquire a deep understanding of geometry and measurement through the process of creating clothing. This example shows how practical skills often involve sophisticated mathematical thinking, which is learned through apprenticeship and observation (Rogoff, 2003). It highlights the concept that learning and applying geometry are not confined to formal classrooms but thrive in everyday practices. Mathematical concepts in action include Measurement-Accurate body measurements and fabric cutting require understanding lengths, proportions, and ratios. Geometry-Creating patterns involve recognizing shapes, angles, and symmetry. Transformations- Tailors often visualize how flat patterns transform into three-dimensional clothing. Learning by Apprenticeship. Learning occurs through observation, imitation, and guided practice.

Street Vendors in Brazil

Research on Brazilian street vendors reveals how children develop complex mathematical strategies to calculate prices and give change. By analyzing everyday practices, Saxe examined the socio-cultural dynamics of developmental change among children selling candy in Brazil. This research highlights the adaptive and flexible nature of mathematical thinking in response to real-world economic activities (Cole, 1998).Children learn through collaborative processes, as they interact with customers, other vendors, and family members, further emphasizing the role of social interaction in learning. This could be applied in classrooms where peer collaboration and community-based learning are central to the development of mathematical understanding.

Measurement Techniques and Trade in Nigeria

Indigenous Nigerian counting practices and traditional games like *I'tche* (a variation of Mancala) incorporate mathematical concepts that promote strategic thinking and enhance children's counting skills. Likewise, the *Mudu* system, a traditional unit of measurement still employed in markets across Nigeria, exemplifies the practical application of mathematical reasoning in commerce and trade. These culturally embedded practices illustrate the sophisticated mathematical understanding developed through community participation and hands-on observation (Abah, 2020).

Ethnomathematics Frameworks for Creating More Equitable Mathematics Learning Environments

Many ethnomathematics researchers agree on the importance of prioritizing education for social justice. Teaching mathematics for social justice through an ethnomathematical approach by emphasizing the understanding of mathematical ideas, procedures, and practices within the context of the communities that develop them ensures equitable opportunities for students from diverse cultural backgrounds (Leonard et al. 2010, Harper, 2019). This approach challenges assumptions about truth and knowledge, which can sometimes be mistaken for fixed notions of right and wrong in mathematics. In this context, information gains meaning only when situated within an appropriate cultural framework. Therefore, promoting social justice in mathematics instruction requires considering the political and cultural dimensions of mathematics, fostering an environment where students are encouraged to explore, interpret, and critically re-evaluate how humanity perceives the nature of mathematics.

Social justice in mathematics education seeks to ensure equitable access and opportunities for all students, especially those from marginalized communities. This approach involves addressing power dynamics, agency, and oppression within the mathematics curriculum. Leonard et al. (2010) and Harper (2019) explored the frameworks of culturally relevant pedagogy (CRP) and social justice pedagogy (SJP), emphasizing that mathematics is not a race-neutral subject. Despite efforts to increase the participation of underrepresented minority students in mathematics, limited attention has been paid to understanding these students' identities as learners and the contexts in which they learn mathematics. The authors contend that integrating culturally relevant instruction with social justice teaching can motivate marginalized students to engage with and succeed in mathematics.

Gutiérrez (2013, p. 44) argues that many researchers in ethnomathematics address issues related to the "**sociopolitical turn,"** which emphasizes understanding the connections between knowledge, power, and identity in mathematics education. By centering on marginalized voices, researchers highlight the strength and agency within these communities, paving the way for more inclusive and just approaches to teaching and learning mathematics. Building on this, Rochelle (2022) introduces the concept of the ***"spiritual turn"*** in mathematics education. This perspective advocates for integrating desire-based research frameworks and Indigenous futurity praxis, emphasizing healing, (re)membering, and ethical futures. The spiritual turn focuses on honoring the desires and wisdom of marginalized communities, especially indigenous groups, and challenging dominant ways of knowing and being.

While the sociopolitical turn in mathematics education examines issues of power and knowledge such as who is deemed competent in mathematics and whose knowledge is valued (Gutiérrez, 2013), the spiritual turn shifts the focus to questions like *"Toward what futures?"* and *"With what values and ethics, and what implications for human relationships?"* Desire-based research embraces *"complexity, contradiction, and the self-determination of lived lives"* (Tuck, 2009, p. 416). Rather than ignoring the struggles and losses of communities, it highlights *"the hope, visions, and wisdom of lived lives and communities"* (Tuck, 2009, p. 417). This approach invites a more holistic, forward-looking, and ethically grounded way of engaging with mathematics education.

In conclusion, when implementing ethnomathematics in various educational contexts, it is crucial to prioritize teacher professional development to ensure they possess the necessary knowledge and skills for successful integration. This includes understanding the mathematical principles embedded in different cultural practices, developing culturally responsive teaching strategies, and aligning ethnomathematics with curriculum standards. To avoid superficial representations of cultures or treating cultural practices as merely "folkloric" introductions to math (Powell & Frankenstein, 1997), ethnomathematical approaches must be thoughtfully and meaningfully integrated into the curriculum. Engaging with local communities and collaborating with cultural experts is essential for ensuring that cultural practices are accurately and respectfully represented, while also tapping into the rich resources and knowledge these communities offer.

Further research can explore the impact of ethnomathematics on student achievement, attitudes toward mathematics, and their understanding of social justice. It can also investigate how teachers can effectively apply ethnomathematical approaches in diverse classrooms, balancing cultural relevance with standardized curricula. Additionally, research can examine how ethnomathematics challenges power dynamics and fosters equity in mathematics

education. By addressing these areas, educators can continue to refine and develop ethnomathematical teaching approaches, ultimately creating more meaningful, empowering educational experiences for all students.

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