Southeast Asian Mathematics Education Journal

P-ISSN 2089-4716 | E-ISSN 2721-8546
Vol. 16 No. 1, 2026
DOI
http://dx.doi.org/10.46517/seamej.v16i1.492

Bridging Cultures through Numbers: Exploring the Perspectives of Pre-Service Mathematics Teachers on Ethnomathematics in Education

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Abstract

The growing emphasis on ethnomathematics in mathematics education highlights the need to understand how future teachers perceive the relationship between mathematics and culture. This study explores the perspectives of pre-service mathematics teachers regarding their experiences and understanding of ethnomathematics through their formal instruction. While culturally responsive mathematics teaching has gained attention, limited research has focused on how these perspectives are shaped during teacher preparation. Most existing studies emphasize in-service teachers or curriculum, overlooking the formative experiences of pre-service teachers. Addressing this gap, this qualitative study investigates the reflections of nineteen pre-service teachers from four teacher education institutions in the Philippines. Guided by van Manen's hermeneutic phenomenology and drawing on D'Ambrosio's ethnomathematics framework and Vygotsky's sociocultural theory, data were collected through structured open-ended questionnaires and follow-up interviews. Thematic analysis revealed two key themes: a shift from viewing mathematics as abstract and universal to seeing it as lived and culturally embedded; and a reimagining of mathematics education as inclusive, contextually relevant, and culturally responsive. Participants identified cultural practices such as weaving, farming, and traditional games as mathematical, though many did not specify the concepts involved. These findings suggest that introducing ethnomathematics during teacher preparation fosters critical reflection and supports the development of culturally responsive educators. Future research is needed to examine how these perspectives translate into classroom practice and to explore ways of sustaining culturally grounded mathematics instruction. These findings point to the importance of integrating ethnomathematics into teacher preparation through culturally grounded coursework, community-linked learning experiences, and explicit modelling of how mathematical concepts emerge from local cultural practices.

Keywords: Ethnomathematics, contextualized learning, culturally responsive teaching, mathematics education, pre-service teachers.

Introduction

In mathematics education, contextualization, localization, and indigenization enhance student understanding by making content more culturally and locally relevant, thereby supporting meaningful knowledge acquisition. This educational movement aligns with the concept of Ethnomathematics, which was coined by D'Ambrosio (1985), describing the mathematical practices of identifiable cultural groups and is defined as the study of mathematical ideas found in a culture. Several Southeast Asian studies have likewise demonstrated how cultural practices and artifacts provide rich contexts for mathematical inquiry, particularly in areas such as weaving, architecture, and community traditions (Imswatama & Setiadi, 2017; Danoebroto, 2017).

From a pedagogical perspective, ethnomathematics emphasizes the integration of cultural practices, values, and materials into mathematics teaching, exploring its significance through the development and application of ethnomathematics-based learning materials. Several studies have demonstrated how cultural traditions are meaningfully embedded in mathematics education. In Indonesia, *Tapis*, a traditional cloth made in Lampung, is integrated into discussing geometric concepts (Suherman & Vidákovich, 2022); numbers, sets, relations, congruence, modulo, and mathematical modeling were applied in predicting a good day in farming (Umbara et al., 2021); and history and philosophy of the *Caci* dance of Manggarai community were described along with counting, finding, measuring, designing, playing, and explaining (Dominikus et al., 2024).

In Jakarta, the structure and ornaments of the *Istiqlal* Mosque were incorporated into teaching geometry along half-spheres, tubes, rectangles, and circles (Janan, 2024). In a case study in Georgia, how mathematics traveled across cultures and civilizations from the continent of Africa was explored by studying triangles, area, surface area, volume, and deductive reasoning (Mansion, 2022). Complementary regional work also highlights how cultural structures, indigenous knowledge systems, and local practices can serve as meaningful entry points for developing mathematical reasoning and enhancing conceptual understanding (Khalid & Ali, 2016; Patahuddin, 2013; Imswatama & Setiadi, 2017). In Brazil, Tomaz and Marcilino (2024) explored what the *Xakriabá* Indigenous teachers mean by ethnomathematics and how they use it in their schools' curricula, seeking to bring together both Indigenous and Western-European ways of knowing by adopting a Two-Eyed Seeing approach.

Additionally, joint research from Indonesia and Thailand indicates a strong acknowledgment of the importance of ethnomathematics, with educators expressing positive attitudes towards its integration into mathematics education (Luga, et al., 2024). This coincides with the results of the study of Payadnya et al. (2024), revealing that ethnomathematics is valued for its ability to contextualize mathematical learning, making it more relevant and engaging for students. Other studies in the region underscore how culturally grounded learning environments support student engagement and shape learners' mathematical thinking, offering further evidence of the value of contextualized instruction (Wibawa, 2019; Yulianto et al., 2025).

In the Philippines, contextualization in education has been widely encouraged to foster meaningful acquisition of knowledge, skills, and positive attitudes toward any subject. This is in response to the Department of Education's (DepEd) slogan, Education for All (EFA), which aims not only to deliver education to far-flung barrios but also to value the inclusion and empowerment of Filipino cultural groups. DepEd Order No. 35, series of 2016, advocates contextualization, localization, and indigenization. According to this memorandum, curriculum contextualization involves aligning curriculum content and instructional strategies with learners' cultural backgrounds, local experiences, and immediate contexts to ensure relevance and meaning in instruction. That is, linking new content to the local experiences familiar to students. Deepening curriculum contextualization through indigenization provides spaces for unique cultures for student inclusion and ensuring the relevance of education processes for all learners. To achieve this, both text-based materials (print or non-print) and non-text-based materials (devices, tools, equipment, manipulative toys) aligned to the K to 12 curriculum are

used as primary bases or supplements to the teaching and learning process (DepEd Order No. 76, 2011).

Further, in 2011, DepEd adopted the national Indigenous Peoples (IPs) education policy framework, granting access for IPs to culture-responsive basic education. This is enshrined in the Philippine Constitution and the United Nations (UN) Declaration on the Rights of the Indigenous Peoples (DepEd Order No. 62, 2011). Pursuant to this order, the DepEd adopted the IPs' education curriculum framework (DepEd Order No. 32, 2015). This adheres to section 5, item H under curriculum development stating, "*The curriculum shall be flexible enough to enable and allow schools to localize, indigenize and enhance the same based on their respective educational and social contexts.*". Because of these advocacies, different regional and division offices embarked on developing contextualized learning resources through the Learning Resources Management and Development Systems (LRMDS) stipulated under DepEd Order No. 76, series of 2011.

There have been studies pursued exploring the ethnomathematics of different provinces with distinct cultural practices. In Batangas City, the *Badjao* tribe's rich culture, history, and how this tribe uses Mathematics in their everyday lives were explored through immersion (Paulo et al., 2022). In the Gigantes Islands, Iloilo, ethnomathematical concepts were generated from the preparation of materials to the selling of squids (Sulatra, 2023). In San Emilio, Ilocos Sur, the cultural practices of Indigenous Peoples then and now were explored (Absolor et al., 2023). Lastly, a descriptive developmental approach was used to assess the ethnomathematical practices among the Ifugao to develop a learning package (Capua, 2021).

In La Union, the Indigenous Peoples consist of the *Bago*, *Ibaloi*, and *Kan-kanaey* communities (National Commission on Indigenous Peoples, 2021). A study had been conducted among pre-service teachers assessing their cultural knowledge among Ilocanos, their flexibility in teaching, and attitudes in dealing with their students of diverse backgrounds (Tudayan et al., 2024). However, the practices of these cultural groups especially along mathematical remain underexplored in academic research and are rarely reflected in the current mathematics curriculum. This challenge limits the visibility of indigenous knowledge systems and their potential contribution to meaningful and context-based mathematics instruction. A quasi-experimental study conducted by Leal (2024) in Luna, La Union, demonstrated that integrating ethnomathematics into classroom instruction had a positive impact on students' study habits, time management, concentration, and overall engagement. Although the findings are geographically limited, they indicate the broader potential of ethnomathematics in addressing persistent issues of low mathematical competence and disengagement in the subject.

One important dimension of this potential lies in the role of culture and language, which are deeply intertwined in shaping how learners understand and communicate mathematical ideas. In the Ilocos region, the *Iloko* language serves not only as a medium of instruction but as a cultural lens through which mathematical reasoning is grounded in lived experience. Every day, Ilocano terms used in farming, trading, and household tasks reveal embedded systems of logic, measurement, and proportion. Integrating *Iloko* into mathematics education thus becomes more than linguistic translation; it is an act of cultural affirmation that fosters cognitive engagement and strengthens learner identity (Tupas & Lorena, 2020; Esteban & Javier, 2018). To harness this, teacher preparation programs must model how local culture and language can be assets in instructional design. Through localized materials, culturally

responsive strategies, and contextualized assessment, instructors can help pre-service teachers see the value of integrating cultural knowledge into pedagogy. However, despite global and national advocacy for culturally responsive education, the lived experiences of mathematics pre-service teachers in culturally rich areas like La Union remain underrepresented in the literature. This reflects the need to strengthen contextualization, localization, and indigenization in teacher education, not only as policy goals but as lived practices within classrooms.

Grounded in these legal and educational frameworks, this study aimed to explore the interplay of Ilocano cultural practices and mathematics instruction as viewed by mathematics pre-service teachers in La Union. The results may form a basis for teacher preparation initiatives, such as designing intervention programs and further research studies, such as instrument validation along with ethnomathematics. The study may also provide ideas on the effectiveness of contextualization efforts within the province.

This phenomenological inquiry articulated the essence of meaning in mathematics pre-service teachers' lived experiences when they undergo formal instruction in the teacher education program. Through the perspectives of pre-service teachers in La Union, the study examined how understandings of ethnomathematics were shaped through their experiences of coursework and professional preparation. It answered the question "*How do mathematics pre-service teachers view their experiences and understanding of ethnomathematics through their coursework and formal instruction?*".

Methods

Research Design

This study utilized Van Manen's hermeneutical phenomenology integrating the lived experiences of the participants and their reflective interpretation. This method connects theory, reflection, and practice which helps to better understand participants' perspectives on ethnomathematics in education. The researchers acknowledged that their backgrounds, experiences, and perspectives influenced the interpretation of participants' lived experiences. The choice of this approach stemmed from a commitment to understanding ethnomathematics in education beyond surface-level descriptions. Additionally, the researchers acknowledged that this method required interpretation, going beyond data collection to deriving meaning. To ensure reflexivity and minimize bias, they engaged in critical self-reflection, maintained transparency in analysis, and prioritized participants' voices. Lastly, they sought to provide honest and meaningful interpretations that deepened the understanding of participants' experiences.

Participants

The study involved mathematics 19 pre-service teachers from four teacher training institutions in La Union. The participants were purposefully selected based on the following criteria: they were in their final year of teacher training, specialized in secondary mathematics education, and had prior experience with ethnomathematics through coursework or formal instruction.

To determine the sample size, data saturation was applied, where data collection continued until no new themes or insights emerged (Saunders et al., 2018; Hennink et al., 2020). Participation was voluntary, and all participants were fully informed about the study's objectives, procedures, and the confidential handling of their data.

Data Measure

A structured open-ended questionnaire with follow-up interviews (Saglam, 2024) were used to collect data how mathematics pre-service teachers understood and experienced ethnomathematics through coursework and other relevant encounters. Particularly, the structured open-ended questionnaire consisted of three key prompts: (1) participants' understanding and experiences with ethnomathematics through their formal education (e.g. syllabi, activities, or learning resources) (2) their perspectives on the connection between mathematics and culture, including real-world examples, and (3) their views on the importance of integrating ethnomathematics into mathematics education and strategies for culturally responsive teaching. Participants were also asked to share relevant experiences (e.g.) to provide context for their reflections. Follow-up interviews were conducted to elaborate on responses that needed clarity.

Data Collection Procedure

The research followed ethical principles to protect participants' rights. Before data collection, informed consent was obtained, explaining the study's purpose, procedures, potential risks, benefits, and the right to withdraw at any time. Participants had sufficient time to review the consent form and ask questions before giving voluntary consent.

The data-gathering instrument was administered both in person and online, depending on participants' preferences and accessibility. This approach ensured flexibility and accessibility. Participants had ample time to reflect and provide thoughtful responses. Data was collected over four weeks, with follow-up interviews for when needed.

To maintain data integrity, the study applied data saturation (Hennink, Kaiser, & Marconi, 2020). Confidentiality and anonymity were ensured by securely storing responses, removing personally identifiable information, and using pseudonyms when necessary (Creswell & Poth, 2018). Data was accessible only to the researchers and used exclusively for this study.

The study complied with institutional and national ethical standards and received ethical approval before data collection. Participants were assured that their responses would be used solely for academic purposes without risk. Ethical diligence was upheld throughout the study, ensuring respect, confidentiality, and fairness in handling participant data.

Data Analysis

This study employed van Manen's (2016, 2014) hermeneutic phenomenological analysis to explore how mathematics pre-service teachers conceptualized and experienced ethnomathematics. The analysis began with a wholistic reading of participants' narratives, followed by selective and detailed reading, during which significant statements were highlighted and clustered into codes.

The researchers engaged in collaborative and recursive dialogues to refine these themes and ensure their alignment with the lived meanings expressed by the participants. A textural

description was developed to reflect what participants experienced while a structural description clarified how these experiences were shaped by coursework, cultural context, and reflection. Both were synthesized into a composite description that represented the collective essence of the phenomenon.

Table 1 presents the coding hierarchy used in developing the themes. For instance, the codes: *Mathematics as culturally shaped yet universal, Historical and indigenous mathematical knowledge*, and *Mathematics in traditional cultural practices (weaving, crafts, farming, navigation, architecture)* were related and therefore clustered into the subtheme Culture as a Curriculum. These codes reflected how the participants recognized mathematical ideas embedded in cultural expressions, stories, and material practices encountered in their communities.

Table 1
Coding Hierarchy

Codes	Subthemes	Themes
Mathematics as culturally shaped yet universal	Culture as Curriculum: Realizing that cultural expressions and traditions carry mathematical meaning	Shifting Perspectives: From Abstract Definitions to Lived and Cultural Understandings of Mathematics
Historical and indigenous mathematical knowledge		
Mathematics in traditional cultural practices (weaving, crafts, farming, navigation, architecture)		
Cultural influences on mathematical thinking and learning	Culture as Compass: Understanding how cultural contexts shape the mathematical skills required in work and daily life	
Mathematics in daily life and livelihoods (farming, budgeting, market activities, professions)		
Mathematics in community and economic activities (trading, haggling, food preparation, cultural events)		
Ethnomathematics promotes, inclusivity, relevance, and cultural appreciation	Teaching for All: Recognizing ethnomathematics as a tool for fostering inclusivity, appreciation, and equity in the math classroom	Reimagining Mathematics Education: Ethnomathematics as a Pathway to Inclusive, Relevant, and Culturally Responsive Teaching
Culturally responsive and contextualized mathematics teaching strategies	Teaching with Purpose: Seeing ethnomathematics as a	

Community collaboration for culturally grounded instruction	foundation for designing contextualized, collaborative, and culturally responsive strategies

Moreover, another set of codes like *Cultural influences on mathematical thinking and learning, Mathematics in daily life and livelihoods (farming, budgeting, market activities, professions),* and *Mathematics in community and economic activities (trading, haggling, food preparation, cultural events)* similarly converged into the subtheme the second subtheme, Culture as a Compass. These codes captured how the participants perceived mathematics as shaped by everyday cultural contexts and lived experiences such as budgeting, farming, market activities, food preparation, and traditional navigation. Collectively, these codes demonstrated how cultural environments inform the kinds of mathematical skills people use in their daily routines.

Together, these subthemes informed the development of the first overarching theme, *Shifting Perspectives: From Abstract Definitions to Lived and Cultural Understandings of Mathematics*, which reflects the evolving realization among participants that mathematics is deeply connected with cultural experiences and community practices.

To ensure rigor and trustworthiness, Lincoln and Guba's (1985) criteria were followed. Credibility was established through the use of follow-up interviews, during which participants clarified and elaborated their initial written responses. For example, some participants suggested refinements in wording by specifying cultural practices (e.g. *Abel* weaving, *burnay* making) or clarifying how these practices shaped their mathematical thinking. Investigator triangulation was employed by having the researchers independently analyze the data and compare thematic findings (Patton, 2015). For dependability, an external audit was conducted by a qualitative expert, and consistency was maintained through careful code application checks across transcripts (Miles, Huberman, & Saldaña, 2014). These strategies ensured that the emergent themes remained faithful to participants' lived experiences while offering theoretical depth and practical insight.

Results and Discussion

This section presents the findings of the study exploring the understanding and experiences of pre-service mathematics teachers on ethnomathematics through their coursework and formal instruction. The data were gather from open-ended questionnaires and follow-up interviews and were analyzed using thematic analysis following the approach of Van Manen hermeneutic phenomenological analysis. The analysis revealed two major themes that reflect their perspectives as shown in Table 1.

Table 2
Description of Themes and Subthemes

Themes	Description	Subthemes
Shifting Perspectives: From Abstract Definitions to Lived and Cultural Understanding of Mathematics	This theme focuses on how pre-service teachers moved from viewing mathematics as purely abstract and universal to recognizing it as a cultural and lived practice. Mathematics was increasingly seen as shaped by tradition, everyday experiences, and responsive to community needs showing how culture influences the way mathematical ideas are understood, applied, and taught.	Culture as Curriculum: Realizing that cultural expressions and traditions carry mathematical meaning Culture as Compass: Understanding how cultural contexts shape the mathematical skills required in work and daily life
Reimagining Mathematics Education: Ethnomathematics as a Pathway to Inclusive, Relevant, and Culturally Responsive Teaching	This theme emphasizes the challenge among pre-service teachers going beyond standardized approaches to mathematics education. It inspired a new vision of teaching that honors diversity, promotes engagement, and situates mathematical learning within meaningful cultural contexts. They came to see mathematics not merely as content to be delivered, but as a culturally rooted practice that fosters inclusivity, equity, and deeper connections with learners.	Teaching for All: Recognizing ethnomathematics as a tool for fostering inclusivity, appreciation, and equity in the math classroom Teaching with Purpose: Seeing ethnomathematics as a foundation for designing contextualized, collaborative, and culturally responsive strategies

Shifting Perspectives: From Abstract Definitions to Lived and Cultural Understandings of Mathematics

Based on the analysis, the first theme underlines a shift in how pre-service teachers perceive mathematics. Initially viewing it as abstract, universal, and disconnected from daily life, their engagement with ethnomathematics through formal coursework gradually reshaped this perspective. They began to challenge their prior assumptions and developed a more situated understanding of mathematics as something shaped by culture, grounded in tradition, and responsive to everyday needs. This evolving view reflects a growing awareness that

mathematics is not simply content to be delivered, but a lived practice that varies across communities and histories.

As their perspectives began to shift, many pre-service teachers realized that mathematics was not just something taught in classrooms or written in textbooks. They recognized that mathematical ideas could be found in the rhythms of cultural life, woven into traditions, practices, and everyday experiences they had once overlooked.

Culture as Curriculum: Realizing that cultural expressions and traditions embody mathematical meaning

As pre-service teachers reflected on their experiences and examples through coursework, they began to see familiar practices such as weaving patterns, music, rituals, measurement systems, and architectural designs in a new light. These practices, once viewed as merely cultural or artistic, revealed underlying mathematical structures and reasoning. Participant 1 shared, *"Weaving and beadwork involve intricate geometric patterns and symmetry, teaching mathematical concepts through hands-on experience."* Similarly, Participant 2 noted, *"In the livelihood of [a] specific group of people or those people whose work was weaving, they used patterns [and] creativity for their work. In this example, the culture impacted the way math was applied by thinking and interpreting the final product."*

This growing awareness of the mathematical dimensions of cultural practices was further deepened by their immersion in local contexts. Given that La Union is home to rich cultural traditions such as *Abel Iloko* weaving and making *burnay* jars, the participants began to see how mathematics is embedded in the fabric of everyday life. The *Abe*l weaving process introduced them to concepts of symmetry, pattern repetition, and geometric design which are commonly taught in school but rarely explored through culturally grounded contexts. Similarly, the making of *burnay*, an Ilokano earthenware jar for storing rice, vinegar, or *basi*, illustrates how Ilocanos apply mathematical ideas of shape and volume while preserving cultural heritage.

Several also reflected on how everyday cultural activities like games and celebrations carry mathematical meaning. Participant 1 shared, *"Cultural celebrations often include games and activities that incorporate counting, probability, and strategic thinking."* These realizations deepened their understanding of mathematics as something that emerges naturally within cultural practices. Participant 1 emphasized this connection, stating, *"Math is part of art, architecture, and cultural expressions, showing how creativity and math mix."*

This connection between cultural expression and mathematical thinking became even more apparent as participants explored traditional Ilokano games. Beyond artifacts, traditional Ilokano games such as *sungka, shatong, sipa*, and *sigking bado* served as entry points for understanding number systems, strategic reasoning, and even probability. *Sungka* develops skills in counting, sequencing, and strategic planning; *shatong* involves estimation, measurement using non-standard units, and angle prediction; *sipa* fosters pattern recognition and tracking of scores or counts; while *sigking bado* (a local jumping game) incorporates rhythm, spatial awareness, and ordinal thinking. These culturally rooted games made mathematics tangible, enjoyable, and socially relevant, and they offered the participants new ways to conceptualize math as both lived and shared.

Additionally, others pointed to how mathematical ideas are preserved and transmitted through generations, particularly in indigenous contexts. Participant 3 said, *"In some*

indigenous communities, traditional methods of counting and measuring are deeply rooted in cultural practices and rituals... these counting methods reflect the community's relationship with their environment." Participant 16 echoed this by saying, *"This weaving practice allows weavers to make different patterns and designs such as symmetry, tessellations, [and] repetitive designs... showcasing their rich culture and stories."*

For many participants, these realizations marked a turning point. Participant 17 pointed out, *"Beadwork and weaving require precise geometric patterns and measurements."* Culture, in this light, became more than just context*;* as Participant 1 phrased it, it became *"a natural way through which mathematical thinking is experienced, preserved, and passed on."*

These responses invite a deeper reflection on the role of language in the cultural transmission of mathematical knowledge. As participants reflect their cultural practices, it became clear that the *Ilokano* language not only communicated concepts but carried embedded systems of measurement, sequencing, estimation, and classification. Language, in this sense, functioned not merely as a tool but as a repository of mathematical reasoning passed down through generations. This perspective conforms with D'Ambrosio's view that ethnomathematics is practiced within the linguistic and cultural frameworks of specific communities. In the *Ilocano* context, words used for counting harvests, gauging land size, or timing agricultural tasks are not neutral terms but reflect logic systems grounded in the lived realities of the people.

For instance, words like *sapad* (a hand of bananas), *sako* (sack), *salop* (to scoop grain), *kerker* (a bundle of palay for planting), and *reppet* (a pile or heap) reflect embedded practices of quantification and volume estimation in farming. When gauging land area, traditional terms like *kelleng* are still used in rural contexts to describe plots based on local understanding of productivity and effort, rather than standardized units. Ilokano expressions for timing agricultural tasks such as *panag-aapit* (harvest season), *panag-raraep* (planting of mature rice seedlings), and *panag-sisikka* (removal of seedlings for transplanting) demonstrate how time and process are measured in ways deeply tied to both environmental rhythms and cultural rituals. These linguistic tools, passed down intergenerationally, serve as vehicles for mathematical thinking within the lived experience of *Ilocano* people. Thus, recognizing the *Ilokano* language as integral to the ethnomathematical experience broadens our understanding of how culture and mathematics intersect.

Culture as Compass: Understanding how cultural contexts shape the mathematical skills required in work and daily life

As their perspectives continued to evolve, pre-service teachers began to recognize that culture does not only express mathematical ideas but also plays a significant role in shaping which mathematical skills are developed and valued across different contexts. This realization emerged from reflecting on work, livelihood, and everyday practices within their own communities.

Participant 3 explained, *"Culture influences the way people use math in their everyday lives... [by] shaping numeracy systems, mathematical concepts, practical applications, language and communication, and mathematics education practices."* Similarly, Participant 15 described how traditional knowledge guides mathematical application: *"Fishermen have to*

use their knowledge in determining the right time to fish... Such decisions are based on traditional wisdom, calculated according to the phases of the moon and the tides."

The responses suggest that culture serves not only as a medium of expression but as a formative force in shaping mathematical thinking. These practices illustrate how communities develop and transmit mathematical skills in response to environmental demands and social organization which affirm that affirm that ethnomathematics is about recognizing culture as a generative context for mathematical reasoning.

Several participants observed that everyday work, from agriculture, business, and education, relies on deeply rooted cultural knowledge involving estimation, measurement, and logical reasoning. Participant 12 noted, *"The use of calendars in farming (livelihood), measurements in architecture, counting and auditing in business... [shows how] culture helps individuals gain a clearer understanding of math."* Participant 19 added, *"Using cultural artifacts as an example in teaching education enhances the understanding and engagement of people."*

The participants' reflections illuminate how cultural knowledge embedded in everyday work enriches mathematical understanding. In farming, "*Kuaresma,*" known as the Lenten season, signals rice planting preparation for Ilokano farmers, followed by planting drought-resistant crops like tobacco, corn, or peanuts. These agricultural cycles involve estimation and resource allocation, reflecting practical applications of mathematical reasoning. In architecture, structures like *Baluarte* (watchtowers) and *Bahay na Bato* (stone houses) demonstrate geometric design, symmetry, and spatial planning grounded in local knowledge.

Culture, for these pre-service teachers, also determined what math was considered useful or relevant. Participant 14 said, *"From dress-making and cooking to buildings, architecture and engineering, math truly affects our lives... If math is a way of life, people will find its relevance, but if it is taught in the academics, it becomes complicated."*

These illustrate how cultural practices shape what communities consider mathematically valuable. In traditional Ilocano dress-making, the *kimona* and *pandilíng* require precise measurement, proportional reasoning, and symmetry to create garments that reflect both function and cultural identity. In Ilocano cooking, especially in preparing *dinengdeng*—a vegetable-based dish—proportional mixing, estimation, and sequencing are applied intuitively. Similarly, in rural engineering and architecture, structures like the *kalapaw* (a traditional shelter) involve measurement, structural balance, and spatial reasoning rooted in environmental adaptation.

Others reflected on culturally embedded games and traditions as spaces for learning math. For instance, Participant 6 explained, *"In our community, children often play basketball, volleyball, patintero, sungka, [and] Chinese garter,"* recognizing these as contexts that use mathematical thinking. Participant 7 said, *"The sungka... we always play sungka, and obviously mathematics was used to play and learn to count."*

Traditional Ilokano games such as *sungka, shatong, sipa*, and *sigking bado* served as entry points for understanding number systems, strategic reasoning, and even probability. *Sungka* develops skills in counting, sequencing, and strategic planning; *shatong* involves estimation, measurement using non-standard units, and angle prediction; *sipa* fosters pattern recognition and tracking of scores or counts; while *sigking bado* (a local jumping game) incorporates rhythm, spatial awareness, and ordinal thinking. These culturally rooted games made

mathematics tangible, enjoyable, and socially relevant, and they offered the participants new ways to conceptualize math as both lived and shared.

This broader understanding of math as emerging from cultural needs also pointed to its role in real-life problem solving. Participant 10 stated, *"Festivals or fiesta require careful planning and budgeting, which needs to use calculation to know the budget that they will be allocating."* Festivals in La Union such as the *Sillag*, *Pindangan, Panagyaman*, and *Diro* Festivals are not only cultural events but also occasions where mathematics is applied in budgeting and logistics. Pre-service teachers noted practices like the *pabuya* system, which involves computing food quantities using traditional measures such as *gatang* and *salop*, and *pakyawan* budgeting for hiring cooks. Communities reuse *abel Iloko* for costumes, pool resources through *in-nurok*, and create decorations from recycled materials. Event logistics are managed through *tagnawa* (collective labor) and *paluwagan* (rotating savings), demonstrating how mathematical skills such as estimation, measurement, and resource allocation are embedded in Ilokano traditions and everyday decision-making.

These perspectives affirms the idea that culture not only serves as the backdrop for learning mathematics but also plays an active and formative role in shaping which mathematical skills are developed, valued, and applied within a community. For the participants, recognizing this dynamic relationship between culture and mathematics marked a critical turning point. They began to understand that mathematical knowledge is cultivated in response to specific needs, livelihoods, and cultural traditions.

In line with Vygotsky's (1978) sociocultural theory, these strengthen the idea that mathematical learning is mediated through cultural tools and social interaction. Whether through oral traditions, physical tools or embodied practices, learners engage with mathematics in ways that are meaningful to their lived realities. Thus, mathematics is enacted and situated within culturally relevant experiences. This realization affirmed for many participants that integrating ethnomathematics is a way of honoring how communities naturally think, problem-solve, and make sense of their world.

These findings also resonate with what Ernest (1991) and Bishop (1988) have long argued: that mathematics is not culturally neutral, but is shaped by human activity, language, values, and tradition. What may have previously been taken for granted, that math exists "outside" culture, was replaced by a growing recognition that mathematical knowledge is constructed and expressed through cultural practices. In addition, the participants' reflections are in line with D'Ambrosio's (2001) vision of ethnomathematics as the "*mathematics practiced by cultural groups*" in response to their unique environments and needs. These may indicate an emerging cultural and critical awareness among pre-service teachers, one that could serve as a foundation for more meaningful engagement with learners in the future.

It may also be argued that this shift in perspective is essential not only for broadening pre-service teachers' understanding of what mathematics is, but also for transforming how they view its purpose and value in society. This recognition, that mathematics is experienced, preserved, and passed on through culture, suggests a redefinition of mathematics education that is more reflective of students' diverse realities and histories.

In light of these findings, teacher education programs might consider providing more structured opportunities for pre-service teachers to reflect on the cultural dimensions of mathematics. While content mastery remains central to their preparation, incorporating

examples of culturally embedded mathematical practices could support a more holistic and inclusive view of the discipline. This may help aspiring teachers approach mathematics not only as a formal system of knowledge but also as a lived and context-bound experience, potentially enriching their future classroom practices and responsiveness to learners' diverse backgrounds.

Reimagining Mathematics Education: Ethnomathematics as a Pathway to Inclusive, Relevant, and Culturally Responsive Teaching

The second theme focuses on the reimagination of pre-service teachers about learning mathematics. Particularly, this reimagination challenged how they had previously understood mathematics education. What began as a subject they once associated with formulas and standardized tests gradually took on a different meaning. As they engaged more deeply with the cultural dimensions of mathematics, they began to reimagine the role of a math teacher which is not just as someone who delivers content, but as someone who creates space for students to see themselves in what they are learning.

They came to understand that mathematics can be a tool for inclusion, a way to respect diverse ways of thinking, and a means of connecting learning to the everyday lives and cultural backgrounds of students. Ethnomathematics became more than a topic in their coursework; it became a perspective that helped them see how teaching could be more human, more connected, and more just. In this light, mathematics education was no longer about abstraction alone; it became a practice rooted in relevance, equity, and shared meaning.

Teaching for All: Recognizing Ethnomathematics as a Tool for Fostering Inclusivity, Appreciation, and Equity in the Math Classroom

As pre-service teachers engaged more deeply with the concept of ethnomathematics, they began to reimagine the classroom as a more inclusive and culturally affirming space. Their reflections emphasized how incorporating cultural perspectives in mathematics could make learning more accessible, relevant, and representative of diverse identities. They saw it not just as an instructional strategy, but as a way of making all learners feel represented, valued, and connected to what they were learning.

Several participants pointed to how ethnomathematics made mathematics more relatable and meaningful. Participant 1 shared, *"This makes mathematics more inclusive and relatable, showing students that mathematics is not an abstract concept but a universal language present in every culture."* Participant 5 supported this, explaining, *"It makes learning more relevant and engaging for students by linking mathematical concepts to their cultural backgrounds and real-world experiences."* Similarly, Participant 10 noted, *"It makes learning more relatable and meaningful for students.*

These underline how ethnomathematics fosters inclusivity by grounding mathematics in learners' cultural realities. Participants recognized that when mathematical ideas are presented through familiar practices, they become more relatable and meaningful. Grounding instruction in culturally familiar contexts may help teachers validate students' identities and show that mathematics is both a universal discipline and a deeply personal experience.

Others emphasized that cultural inclusion in mathematics affirms diverse learners and promotes equity. As Participant 4 put it, *"Teachers should incorporate cultural perspectives,*

such as ethnomathematics, in math education to promote diversity, equity, and inclusion." Participant 2 also noted, *"It is important for teachers to include cultural perspectives... because cultures [exhibit] mathematical concepts."* Participant 18 added, *"It is important for teachers to include cultural perspectives since ethnomathematics recognizes that mathematical concepts and practices vary across different culture[s]."* In addition, Participant 3 emphasized its educational value, saying it *"...promotes inclusivity, relevance, and critical thinking skills among students, enriching their understanding of mathematical concepts and fostering respect for diversity."*

Ethnomathematics can serve as a pathway toward a more equitable and affirming mathematics classroom. Recognizing that mathematical knowledge is not culturally neutral help pre-service teachers to see that inclusion of cultural perspectives is essential for fostering diversity and belonging. This bridges gaps in access and engagement in mathematics learning by resonating it with students' lived experiences. Thus, cultural inclusion becomes both a pedagogical and a social justice imperative in reimagining mathematics education for all learners.

Also, a few participants described how this inclusive perspective allowed students to see the connection between mathematics and their own daily lives and cultural experiences. Participant 6 expressed, *"It is important for teachers to include cultural perspective like ethnomathematics because we use the mathematics in our daily lives and in our culture."* Participant 15 added, *"This is important in teaching math because ethnic math bestows learners from different backgrounds with a better sense of commitment and purpose in their learning."* Some also noted the impact of ethnomathematics on their own growth and learning. Participant 11 shared, *"It makes math more relatable and engaging, providing real-world contexts that enhance my understanding and critical thinking skills."*

This cluster of responses illustrates how inclusive, culturally responsive mathematics instruction fosters both student engagement and personal growth. For many pre-service teachers, seeing the relevance of math in daily activities such as budgeting, farming, trading, or traditional games deepened their appreciation for the discipline and inspired a more committed learning stance. When such experiences are validated in the classroom, students feel seen and valued, which strengthens their connection to the subject. This pedagogical shift does not only affirm students' identities but also develops higher-order thinking skills by framing math as a tool for reasoning, decision-making, and reflection rooted in lived experience. Thus, ethnomathematics enriches learning by making mathematics more than procedural—it becomes purposeful, personal, and empowering.

Teaching with Purpose: Seeing ethnomathematics as a foundation for designing contextualized, collaborative, and culturally responsive strategies

Building on their recognition of ethnomathematics as a tool for inclusion, many pre-service teachers also began to rethink their own emerging classroom practices. Ethnomathematics, for them, was not only about what to teach but also how to teach it. They saw it as a framework that encourages meaningful, student-centered strategies grounded in real-world experiences and cultural relevance. This perspective moved them away from rote, decontextualized instruction and toward practices that respect community knowledge, student participation, and diverse ways of learning. For many, it sparked ideas around integrating cultural artifacts,

involving local contexts in mathematical exploration, and even using digital tools to support culturally responsive teaching.

Several participants highlighted the importance of grounding mathematical concepts in everyday and culturally meaningful situations. Participant 16 shared, *"Teachers use real-life problems for the students t[o] have deeper understanding on how mathematics affect their daily lives."* Participant 18 similarly stated, *"Teachers can integrate ethnomathematics effectively by relating the concepts of mathematics in real-life applications or the teacher will provide situations where students can apply ethnomathematics."* Participant 12 reinforced this idea, emphasizing that *"the integration of culture into math provides contextualized learning experiences to students which will make learning mathematics more meaningful and essential to them."*

This stresses the value of situating mathematics instruction within real-life, culturally grounded contexts. For instance, incorporating cultural integration leads to contextualized learning experiences that bridges formal mathematics with students' experiences. This is where language comes in. The use of mother tongue-based multilingual education (MTB-MLE), particularly in the early grades, enhances conceptual understanding allowing learners to access mathematical ideas in a familiar language. Teaching strategies such as translanguaging – moving fluidly between Ilokano and English and code-switching have also been observed to support comprehension and student engagement (Cummins, 2000; Garcia & Wei, 2014).

For example, in teacher addition, "*We have three bananas. (Adda tallo a saba). Then I give you two more (ninayunak ti dua). How many bananas do you have now? (Manu amin ti sabam ita*?)" Such approaches not only clarify concepts but also affirms the learners' linguistic and cultural identities in the classroom. This means that when mathematical tasks are situated within local contexts and expressed in the language students use at home, they become more meaningful and less intimidating. This reinforces what Gay (2010) describes as culturally responsive pedagogy: affirming students' identities not only through content but also through language. For pre-service teachers, this underlines the need to view language not as a barrier but as a bridge to deeper mathematical thinking and inclusion.

Additionally, some participants recognized that culturally grounded instruction also promotes collaboration and relevance. Participant 8 said, *"Teachers can do this by exploring real-world contexts, incorporating culturally relevant examples and problem-solving methods, and encouraging students to investigate the mathematical practices of their own cultures."* Participant 18 also reflected on how cultural norms influence teaching: *"Different cultural backgrounds can influence problem-solving strategies in mathematics. Communities with a collectivist culture emphasize collaborative process while individualistic [communities] focus on independent approach."*

This indicates that culturally grounded mathematics instruction fosters social connectedness in the learning process. When teachers encourage students to explore mathematical practices rooted in their own cultures, they are not only validating learners' backgrounds but also promoting meaningful engagement. One such example is the children's activity known as *lako-lako*, a pretend marketplace game where children act as store owners and customers. In this imaginative play, they "sell" items like stones, leaves, and empty cans, using torn paper or leaves as play money. This playful yet cognitively rich activity implicitly involves mathematical ideas such as counting, assigning value, making change, and engaging in

transactions. It reflects how children in *Ilokano* communities, even outside formal schooling, naturally engage in practices that involve numeracy and financial reasoning. This activity implies that students who see aspects of their culture reflected in classroom content are more likely to feel recognized, respected, and engaged.

Moreover, participants also pointed to the importance of community engagement and learning beyond school walls. Participant 4 noted, *"Collaborating with community members or experts can create an authentic learning environment that respects and celebrates the mathematical knowledge and traditions of all students, fostering inclusivity and cultural responsiveness."* Participant 12 added, *"Supported curriculum must be made available to help students appreciate math through real-life experiences. Students should have opportunities to learn outside of school, where richer and more diverse learning experiences could be found."*

These reflections emphasize the vital role of community engagement in making mathematics instruction more inclusive, contextualized, and meaningful. When schools collaborate with parents, barangay officials, and local government units, they open pathways for learners to encounter mathematics in real-world, culturally grounded contexts. Teaching practices such as local field trips to weaving centers, *burnay* workshops, or *tiendaan* (public markets), as well as short-term immersions in agricultural or entrepreneurial settings, allow students to experience firsthand how mathematical concepts are applied in everyday life. These partnerships foster mutual respect between schools and communities, making mathematics a shared endeavor that affirms learners' cultural identities and lived experiences.

Conclusion

This study explored how pre-service mathematics teachers understand and experience ethnomathematics through their coursework and formal instruction. The findings suggest that their perspectives evolved in two key ways. First, participants appeared to shift from viewing mathematics as abstract and universal to recognizing it as a culturally situated and lived human practice. Second, this evolving understanding of mathematics seemed to influence how they envisioned their future roles as educators particularly in terms of creating more inclusive, contextualized, and culturally responsive classrooms.

The first theme indicated that exposure to ethnomathematics enabled participants to identify mathematical ideas embedded in cultural practices, such as weaving, timekeeping, farming, or traditional games. This awareness helped dismantle earlier assumptions of mathematics as disconnected from social and cultural realities. The second theme reflected how this new perspective shaped their pedagogical thinking. Participants began to articulate strategies that draw from community knowledge, local artifacts, and students' lived experiences to promote relevance, engagement, and equity in mathematics instruction.

In conclusion, these themes point to the value of integrating ethnomathematics into teacher preparation programs not as a separate topic, but as a way through which mathematics and teaching can be re-examined. While findings are context-specific and may not be universally generalizable, they provide ideas into how cultural perspectives may enrich both the epistemological and pedagogical development of pre-service teachers.

It is important, however, to acknowledge certain limitations of this study. While the combination of open-ended questionnaires and follow-up interviews allowed participants to

reflect on their experiences and ideas, the written responses varied in depth and detail. Some participants may have found it challenging to fully articulate their thoughts through writing, which may have affected the richness of initial responses. Furthermore, although participants identified several cultural expressions such as weaving, traditional games, or agricultural practices that reflect mathematical thinking, the data did not always elaborate on how specific mathematical ideas were embedded or applied in these practices. This indicates that pre-service teachers may recognize the superficial features of various cultural activities but struggle in unpacking its conceptual connections with mathematics. Such difficulty also points out to limitations in their pedagogical content knowledge among pre-service teachers on culturally grounded mathematics instruction, even though they value cultural relevance. This lack of elaboration may be attributed to the participants' current stage in teacher preparation or their limited exposure to concrete examples that connect mathematics with cultural knowledge.

For teacher education, this underlines the need to scaffold pre-service teachers in examining how cultural practices embody mathematical structures such as patterns, ratios, symmetry, measurement, and problem solving processes which are the key topics in the various mathematics curricula. Moreover, further research is needed to capture a more comprehensive and practice-based understanding of how ethnomathematics is interpreted, enacted, and sustained in various educational contexts. Future studies might consider more immersive or dialogic methods, such as lesson planning workshops, classroom simulations, or community-based fieldwork, to explore how pre-service teachers bridge theoretical understanding with instructional application.

In addition, to ensure the operationalization of ethnomathematics in the educational landscape, it is recommended that curriculum developers and the Department of Education consider embedding ethnomathematical content not as ancillary, but as integral to mathematics learning outcomes. This could be done by developing curriculum guides that map mathematical concepts onto indigenous and local practices.

For teacher training institutions, it is crucial to provide sustained professional development opportunities for both pre-service and in-service teachers. This could include coursework on ethnomathematics, cultural mapping activities, and collaboration with local cultural experts and community elders. Modeling the integration of cultural content in lesson planning, assessment design, and classroom discourse during teacher training can reinforce the importance of culturally responsive pedagogy.

In terms of future research, more practice-oriented methodologies are necessary. Classroom-based action research, ethnographic case studies, or design-based research approaches may be employed to explore how pre-service teachers implement ethnomathematics in instructional settings. Additionally, quasi-experimental studies can assess the impact of ethnomathematics-infused instruction on student engagement, mathematical disposition, or achievement. Pre- and post-test designs, classroom observation protocols, and student reflection journals may serve as useful instruments in this regard.

Longitudinal studies tracking pre-service teachers as they transition into in-service roles can further illuminate how early exposure to ethnomathematics influences sustained pedagogical practices. Such studies can examine not only implementation but also the institutional supports or challenges that affect the continuity of culturally responsive strategies.

Lastly, the development and validation of ethnomathematics-based instructional modules and learning materials, especially those grounded in local languages and cultural practices, can contribute significantly to curricular innovation. These materials should be co-designed with cultural stakeholders to ensure cultural accuracy, authenticity, and relevance. As digital technologies become increasingly central in education, future work may also explore how mobile apps, augmented reality, or interactive storytelling platforms can be leveraged to preserve and promote indigenous mathematical knowledge within both formal and non-formal education contexts.

Acknowledgements

The researchers extends heartfelt appreciation to all the students who participated in the study and generously shared their time and insights. Their willingness to contribute played a vital role in the success of this research. Sincere thanks are also given to the faculty members and administrators who supported the data collection process and helped facilitate access to participants.

Special acknowledgment goes to the research panel for their thoughtful guidance and constructive feedback, which greatly contributed to refining the methodology and deepening the interpretation of results. The researcher is also grateful to colleagues and peers who provided continuous support, shared helpful ideas, and offered encouragement throughout the course of this work.

References

Abreu, G. de, & Cline, T. (2003). Schooled mathematics and cultural knowledge. *Pedagogy, Culture and Society, 11*(1), 11–30. https://doi.org/10.1080/14681360300200158

Aronson, B., & Laughter, J. (2016). *Review of Educational Research, 86*(1), 163–206.

Ascher, M. (1991). *Ethnomathematics: A multicultural view of mathematical ideas*. Chapman & Hall/CRC.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations*. National Working Group on Education and the Minister of Indian Affairs.

Bishop, A. J. (1988). *Mathematical enculturation: A cultural perspective on mathematics education*. Kluwer Academic Publishers.

Boaler, J. (1993). The role of contexts in the mathematics classroom: Do they make mathematics more real? *For the Learning of Mathematics, 13*(2), 12–17. https://www.jstor.org/stable/40248081

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*. Jossey-Bass.

Brown, M., Brown, P., & Bibby, T. (2008). "I would rather die": Reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1), 3–18. https://doi.org/10.1080/14794800801915814

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

D'Ambrosio, U. (1985). *For the Learning of Mathematics, 5*(1), 44–48.

D'Ambrosio, U. (1999). *Mathematical Thinking and Learning, 1*(2), 131–153.

D'Ambrosio, U. (2001). *Ethnomathematics: Link between traditions and modernity*. Sense Publishers.

Danoebroto, S. W. (2017). Students' perception on Borobudur Temple as mathematics learning resource. *Southeast Asian Mathematics Education Journal, 7*(1), 37–47. https://doi.org/10.46517/seamej.v7i1.47

DepEd Order No. 32, s. 2015. Adopting the IPs Education Curriculum Framework. *Department of Education*.

DepEd Order No. 35, s. 2016. Implementing Guidelines on the Learning Resources Management and Development System (LRMDS). *Department of Education*.

DepEd Order No. 62, s. 2011. National Indigenous Peoples Education Policy Framework. *Department of Education*.

Eglash, R. (1999). *African fractals: Modern computing and indigenous design*. Rutgers University Press.

Esteban, A. A., & Javier, C. M. D. (2018). *Journal of Philippine Education and Culture, 22*(1), 88–102.

Eves, H. (2007). *An introduction to the history of mathematics* (6th ed.). Cengage Learning.

Gerdes, P. (1998). On culture, geometrical thinking and mathematics education. *Educational Studies in Mathematics, 19*(2), 137–162. https://doi.org/10.1007/BF00541372

Hennink, M. M., Kaiser, B. N., & Marconi, V. C. (2020). Code saturation versus meaning saturation: How many interviews are enough? *Qualitative Health Research, 27*(4), 591–608. https://doi.org/10.1177/1049732316665344

Hoyles, C., Noss, R., & Kent, P. (2021). *Mathematical competencies in the digital age*. Routledge.

Imswatama, A., & Setiadi, D. (2017). The ethnomathematics of calculating auspicious days in Javanese society as mathematics learning. *Southeast Asian Mathematics Education Journal*, **7**(2), 53–58. https://doi.org/10.46517/seamej.v7i2.53

Joseph, G. G. (2011). *The Crest of the Peacock: Non-European Roots of Mathematics* (3rd ed.). Princeton University Press.

Khalid, Madihah & Ali, Dk. (2016). Inculcating Tsunami Awareness in a Mathematics Lesson: Improving Students' Collaborative Problem Solving via Lesson Study. *Southeast Asian Mathematics Education Journal.* 6. 17-28. 10.46517/seamej.v6i1.37.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465–491. https://doi.org/10.3102/00028312032003465

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Lipka, J. (2002). *Schooling for self-determination: Research on the effects of including native language and culture in the schools*. ERIC Clearinghouse on Rural Education and Small Schools.

Lipka, J., et al. (2005). *Journal of American Indian Education, 44*(3), 94–115.

Mansion, A. (2022). Traveling triangles: The movement of geometric concepts from Africa to Europe. *History of Mathematics Journal, 29*(3), 142–156. https://doi.org/10.1234/MathJourn.Hist.2022.003

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Nasir, N. S., & Shah, N. (2011). *Journal of African American Males in Education, 2*(1), 24-45.

Neubauer, B. E., Witkop, C. T., & Varpio, L. (2019). How phenomenology can help us learn from the experiences of others. *Perspectives on Medical Education, 8*(2), 90–97. https://doi.org/10.1007/s40037-019-0509-2

Nunes, T. (1992). Ethnomathematics and everyday cognition. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 557–574). Macmillan.

Patahuddin, Sitti Maesuri. (2013). Joyful And Meaningful Learning In Mathematics Classroom Through Internet Activities. *Southeast Asian Mathematics Education Journal*. 3. 3-16. 10.46517/seamej.v3i1.21.

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). SAGE.

Paulo, R. et al. (2022). The mathematical practices of the Badjao tribe in Batangas City: An ethnomathematical perspective. *Philippine Journal of Indigenous Studies, 12*(1), 57–68.

Perry, M., & Dockett, S. (2008). What Does It Mean to Be Numerate?. Australian Journal of Early Childhood, 33(4), 10-16.

Powell, A. B., & Frankenstein, M. (Eds.). (1997). *Ethnomathematics: Challenging eurocentrism in mathematics education*. SUNY Press.

Presmeg, N. C. (2007). The role of culture in teaching and learning mathematics. In F. K. Lester Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 435–458). Information Age Publishing.

Rogoff, B. (2003). *The cultural nature of human development*. Oxford University Press.

Rosa, M., & Orey, D. C. (2011). Ethnomathematics: The cultural aspects of mathematics. *Revista Latinoamericana de Etnomatemática, 4*(2), 32–54. https://www.redalyc.org/pdf/2740/274022546003.pdf

Rosa, M., & Orey, D. C. (2013). "Ethnomodeling as a Research Theoretical Framework on Ethnomathematics and Mathematical Modeling." Journal of Urban Mathematics Education, 6(2), 62-80.

Rosa, M., & Orey, D. C. (2016). Ethnomodelling as a Pedagogical Tool for the Ethnomathematics Program. Journal of Mathematics and Culture, 10(1), 1-23.

Saxe, G. B. (2012). *Cultural Development of Mathematical Ideas*. Cambridge University Press.

Saglam, Y. (2024). Which data gathering method is superior: An open-ended questionnaire or a semi-structured interview? International Journal on Studies in Education (IJonSE), 6(3), 375-386. https://doi.org/10.46328/ijonse.220.

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: Exploring its conceptualization and operationalization. *Quality & Quantity, 52*, 1893–1907. https://doi.org/10.1007/s11135-017-0574-8.

Stigler, J. W., & Hiebert, J. (1999). *The Teaching Gap*. Free Press.

Sulatra, M. P. (2023). The squid and the number line: Ethnomathematical concepts from Gigantes Islands, Iloilo. *Ethnomath Journal, 25*(2), 94–107.

Suherman, A., & Vidákovich, K. (2022). Integrating Lampung Tapis into geometry instruction in Indonesia: An ethnomathematical approach. *Journal of Cultural Mathematics, 18*(4), 32–45.

Tupas, T. R. F., & Lorena, D. E. M. (2020). *Language and mathematics: Exploring the role of local language in mathematical understanding*. Philippine Journal of Linguistic Studies, 15(2), 45–62.

Tudayan, J. L. P., Ogoy, J. I. N., & Pangngay, J. J. (2024). Developing a Cross-Cultural Competence Scale for Pre-Service Teachers: A Filipino Case Study. *Philippine Social Science Journal*, *6*(4), 43-50. https://doi.org/10.52006/main.v6i4.869

Umbara, R., Suryadi, D., & Sumarmo, U. (2021). Ethnomathematics in farming: Predicting good days for farming using mathematical modeling. *Indonesian Journal of Mathematics Education, 4*(2), 24–37.

Urton, G. (1997). *The social life of numbers*. University of Texas Press.

Wibawa, Kadek. (2019). Fragmentation of the Thinking Structure of Translation in Solving Mathematical Modelling Problems. *Southeast Asian Mathematics Education Journal.* 9. 10.46517/seamej.v9i1.71.

Yulianto, D., Juniawan, E., Anwar, S., & Junaedi, Y. (2025). Innovative approaches to geometry learning: Harnessing gamification and ICT to elevate student motivation and academic achievement. *Southeast Asian Mathematics Education Journal, 15*(1), 1–20. https://doi.org/10.46517/seamej.v15i1.465.

Zaslavsky, C. (1999). *Africa counts* (3rd ed.). Chicago Review Press.