



Ethnomathematics: The use of cultural games in mathematics in the early grades: A South African case study

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Abstract

BACKGROUND: South Africa is known as a rainbow nation due to its ethnicity and cultural diversity. Learning in the early grades is often through play-based teaching through games. The Curriculum and Assessment Policy Statement clearly articulate that the curriculum embraces and accommodates diversity in learning using ethnomathematics. Therefore, it envisages teachers and learners show an 'appreciation for the beauty and elegance of Mathematics' and developing 'critical awareness of how mathematical relationships are used in social and cultural environment.' Cultural games can strengthen mathematics teaching and learning.

METHOD: This qualitative study within an interpretivist paradigm explored teachers' views on using ethnomathematics in the Foundation Phase especially through cultural games. This study was conducted in a semi-rural school in Gauteng province with six Foundation Phase teachers. The author collected the data through written responses followed by online interviews using a semi-structured interview schedule. Data were analysed using Creswell's six steps of data analysis.

RESULTS: The findings revealed that teachers had little understanding of the concept 'ethnomathematics', however they were using games for teaching and learning. They believed that cultural games refer especially to African cultural games. They used western and eastern games in their mathematics teaching.

DISCUSSION: Teachers agreed that ethnomathematics is crucial for building self-confidence and self-esteem of young learners. They indicated that culturally appropriate mathematics games improved learners' mathematics knowledge, skills, and understanding. Learners were able to apply mathematics principles confidently. They recommended further training and development in the use and design of cultural games.

Keywords: ethnomathematics, cultural identity, cultural games, foundation phase teachers

Introduction

South Africa (SA) is known as a rainbow nation due to its ethnicity and cultural diversity with each culture having its own indigenous knowledge and learning systems. Learning through games is integral to teaching and learning in the early grades. This is evident in the works of theorists such as Maria Montessori, who advocated for game-based learning, and Vygotsky, who promoted learning through fun collaboration and engagement with the environment (Rothmeyer, 2019). This study aimed to explore teachers' understanding of the use and advantages of cultural games [ethnomathematics] in teaching mathematics. Lopez-Leiva et al. (2024) state that the teaching and learning mathematics should reflect and embrace culturally-based mathematics, one that incorporates the diversity of the classroom. Ethnomathematics has the potential to help learners connect mathematical learning to their lives; furthermore, it allows learners whose voices have been historically marginalised (Bhuda & Pudi, 2020).

Naidoo (2021) and Machaba (2019) state that Indigenous games (cultural games) are essential to the broader scope of Indigenous knowledge. They agree that games, in general, are usually viewed from a limited perspective of play, enjoyment and recreation rather than as a resource for learning mathematics. Public schooling in the South is multicultural and multiracial, with all learners accommodated in a single class and who are subjected to a single curriculum; therefore the need for an inclusive teaching and learning pedagogy. To foster an all-inclusive environment, Bhuda and Pudi (2020) agree that games play a significant role in the teaching and learning of diverse

learners since African traditional people across the continent have shown that Indigenous people used mathematics games since time immemorial.

The Department of Basic Education's (2011, p 8) Curriculum and Assessment Policy Statement (CAPS) articulates that the mathematics curriculum embraces and accommodates diversity in learning. Therefore, it envisages teachers and learners showing an "appreciation for the beauty and elegance of Mathematics' and developing 'critical awareness of how mathematical relationships are used in social and cultural environments". Ethnomathematics is one way of embracing and accommodating cultural games in the mathematics lesson. The author believes that in many parts of the world, including South Africa, most teachers are expected to work with learners from various ethnic, linguistic, and cultural groups distinct from their own; therefore, there is a need to accommodate all learners' cultural backgrounds (Forbes, 2018; Machaba, 2019)). Clarkson, cited in Favilli (2004), states that cultural, linguistic, political, and social issues in mathematics learning have often been seen as distant and have little impact on the teaching and learning of mathematics. Therefore, he argues that if mathematics education is to become an equitable practice, these issues need to be seriously addressed through ethnomathematics (D'Ambrosia & Rosa, 2017) .

Gasteiger et al. (2015) believe that cultural games can be effective in supporting young learners' learning. However, they argue that some games are developed with clear intentions, structure, and learning objectives, while others are for entertainment. Since every culture in South Africa has its own Indigenous knowledge and learning systems, young learners can share their learning experiences in the classroom (Naidoo, 2021). For this reason, the author believes cultural games can strengthen mathematics teaching and learning, at the same time respecting the uniqueness of each culture, norms and values.

Explanation of ethnomathematics

According to D'Ambrosio in Favilli (2004: p IX), "ethnomathematics is a research programme in the history and philosophy of mathematics, with pedagogical implications, focusing the arts and techniques (tics) of explaining, understanding and coping with [mathema] different socio-cultural environment [ethno]. Ethnomathematics refers to how members of various cultural groups mathematise their reality because it examines how mathematical ideas and practices are processed and used in daily activities (D'Ambrosio & Rosa, 2017, p. 288)." D'Ambrosio in Favilli (2004) argues that ethnomathematics should promote creativity by helping people attain their optimal potential and promote citizenship by transmitting values and understanding rights and responsibilities in society. D'Ambrosio (2016:10) believes that ethnomathematics is a tool for achieving 'a culture of peace' in his quote, "If education is to contribute to achieving a just social order, we content that educational practices should be grounded in the ethics of diversity." For this reason, UNESCO (2017) believes that ethnomathematics can be viewed as a facet of cultural diversity or 'cultural pluralism'. Thus, Machaba (2019) believes games and artefacts can include ethnomathematics in mathematical activities in the early grades to instil pride and dignity in young learners.

Values of cultural games in mathematics learning

Young children enjoy playing games from an early age, and Louw et al. (2024) agree that games enhance and stimulate the development of social interaction, logical and strategic thinking, competitiveness and often teamwork. Machaba (2019) states that mathematical games provide children with joy, challenges and fun when finding solutions to problems. These games strengthen and improve young learners' attitudes towards mathematics, motivate them and support their problem-solving abilities (Bragg, 2012). Nonhlanhla and Venketsamy (2022) believe that through mathematical games, young learners engage in discussion, critical thinking and problem-solving and debating skills (arguments).

Mimaar (2023) states that cultural games reflect the history and customs of societies. These games serve as a bridge that connects learners to their cultural roots and history, thus fostering a sense of identity and belonging. Cultural games allow learners to learn about their customs, stories and values interactively and memorably. Games can develop learners cognitively, physically, socially, emotionally, culturally, and creatively (Machaba, 2019). Through games, learners can practice problem-solving skills, logical thinking and creativity. Examples of these games are chess and other board games. The author believes that games also improve memory and concentration among learners, whereby they need to remember rules and learn to abide by the rules of the game. Physically, games enhance learners' coordination and fine motor skills. Through cultural games, young learners learn social and emotional skills (Sutapa et al., 2021). They learn to work in teams to share, take turns and negotiate rules. Games also teach them to manage their frustrations and joy and foster resilience and empathy. Playing games teaches children about different cultures, cultural heritage and values. Cultural games also foster respect and appreciation for diversity (Mimaar, 2023). Unlike many modern games with set rules and outcomes, some cultural

games allow learners to be creative and develop and adapt their own rules and outcomes. This flexibility stimulates creativity and the ability to think outside the box (Machaba, 2019). Research has shown that teachers have incorporated various games into their teaching curriculum over the past several years to create a fun and engaging learning environment (Machaba, 2019; Sutapa et al., 2021).

According to Mimaar (2023) and Gasteiger et al. (2015), setting up games can be time-consuming but enjoyable, games that are interactive, collaborative and competitive which tend to motivate and encourage learner participation. Jaaska and Aaltonen (2022) found that some of their learners learnt more when competing in a game-based activity, while others were bored or distracted. Despite these, Machaba (2019) and Nonhlanhla and Venketsamy (2022) agree that through games, learners have the potential to develop higher levels of critical thinking skills, decision-making, teamwork, interpersonal relationships and collaboration. Some games help learners develop strategic skills and acute decision-making, while others help learners sort out activities, logical thinking and prediction.

Theoretical framework

For this paper, the author underpinned his study using various theorist's views on play and games. According to Ndlovu et al. (2023), Vygotsky advocated the importance of play-based learning through his theory of social constructivism. Vygotsky argued that young children learn critical skills required for later life through social interaction. His social learning theory advocated that young children learn through interaction, collaboration and communication with each other.

In 1907, Dr Montessori cared for a group of children in Rome's San Lorenzo district. She observed that through play and fun activities, young children developed socially, intellectually, physically and spiritually (Montessori, 2014). She stated that classrooms should be designed in a way that gives children the opportunity to learn and play in many different ways. Montessori believed that through hands-on play, the most basic foundations of mathematics are introduced through games and activities that appeal to young children. Fler and Hedegaard (2010) agree that through play and game-based teaching and learning, children are taught how to regulate their social interaction, a view that concurs with Vygotsky's theory of social constructivism. When games are introduced as fun-based activities, young learners are unrestricted and immerse themselves fully into the activity (Sutapa et al., 2021).

Playworlds as a play pedagogy is the original work of Lindqvist (1995). Playworlds are a form of adult-child joint play in which adults and children create a common fantasy to support their development (Marjanovic-Shane, 2011). A cultural-historical conception of play underpins it. Lindqvist was interested in how children make meaning in play. They state that Playworlds can be described as joint acts of creation or ways of being that promote the development of children through games and other play activities. According to Brèdikytė (2022), Playworlds are designed to include all who wish to participate and support each other, similar to Vygotsky's social learning theory. Fler (2021) agrees that through Playworlds, teachers can encourage young learners' scientific curiosity, mathematical logic, and design thinking and strengthen their social and emotional development.

Method

The author used a qualitative research approach embedded within the interpretivist paradigm to explore and describe early-grade teachers' use of cultural games to teach mathematics. The rationale for this approach was to elicit the participants' views, understanding, and use of cultural games. The case study paradigm assisted in revealing participants' personal experiences of ethnomathematics and the use of cultural games (Maree, 2020). Using purposive sampling with specific criteria, six (6) early-grade teachers were selected to participate in this open-ended questionnaire and online interview. The participants were from one district and two (2) schools in the Gauteng province. The criteria used were that (i) each participant must be teaching in a primary school, (ii) be trained to implement the South African National Curriculum Statement, and (iii) use games for teaching mathematics.

Each participant completed an open-ended schedule and returned it via email. After that, the author followed up with an online interview since South Africa was in lockdown due to the Covid-19 pandemic. The open-ended interview schedule allowed participants to share their knowledge, understanding and experiences of using cultural games for teaching and learning (Creswell, 2014). The online interview assisted the author in probing each participant's response. Participants were informed of the ethical principles of confidentiality, voluntary participation, and withdrawal from the data collection process whenever they wanted to, without giving a reason (Creswell, 2014; Maree, 2020). To protect the identity of the participants and their institution, the author used codes as indicated in the table below.

School	PARTICIPANTS	GENDER	GRADE	CODES USED
SA	Participant 1	Female	1	P1
SA	Participant 2	Female	2	P2
SA	Participant 3	Female	3	P3
SB	Participant 4	Female	1	P4
SB	Participant 5	Female	2	P5
SB	Participant 6	Female	3	P6

Table 1: Participant Information (compiled by the author)

Using Creswell's six data analysis steps, the author transcribed the data, read it, and identified preliminary themes and subthemes. Once the six steps were thoroughly interrogated, the research identified three main themes, which were used in this manuscript. To ensure the trustworthiness and credibility of the data, the author cross-checked and compared data with audio recordings of the online interviews. The data was analysed thematically (Cohen et al., 2018). Verbatim quotes were used in the findings and discussion.

Permission to undertake this study was obtained from a South African university's ethics committee. The ethics protocol approval number is UP 09/04/01. All ethical principles were upheld during the study (Cohen et al., 2018; Maree, 2020). All participants agreed verbally to participate in this study, thus completing the open-ended schedule and agreeing to the online interview.

Findings

After careful analysis of the data, the author identified three main themes: (i) the teacher's understanding of ethnomathematics, (ii) the teacher's use of cultural games and (iii) the advantages of using cultural games.

Since this study focused on ethnomathematics and the use of cultural games in teaching mathematics, the author delved into the participant's understanding of ethnomathematics. The author asked the participants to share their understanding of ethnomathematics. Most participants (P1; P2; P4; P6) indicated that

They did not understand the concept of 'ethnomathematics'. It was the first time they had come across the concept. They all agreed that it has something to do with mathematics, but they needed help understanding the concept 'ethno'.

To assist these participants, the author explained the concept of 'ethnomathematics,' and then the participants agreed that they used cultural 'games' to teach their learners mathematics. For example, P1, P2, and P6 indicated that they ask their learners to share counting in their African languages. P2 mentioned that one of her learners indicated that her parents play *Umrabaraba* at home to help her count and understand mathematics concepts.

Despite the participants' lack of understanding of the concept of 'ethnomathematics,' they are using cultural games and code-switching when teaching mathematics concepts in the early grades.

In contrast to the above participants, P3 and P5 indicated they had an idea of what ethnomathematics is.

They both indicated that ethnomathematics involves a learner's culture and tradition. Furthermore, they stated that ethnomathematics is also about appreciating the learner's life world and bringing into the classroom what the learner has learned from their learning environment. This can be done through games and code-switching to the learners' language.

According to P3, she stated *"If we appreciate a learner's culture and diversity, then we can incorporate their cultural values and beliefs in the classroom. I feel that if we embrace a learner's cultural identity, then we are developing the child to become tolerant and accepting in society."*

The above findings indicate that P3 has a good understanding of ethnomathematics. She understood the significance of accommodating the learners' cultural values in teaching and learning.

The next question the author asked the participants was, "Do you use cultural games in your classroom while teaching mathematics?" To this question, all participants (P1, P2, P3, P4, P5, and P6) agreed that they used games to teach mathematics. P1 said, *"I teach Grade 1 mathematics, and most of my lessons are game-based. We play different counting games for number sense, board games, and geo-boards to make shapes."* P2 and P5 also agreed that they used a variety of games in their classroom during their maths lesson. Their games involved 2x2 and 3x3 sudoku. These games were played on the learner's iPad.

In her response, P3 said:

I try to use different cultural games from all cultural groups in my class. Since my class is multiracial, I ask my learners to bring and share a cultural game. Some of the games that these learners brought into my class were Upuca, Black-toti, Umrabaraba, Chess (Chaturanga), and Snakes and Ladders (Moksha Patam). Note that 'Chaturanga' and 'Moksha Patam' are both Indian traditional mathematics games that is called 'Chess' and 'Snakes and Ladders' in the western world.

Although the question focused on 'cultural games', participants agreed that they used games. The author opined that these participants used 'games' but were unaware that all games originated from a particular culture. Most participants indicated that they used beads, snakes and ladder, bingo, chess, monopoly and Maths 24 to teach mathematics. Participants were unaware that these games were embedded with a particular culture and were adapted according to a culture's need, for example, 'Chaturanga' an Indian originated game was a precursor to modern-day chess and Snakes and Ladder was called 'Moksha Patam' which originated in India during the Gupta Empire (Prabakaran, 2024).

The researchers probed further into participants' understanding of cultural games. From their responses, participants referred to cultural games as those that only pertained to 'African culture'—this did not include Eastern and Western cultures, yet these teachers were using games from different cultures in their classrooms.

The author asked the participants, "What are some advantages/values of cultural games in your early grades?" All participants, P1, P2, P3, P4, P5 and P6, opined that cultural games significantly impact the child's unique identity, enhances their self-esteem, identity, respect and tolerance, at the same time improving their mathematical knowledge, skills, and understanding because they are familiar with the game. The verbatim quotes below are each of the participant's responses to this question:

P1, "I believe that through cultural games, children learn to become more respectful and tolerant of each other. Games teach children to communicate and accept winnings and defeats."

P2 mentioned, "Games are fun, and children enjoy learning through play. They learn sharing and caring through games. I noticed that my Grade 2 learners were enjoying the games, and even the quieter learners participated in the activity."

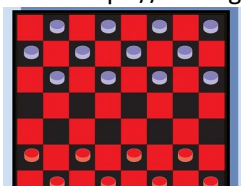
P3 said,

"Cultural games give children a sense of pride while teaching them basic mathematics concepts. For example, **Upuca** is a traditional game among Xhosas and Africans in African countries, and it has different names per culture. This game develops mathematical concepts. **Black Toti** is a children's game played in South Africa which help in counting. **Umrabaraba** is an African logic game that develops prediction skills. **Itreyini** is a cultural game that is called train in English. This game helps learners develop addition and subtraction skills. Furthermore, I use games such as draught, snakes and ladder and Chinese chess.



Umrabaraba <https://www.google.com/search?q=umrabaraba+game&sc= image-licenses stock>

1.



Western games <https://www.britannica.com/topic/checkers>



Chinese Chess <https://www.dreamstime.com/about>

P4 and P5 agreed that mathematics games help learners improve their attention, concentration, and memory. These games also help learners be critical thinkers, build language, and enhance their creativity. P4 further indicated that in her class, the learners.

They started to agree to disagree, showed confidence in their strategy, and were able to explain how they arrived at a place answer. She further indicated that through monopoly, her learners made firm decisions about 'buying property' and could justify their reasons. She said she was amazed at how grade 1 children could think creatively and make decisions without adult intervention.

According to P6, "I noticed that while playing games in my class, some learners became very frustrated at losing, until I heard one learner say, 'In life, we win and lose; you can't win every time.' She also mentioned that through the gaming activity, learners were becoming respectful to each other.

Discussion - Conclusion

Ethnomathematics explores how different cultural groups use mathematical concepts and methods to understand and navigate their reality (Ambrosio & Rosia, 2017). Naidoo (2019) and Ndlovu et al. (2023) agree that teachers play a critical role in including cultural and Indigenous knowledge systems into their mathematics lessons. In this study, the author noted that most participants were not familiar with the concept of ethnomathematics, yet they agreed that they used different cultural games in their classroom after the author explained the concept.

According to P3 and P5, ethnomathematics can develop learners' self-concept, make them proud of who they are, and assist in understanding mathematical concepts since they are familiar with the activity. This view concurs with D'Ambrosio (2016:10), who agrees that mathematics can contribute to self-pride, bring about cultural tolerance and respect, and have the potential to be a social achiever.

According to Naidoo (2021), more and more teachers are incorporating various games into their teaching curriculum. Games are a fun and exciting way of introducing mathematics concepts since young children learn often through play. According to Fleer (2021), most mathematical games help young learners to be critical, make decisive decisions and take responsibility for their actions. This statement concurs with P2, who mentioned that her learners enjoyed learning through games and were making their own decisions. She noticed that even those passive learners in her class participated in mathematics games, thus highlighting the advantages of games in the early grades. This view concurs with Lindqvist, who agrees that Playworlds (games) encourage all learners to participate and support each other. Through games, young learners develop social skills (Ndlovu, 2023) and, therefore, learn how to get along with each other, tolerating and accepting winnings and losing in a game. P2 also noted that her learners were making critical decisions before they made a move, especially in the game 'Snakes and Ladders'. When she asked the learner why he did not move, he indicated, "The snake will bite me, and I will have to go back to the start of the game." Immediately, P2 noted the learner's thinking skills. McLeod (2024) and Montessori (2014) agreed that both Vygotsky and Montessori learning theories advocate that games have the potential to develop young learners cognitively, socially, emotionally and physically. Naidoo (2021); Machaba and Sutapa et al. (2021) also believe that cultural games are an exceptional resource for teaching and learning mathematics in the early years. Therefore, the author opines that all teachers should have a sound knowledge of ethnomathematics and they should embrace and accommodate cultural games into the mathematics lessons.

As P1 and P3 indicated, young learners learn to show tolerance, respect and humility for their fellow learners in the class through cultural games. They also believe that games allow children to communicate with each other through their own language and understanding. Mimaar (2023) agrees that cultural games allow learners to understand different cultures, customs and values in an interactive and memorable way. Through games, learners learn teamwork, help manage their frustrations and joy, and foster resilience and empathy. Furthermore, Naidoo (2021) and Machaba (2019) state that cultural games foster respect and appreciation for diversity. This was evident in P6's response when she noticed that a learner in her class became frustrated but respected the response from his friend that 'you cannot win every time.'

According to Fleer (2021), games are beneficial for developing learners' skills to think outside the box. The author believes that games can help learners develop strategic skills and aid in decision-making. This was evident in P3's use of cultural games, which developed various mathematical skills. Although games are seen as fun, they all have an element of educational value in them. For example, Venketsamy and Hu (2023) and Prabakaran (2024) found that *Upuca* develops mathematical concepts, eye and hand coordination; *black-toti* teaches young learners' basic logic, time management and concentration; *chess* helps learners to develop strategic and critical thinking skills while *snakes and ladders* help young learners develop decision-making skills.

In conclusion, this paper focused on ethnomathematics, especially the use of cultural games in teaching mathematics. Although participants did not understand the concept of ethnomathematics, they all used games to teach and learn mathematics. They agreed that young learners enjoy much fun and excitement during the learning process through games. The participants also agreed that children learn mathematical concepts with ease and confidence through mathematical games. This study found that teachers used games but were unaware that all games were embedded within a particular culture. For example, most participants knew of 'chess' as a Western game. However, this game was developed in India during the Gupta Empire and later became known as chess. Although participants used games in the early grades, they indicated that they need to be exposed to more cultural games and get a deeper understanding of the origins of the games and their value to teaching and learning.

Furthermore, the participants recommended that the Department of Basic Education in the South organise ongoing workshops and training on different educational games. They also requested that a handbook of games be developed and shared. P4 recommended that schools have appropriate technological resources that they could use during their mathematics lessons.

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