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Decolonising mathematics education: Teachers' initial experiences of using ethnomathematical games in the Intermediate Phase

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Abstract: The African Agenda 2063 strives to attain the goals of peace and prosperity, and to do so, there must be a process of political liberation and decolonisation. In the South African context, decolonisation involves transforming the mathematics curriculum to one that is African by employing cultural approaches such as ethnomathematics. However, South African mathematics teachers still rely on Eurocentric methods for teaching mathematics. To decolonise mathematics in the Intermediate Phase, a project was initiated that utilised indigenous games for teaching mathematics. This paper aims to identify whether such efforts to decolonise mathematics education will be accepted or rejected by the mathematics teachers involved in this study. The paper is framed by the Critical Mathematics Pedagogy Theory. A qualitative case study approach was employed to collect data through a focus group interview with ten mathematics teachers who teach in rural and semi-rural areas of KwaZulu-Natal, South Africa. The findings demonstrate that ethnomathematical games encourage mathematics learning, that teachers' initial apprehensions gave way to enthusiasm, that learners were excited to play and learn, and that teachers found it effortless to integrate mathematical concepts such as addition, subtraction, multiplication, factorisation, and quadrilaterals with the indigenous games of Morabaraba, Tshetershere, Diketo, and Kgati. Recommendations include that mathematics educational policies incorporate ethnomathematics as a policy directive and that teachers receive training in alternative cultural pedagogical practices for teaching mathematics, such as the use of ethnomathematics. Future research endeavours should focus on finding avenues to sustain ethnomathematics in the classroom.

Keywords: Decolonisation, ethnomathematics, indigenous games, mathematical concepts, mathematics pedagogy.

1. Introduction

The United Nations Sustainable Development Goals are oriented towards a global sustainable development agenda. To this end, the African Agenda 2063 is linked to the sustainable development goals of the United Nations but is explicitly aimed at addressing Africa's developmental aspirations (Royo, Diep, Mulligan, Mukanga & Parikh, 2022). The African Agenda 2063 seeks to foster peace and prosperity for Africans. However, it is crucial to understand that the goals of peace and prosperity can only be achieved through political liberation and decolonisation (African Union, 2015). Critical Mathematics Education allows mathematics teachers to become politically aware of liberation and decolonisation, and through their pedagogy, they can also create awareness among their learners (Skovsmose, 2020). Therefore, this paper aims to contextualise and help decolonise the teaching of mathematics in Africa, particularly in South Africa.

The challenge in South Africa is that mathematics teaching and learning still rely on outdated teacher-centred strategies (Meeran, 2022). In other words, these teacher-centred approaches detract from the African perspective of ubuntu, which advocates for communalism and shared learning. Hlatshwayo, Shawa, and Nxumalo (2020) agree that an ubuntu curriculum is necessary for transforming the curriculum from the former hierarchical approach to a horizontal, collaborative

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model. While South African policy initiatives mandate learner-centred education and emphasise the importance of utilising learners' prior knowledge (DBE, 2011), the actual practice in some mathematics classrooms does not reflect these initiatives. It can be assumed that teachers have not been sufficiently trained to implement these policy initiatives (Nakidien, Singh & Sayed, 2021), even as South Africa aims to meet United Nations Goal 4 of delivering quality education in mathematics (Mundial, 2016). Mabena, Mokgosi, and Ramapela(2021) confirm that teachers in South Africa face systematic challenges, such as students'; attitudes towards mathematics learning, a lack of pedagogical content knowledge in mathematics, and insufficient professional training for teachers. Consequently, students have achieved poor results in mathematics, as evidenced by the Trends in International Mathematics and Science Study (TIMSS) (Mullis & Kelly, 2022). Therefore, to achieve the goals of the United Nations (SDG4), the African Agenda 2063, and the Curriculum Assessment Policy Statement (CAPS) in decolonising mathematics to make it contextually relevant, training was provided for some teachers. This training focused on using ethnomathematical indigenous games, which have been found to be culturally relevant, enjoyable, and conducive to learning mathematics more easily (Meeran, 2022).

I led a project aimed at equipping Intermediate Phase learners with the skills needed to make mathematics learning relevant to their lives. Mathematics teachers in a region of KwaZulu-Natal attended a workshop on using indigenous games to make mathematics enjoyable and applicable. Research has shown that ethnomathematical indigenous games, as a pedagogical tool, can meet the diverse needs of learners in South African classrooms (Mosimege, 2016).

The aim of this paper is to explore how ethnomathematical Indigenous games were initially received, taught, and experienced by both teachers and learners, allowing me to determine whether the teachers accepted or rejected the use of these games in their classrooms. The participants in the study were the mathematics teachers, who were required to provide feedback on how the learners responded to mathematics taught using indigenous games. Consequently, the following research questions were developed to investigate how the mathematics teacher participants experienced the implementation of the games and to understand how they integrated specific mathematical concepts with the indigenous games they chose to use.

1.1 Research questions

The research questions were formulated as follows:

- What were the initial experiences of using ethnomathematical games in the Intermediate Phase?
- How were ethnomathematical games integrated with mathematical concepts in the classroom?

This paper provides a literature review and theoretical background on ethnomathematics and ethnomathematical games. A qualitative approach within a case study research design was adopted. The findings and discussion follow the methodology section and, finally, the conclusion.

2. Literature Review

2.1 Understanding the concept 'ethnomathematics'

D'Ambrosio (2001, p.1) aptly describes ethnomathematics as the link between culture and mathematics, where 'culture' refers to the cultural identity of a group and 'mathematics' broadly encompasses numbers, ordering, classifying, modelling, and shaping. In using this concept, D'Ambrosio (2001) stressed that culture and mathematics are rarely integrated into teaching and learning. When they are, it is often done inconspicuously and without a proper understanding of the culture involved. This lack of understanding stems from teachers not being familiar with the cultural backgrounds of their learners, as noted in the study by Meeran and Van Wyk (2022). They found that socio-cultural differences created barriers to learning mathematics. The study revealed that the five mathematics teachers struggled to teach multicultural learners due to a lack of understanding of the

specific cultural dynamics in their classrooms. They focused on those learners who could grasp the mathematics content and tended to ignore those who could not, failing to motivate all learners to appreciate mathematics because of their inability to understand them (Meeran & Van Wyk, 2022). A multicultural mathematics education should, therefore, affirm and respect the diverse cultures of learners in the classroom, thereby promoting a better understanding of mathematics. The term 'ethnomathematics' was initially coined as a "neologism glocal," which takes into account the global context alongside local practices of mathematics (D'Ambrosio, 2020, p.3). D'Ambrosio believed that humans encounter problems daily and solve them through "comparing, measuring, quantifying, and organising" (p.3), all of which relate to mathematics. When these problems are solved in a local context, they become culturally significant. Therefore, the origin of the term 'ethnomathematics' reflects cultural identity.

2.2 Ethnomathematics and decolonisation

Ethnomathematics, if used correctly, has the potential to decolonise mathematics education. As D'Ambrosio (2001) emphasises the importance of culture in mathematics education, he asserts that culture shapes how a child thinks and learns. For an African child, the cultural perspective is African, not European, hence the need for decolonisation. However, mathematics education has been imported from influential Western countries, particularly those that have colonised us (Owen, 2023), and has become so ingrained in our education system that we struggle to utilise pedagogical practices such as ethnomathematics to decolonise the way we teach mathematics. Owen's (2023) study on the Papua New Guinean society in Australia reveals a wealth of indigenous mathematical knowledge relating to classification, pattern, design, and numeral systems. He warns that for ethnomathematics to be effective in that context, reflecting the culture of the Papua New Guinean society, it must be made compulsory alongside multilingual classes. In a study conducted in Nigeria, Mosimege and Egara (2023) noted from learners'; reflections that teachers'; use of ethnomathematics was limited; the authors recommend training teachers to effectively incorporate ethnomathematics into their classrooms. To promote the decolonisation of the mathematics curriculum, collaboration between the government, universities, and schools is essential to advance ethnomathematics.

In South Africa, there are eleven official languages, which reflect the multicultural society in which we live. Furthermore, given the cultural variety evident in South Africa, an ethnomathematics approach may be assumed. However, according to Bhuda and Pudi (2020), ethnomathematics has been largely ignored, resulting in the underachievement of learners in mathematics. Forbes (2018) argues that poor results in mathematics have prompted teachers and parents to seek culturally relevant practices. Research shows that if such practices are not forthcoming, learners may become marginalised, with mathematics becoming relevant only to those who have access to Eurocentric practices through their socio-economic status (Mosimege & Egara, 2023; Meeran & Van Wyk, 2022). Therefore, an Africanisation perspective on decolonising mathematics education is needed (Msila & Gumbo, 2016). Ethnomathematics aligns with this agenda if it is mandated and used effectively. Teachers must be aware of past injustices and inequalities to develop methodologies, such as ethnomathematical indigenous games, that meet the diverse needs of learners in their classrooms.

2.3 Using ethnomathematics in the classroom

The use of ethnomathematics in classrooms has proven to be worthwhile and contextually relevant. A study conducted by Putra and Mahmudah (2021) at Yogyakarta University, Indonesia, with student teachers confirmed that the students were able to understand ethnomathematics, which employs local indigenous knowledge for problem-solving, as it improved their critical thinking capacities. However, when these students attempted to implement it in schools during their teaching practice, they were hindered by the preparation of resources and lesson plans. This led to a separation of culture and mathematics teaching (Putra & Mahmudah, 2021).

A study conducted in Turkey by Ergene, Ergene, and Yazici (2020) corroborates the findings of Putra and Mahmudah (2021). These authors found that student teachers often separated mathematics from ethnomathematics and suggested the need for ongoing training to assist pre-service teachers in incorporating ethnomathematics into their mathematics classrooms. The challenges that may arise without adequate training include teachers holding misconceptions about the relationship between mathematics and culture. Even when teachers are willing to implement ethnomathematics in the classroom, they often face a lack of resources and reference materials (Ergene et al., 2020). The researchers used cultural items such as carpet motifs, figures, mosque ornaments, and local clothing from Turkish culture to teach geometric patterns and shapes (Ergene, Ergene, and Yazici, 2020). These two studies highlight the challenge of sustaining ethnomathematics in the classroom. However, Mania and Alam (2021), in their study among primary school teachers in Indonesia, found that traditional meals and indigenous games were utilised more frequently, positively influencing classroom outcomes.

In the South African context, the use of ethnomathematics in the classroom could thrive if sufficient training and resources are provided to teachers. Furthermore, if ethnomathematics were integrated into the curriculum, which it currently is not (Mosimege, 2016), it could contribute to the wealth of cultural knowledge present in South Africa. The country boasts a rich cultural heritage, with cultural artefacts such as Ndebele architecture, kites, wire art, and wooden cars that can enrich mathematics education (Machaba & Dlamini, 2021). Some mathematical concepts that can be related to these cultural artefacts include the properties of shapes, the theorem of Pythagoras, and transformations (Machaba & Dlamini, 2021). For instance, Machaba and Dlamini (2021) illustrate how the Basotho hut can be integrated into mathematical concepts like the theorem of Pythagoras and the distance formula.

2.4 Indigenous games to foster ethnomathematics learning

Games are exciting for children to play, so it can be assumed that they will also find learning mathematics through indigenous games to be equally engaging. Many South African indigenous games play a significant role in teaching and learning mathematics (Meeran, 2022; Meeran et al., 2022), particularly in areas such as counting, shapes, multiplication and division, as well as problem-solving and logical thinking. The Morabaraba game (see Figure 2) is commonly used to teach number patterns, geometric patterns, symmetry, measurement, position and movement, and common fractions. The Tsheretshere game (see Figure 3) aids in understanding quadrilaterals, perimeter and area, common fractions, and the properties of 2-D shapes. Mathematical concepts inherent in the Diketo game (see Figure 4) include measurement, estimation, counting, number patterns, as well as addition and subtraction (Meeran et al., 2022).

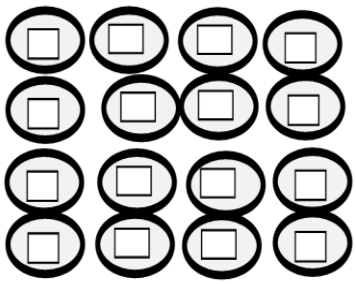

Figure 1: *Moruba/Ncuba/Mefuvha/Morabaraba board game*

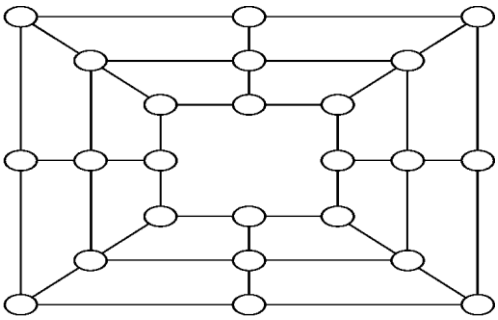

Figure 2: *Morabaraba*
Source: Africa Inland Mission (2017)

Figure 3: *Tsheretshere playing field*
Source: Swaine (2021)

Figure 4: *Diketo playing field*
Source: Department of Basic Education (2018)

The Malepa game (see Figure 5 below) is a string figure construction that can be used to demonstrate mathematical concepts such as the properties of triangles and quadrilaterals, as well as symmetry (Mosimege, 2016). Another popular game in indigenous communities is Kgati – rope-skipping (see Figure 6 below), which can be utilised to teach mathematical concepts like geometric shapes, geometric and numeric patterns, and problem-solving (Moloi, Mosia, Matabane & Sibaya, 2021).

Figure 5: *Malepa Game*
Source: Mosimege (2000:201)

Figure 6: *Kgati – Skipping rope game*
Moloi et al. (2021:247)

Games played by indigenous people are rich sources of culture and, in their relationship to mathematical concepts, provide a cultural pedagogy for mathematics learning. They further promote a critical mathematics pedagogy that raises awareness of the resources we already have in Africa to improve mathematics education rather than borrowing from Western cultures.

3. The Critical Mathematics Pedagogy Theory

Critical pedagogy involves teachers empowering their learners and encouraging them to critically assess their lives, society, and social justice (Kincheloe, 2008). Freire (1971) argued that critical mathematics pedagogy fosters critical thinking and democratic values, and that teachers should cultivate a critical pedagogy in their classrooms. Consequently, learners can gain an understanding of the forces that shape their lives through the application of critical mathematics pedagogy (Freire, 1971). Critical mathematics is linked to critical pedagogy, as it seeks to uncover the technical and hidden uses of mathematics by powerful institutions in capitalist societies (Skovsmose, 2020). A notable argument is that mathematics is used to disadvantage the lower echelons of society by promoting middle- and higher-class values that restrict access to mathematical education (Brantlinger, 2014; Buckley, 2010; Vithal, 2003).

In South Africa, it is essential for the curriculum to employ a critical pedagogy that is responsive to diverse learners, both through curriculum policies and classroom practices. Past inequalities and injustices in the country must be acknowledged, and mathematics teachers should possess a critical awareness of these injustices and inequalities within the curriculum, as this awareness can be translated into social and political action to effect change (Vithal, 2003). Ethnomathematics offers a social justice perspective that aims to decolonise the teaching of mathematics, benefiting the diverse

African children in the classroom. Furthermore, Seal and Smith (2021) identify the principles of critical pedagogy, the first of which is that education is inherently political. Therefore, if a nation wishes to empower its citizens, an understanding of social justice should be at the forefront of this empowerment initiative. Second, ";knowledge should relate to and develop from the lived experience of the participants"; (Seal & Smith, 2021, p. 4). The lived experience is distinctly African. African indigenous games are played daily in communities (Moloi, Mosia, Matabane & Sibaya, 2021), so incorporating these games into mathematics instruction enriches the lived experience of both mathematics teachers and learners. Finally, Sean and Smith (2021, p. 4) argue that ";knowledge should be co-created between all participants in the learning process."; This third principle is significant as it fosters collaboration, embodying the ubuntu perspective of working together to learn. Ethnomathematical indigenous games facilitate this process as learners engage with the games, which integrate mathematical concepts, making the learning experience enjoyable and relevant.

It follows, then, that teachers were skilled in promoting the teaching of ethnomathematical indigenous games through this project, as discussed below.

4. Methodological Considerations

A qualitative approach was used to address the aim of the study, which was to gauge how ethnomathematical indigenous games were initially experienced in the classroom. I sought to explore the initial experiences of both teachers and learners when using indigenous games in this setting. This qualitative approach enabled me to investigate social phenomena in a natural environment (Cohen et al., 2018), specifically within the ten schools from which data was collected.

4.1 Participant selection

Intermediate Phase (Grades 4 to 6) mathematics teachers from ten schools in rural and semi-rural areas of KwaZulu-Natal, South Africa, were identified as participants for the study. The teachers were purposively sampled, as they were specifically trained to teach mathematics at the Intermediate Phase. Additionally, they taught at primary schools in rural and semi-rural areas, which meant their classrooms included multicultural learners. Therefore, the selection of participants was a deliberate choice, as prescribed for the qualitative approach (Bertram & Christiansen, 2020). The learners at these schools come from diverse cultural, socio-economic, and language backgrounds.

4.2 Background to data collection

The project was initiated to provide teachers with alternative methods of teaching mathematics. It spanned three years and began with collecting data from community elders in the Mpumalanga, KwaZulu-Natal, and Limpopo provinces about how to play indigenous games. The community elders discussed games such as Morabaraba, Moruba, Kgati, Tsheretshere, Diketo, Jukskei, and Dibeke. This data was then integrated with relevant mathematical concepts in the Curriculum Assessment Policy Statement (CAPS) for Intermediate Phase mathematics. Subsequently, an intervention programme was conducted with participants in KwaZulu-Natal to train them on how to use the different games in relation to the mathematical concepts outlined in the CAPS curriculum. The training included discussions on ethnomathematics and its theoretical significance, instructions on the indigenous games and how to play them, as well as integrating the games with mathematical concepts using worksheets and resources made from scrap materials. Additionally, participants were organised into networking groups. They were further trained to develop worksheets and resources for use in their classrooms. The teachers were then expected to implement the ethnomathematical game approach in their classrooms.

4.3 Data-collection method

The method used to collect data was a focus group discussion. The questions for the focus group were developed by the research team members and piloted amongst each other. The discussion took

place after teachers had begun experimenting with using indigenous games to teach mathematics in their classrooms. Each participant was given the opportunity to answer each of the semi-structured questions asked. This approach ensured that everyone had a chance to respond and facilitated easier transcription of the data. The focus group interview lasted 50 minutes, with all ten participants involved. They were asked the following questions.

- What were your initial experiences of teaching using ethnomathematical indigenous games in the classroom?
- How did the learners react to the games played?
- Which games did you use, and for which areas of mathematics did you incorporate them into your teaching?
- Will you continue using the games to teach mathematics? Why?

4.4 Analysis of data

The focus group interview was audio- and video-recorded to facilitate accurate transcription of the data. A verbatim transcription was completed. Thematic analysis was conducted in accordance with the guidelines of Braun and Clarke (2006). This involved reading and re-reading the transcripts to become familiar with the content. A grounded thematic analysis was undertaken, wherein patterns in the data were identified, encoded, and categorised. Subsequently, common patterns were collated into the following themes:

- Bringing in the new: teacher experiences
- Learners' reaction to ethnomathematical games
- Pedagogical improvement
- Integrating mathematical concepts with indigenous games

4.5 Ensuring the trustworthiness of the study

Participant confirmation techniques were employed to ensure the trustworthiness of the study. The same questions were posed to each participant to facilitate probing and verify previous responses. Transcriptions were made verbatim to ensure that what was said was accurately captured. Verification of the data was conducted by the participants themselves to confirm that their statements were correctly recorded. I used thick descriptions to enhance the validation of the data.

4.6 Ethical considerations

Ethical clearance, as part of the broader project, was obtained from the institutional ethics committee (Ref No.: 2020/09/09/90441435/10/AM). The university policy stipulated confidentiality and adherence to the protection of students'/participants' identities before, during, and after the interview sessions. Participants were assigned pseudonyms that they agreed upon, ensuring that they could not be identified in any way. They were provided with letters of permission stating that their participation was voluntary and that they could withdraw at any time. The importance of voluntary participation and the option to withdraw from the study were emphasised during the focus-group interview.

5. Findings and Discussion

5.1 Bringing in the new: Teachers' experiences

The teachers who were interviewed expressed similar feelings of anxiety when they first introduced ethnomathematical indigenous games in the classroom.

Devan responded, "*I was apprehensive at first, but when I looked at how the board game was played, we enjoyed it*."

Even though Devan was worried about introducing the new teaching approach, it seems that once he understood how the game was played, both he and the learners enjoyed it. It can be assumed that the learners were already familiar with the game of Morabaraba, while Devan was the one who needed to learn more about it.

For Paddy, it meant that she had to find out more about the game before she used it in the classroom. She said, "*Initially, when I first started my lesson, I used the Morabaraba and my challenge was I had to go and research the rules and once I actually learned the rules, it helped me with the game.*" So, being comfortable about what the game entails helped Paddy to use it in the classroom. Mary had a similar experience: "*So initially I think for me it was new, it was a new experience, because I myself had not been exposed to indigenous games, so it was a new experience for me, but I had to develop myself so I went on and researched so that I can understand how to play the game. Then I felt confident enough to actually go and to teach the learners*."

Devan, Paddy, and Mary, who teach diverse learners—most of whom grew up playing the games—actually played the indigenous games for the first time.

For Thandi and Sipho, their apprehension was due to classroom control. Thandi said, "*When I first started teaching it, it was not easy organising the classroom, and trying to explain to the principal what is happening because of the noise.*" From Thandi's comment, one can assume that the noise was because the learners were excited about the games. Hence, systematic issues such as poor discipline also led to the participant's fear of introducing the game in the classroom. Sipho went on to say, "*For me, first, I was a bit sceptical, but after you know attending all the meetings, and having the group discussions and you were showing us the way it made things much easier and then when I went home and at school I started taking the kids out, we started playing the games.*" Sipho thus identified that workshops and collaborations are important to present new approaches in the classroom, and to show teachers how effective the games can be.

Lethi was very honest with her comment, "*Honestly, the term ethnomaths, I really didn't know what it was. I had to call another teacher and when we did some research, I thought to myself, how am I going to do this in my Maths class because the perception was maths ……. we want control in our class. We want instruction base, we want it to be done A, B, C, D, so I thought no this cannot be done. I do have a better understanding from where I was in the beginning but not completely, but I am really positive looking at it in a positive manner and exploring more activities with the learners.*"

The indigenous games compelled the teachers to collaborate with others to research how these games could be utilised in the classroom. Such research and collaboration are crucial for prompting teachers to consider how they can engage with learners effectively.

Lethi informed us that mathematics is instruction-based and, therefore, teacher-centred. I gathered from her that mathematics possesses strict boundaries and rules that should not be crossed, and that the games enabled Lethi to perceive mathematics differently – which was the aim of this study.

While ethnomathematics has been advocated as a means to decolonise the approach to teaching mathematics, it is evident from the teachers'; statements that they possess limited knowledge about it. As Lethi exemplified, the teachers seem to view the teaching of mathematics as it was perceived during colonial times. Ernest's (1989) analytical model, which profiles mathematics teachers according to their knowledge, beliefs, and attitudes, is applicable here. One of the three models that Ernest utilised is the instrumentalist model. Lethi's comment places her in this category, as she aligns with Ernest's (1989) description of a teacher viewing mathematics as a useful but unrelated collection of facts, rules, and skills. Many mathematics teachers share this perspective, and Owen (2023) stresses that the influence of Western countries that colonised us has perpetuated the instrumentalist style of teaching (teacher-centred) and continues to significantly influence how we teach mathematics today.We have become so entrenched in a particular way of teaching mathematics, as noted from the

statements of the participants, that any change brings anxiety and stress. Ethnomathematics offers teachers the opportunity to alter their teaching methods and make a positive impact on the lives of their learners. As Freire (1971) argued, critical pedagogy encourages critical thinking and democratic values, and when aligned with mathematics, the idea of ethnomathematics is framed by the theory of critical mathematics pedagogy.

5.2 Learners' reaction to ethnomathematical games

During the focus group interview, the participants were asked, "*How did the learners react to the games played?*" The overall confirmation of excitement indicated the implicit effect of the indigenous games.

Samuel said, "*Learners were so excited, they were just all around the classroom.*" So much so, that Samuel explained, "*They actually took it from my cupboard and try to use it again on their own. Not just to play before the maths lesson, but to use it with the maths concept that I was doing, which was numbers – it was related to that.*" It is evident from Samuel';s comments that actual learning was occurring, as the learners were integrating the Morabaraba game with the mathematical concepts of addition and subtraction being taught at the time. It also became clear that the most popular indigenous game played was the Morabaraba board game, possibly because it was more easily accessible.

Lethi described the reaction of the learners as follows: "*My initial reactions of the learners was excitement. They are like doing something different, they like to touch and to learn, so they were really excited. So, there was a positive reaction. It is an enhancing journey, it will encourage the learners. For me it was really positive.*" Lethi's comment suggests that concrete objects enhance the learners' learning experience and that the pedagogical journey was positive for both the teacher and the participants. Furthermore, familiarity with the game and its cultural significance motivated learners to explore and learn the mathematical concepts inherent in Morabaraba. In the same vein, Moses narrated, "T*he kids were very excited, because it took them out of the classroom, and being in the classroom it is like the same old thing every day, so this was something different, exciting, so they were more enthusiastic.*" For Moses, taking the learners out of the classroom was what the learners enjoyed. It was something different from their normal routine.

The ethnomathematical indigenous games were well received by all the learners in the classrooms of the ten participants in the study. This positive reception was likely due to the connection between their familiar culture and mathematics (D'Ambrosio, 2001). Additionally, games are enjoyable and have a significant impact on the teaching and learning of mathematics (Meeran, 2022; Mosimege, 2016).

5.3 Pedagogical improvement

The participants were able to identify how their teaching and learning methods changed through the use of the indigenous games. As Moses said, "*it took them out of the classroom*". This confirms that mathematics pedagogy does not only have to take place in the classroom. Thandi added, "*As for skipping and all of that, that is a bit difficult to take them outside, but when it comes to internal it is fine, in the classroom.*" The game of Kgati, which one expects to be played outside, can clearly also be used in the classroom. The ways the games are played and used for learning experiences are unique to each teacher. In this manner, ethnomathematics provides a platform for teachers to be creative and make a space for learning to take place in a way that best suits them. One of the participants (Paddy) took the notion of alternative learning even further: "*I actually painted the Morabaraba on the school ground, so during the lunch breaks the children are not just playing, they('re) actually relating the maths to the games. It improved mathematics.*"

Samuel noted, "*The first time we were trying to implement the indigenous games, they were enthusiastic because I started using the Morabaraba. They know Morabaraba, so had so many different rules, so we had to decide what rules we will use as a class.*" The learners were not only familiar with the game – they also

had the opportunity to make decisions about the rules. They were able to take responsibility for their own learning. I say this because the decisions they made about the rules allowed them to apply these rules to the mathematical concepts of addition and subtraction for collaborative learning. Thus, we see learner-centredness emerging, where collaborative decisions are made together with the learners, rather than being imposed on the learners. The shift from how mathematics is normally viewed as being teacher-dominated is evident here. The teacher allowed for the democracy of finding rules together with the learners, so this collaboration shows that the teacher shared the task with the learners rather than enforcing it.

Mary remarked, "*They understand the concept in their own way in terms of being indigenous language which builds on what they have already know(n) and bringing in the new knowledge that they are going to get.*" What Mary was describing was the use of learners'; previous knowledge to grasp new mathematical concepts. The games are played at home, and learners are already familiar with them. Although the terms for the games may vary and are culturally specific, the way the games are played remains consistent.

"*From the first day I started using the games, it created creative thinking for my learners because when I was doing the transformation, just doing the types of transformations then I go to the skipping rope and they played with the skipping rope, I was asking them what kind of transformation are we doing as we are playing? I was surprised because they were giving me, they were giving me the answers, they were giving me all the answers."*

The experience above was related by Busi. Her description is aligned with learner-centred pedagogy. While she was facilitating the lesson, the learners were actively involved in the game of Kgati and were able to provide her with the solutions to rotation and reflection, which were the two mathematical concepts she used when teaching the mathematical content area of Transformations. The learners were able to apply the concept to the games, as the concept of transformation now became concrete, and the learners were able to recognise what they had learnt.

For Sipho, it took some time to make the learners understand the properties of quadrilaterals, as the learners initially just wanted to play for fun: "*I was using Morabaraba to teach the shapes for the first time with them; they didn't see any shape, only the square that they saw. I said no, so I have to go and re-teach the properties of the shapes. Then, after that, they say, oh these are rectangle, because they just played for fun, for the first time. Initially they looked at it as a game only*." What is also noticeable is that the teacher was able to identify the learners' misconceptions. So, even though the learners were playing the game for enjoyment, the teacher could gauge at what level the learners were and devise a way to overcome the challenge.

Devan indicated, "*You know, instead of just straightforward teaching out of the textbook, and hear it first-hand and with concrete objects and things, it really was helpful. It also makes a difference when in terms of testing as well, you know, just doing a normal routine maths and then doing this, ethnomaths, you actually see a change in their marks*." He confirmed that abstract mathematical concepts found in factorisation and transformation become identifiable when using concrete objects. The learners'; marks had improved, just as Samuel had stated previously, so ethnomathematics seemed to be making a difference in Samuel's class, although the study was still in its initial stages.

Putra and Mahmudah (2021), as well as Mania and Alam (2021), stress the positive outcomes of using ethnomathematics in the classroom. Teaching and learning take on a different approach, making education more accessible and enjoyable for the learners. The participants were also rethinking their teaching methods, which demonstrates critical reflection, the cornerstone of the critical mathematics pedagogy theory (Vithal, 2003). Furthermore, Sipho was able to identify the learners' misconceptions thanks to the indigenous game, which also entails critical reflection; he was then able to reteach the concept to orientate the learners. This is the aim of Critical Mathematics Pedagogy—being able to meet the diverse needs of learners in a classroom, thereby including those from lower echelons of

society who are perceived not to progress further with mathematics (Brantlinger, 2014; Buckley, 2010; Vithal, 2003). Furthermore, we can also see Van Hiele's (1973) levels of geometric thinking in visualisation, analysis, abstraction, formal deduction, and rigour. There was insufficient visualisation when learners were learning the properties of quadrilaterals; hence, the game was diagnostic in that it highlighted this problem for the teacher. This was because the learners were taught the properties of quadrilaterals but could not apply them until they could actually see the shape through the use of the Morabaraba game. Consequently, they could visualise and apply the properties of quadrilater.

5.4 Integrating mathematical concepts with indigenous games

Interestingly, the participants were able to link many mathematical concepts with the games.

Moses used the Morabaraba board game in the following way: "*Morabaraba actually worked very well in terms of numbers and counting, and I think in that lesson it worked very well.*" Thandi also utilised the Morabaraba board game. She said, "*So, I was keen on Morabaraba because they enjoyed that. I used counting and grouping. I implemented the rules for the game.*" Both Moses and Thandi employed Morabaraba for counting, which integrates with addition. Thandi also spoke about grouping, which refers to multiplication and division. Although they did not explicitly mention it, it was clear from Thandi';s comments about the rules that the learners were able to use logical deduction and problem-solving by adhering to the rules and finding solutions.

Busi used Kgati to teach transformation. She explained, "*In my second lesson, using Kgati (skipping rope), it linked in so well with my lesson in terms of transformation that I could show them physically what reflection was, rotation and translation*." She further described how she integrated the concepts using a worksheet: "*Yes, they could identify those three concepts so well and, in fact, when I actually linked this to the concept, I just re-pasted it on my own activity because no one showed me whatever, but I could demonstrate, and learners could actually, when I have given them the activity, they could actually draw and show what reflection is; they could identify the rotation; they even went home and did the homework*." Devan also used the Kgati game: "*I did skipping with them, and then I taught them how to count – counting, multiples, multiplication, adding, subtracting, all of those skills, mathematical skills*." Indeed, he was able to integrate quite a few mathematical operations. Lethi agreed: "*Normally our learners do this game with the rope during break on their own, and instead of just jumping up and down over the rope, they were actually doing their timetables on their own*." Lethi also used Kgati for multiplication, while pointing out that the learners were having fun and still learning during the lunch break.

Paddy used the Tsheretshere game (similar to hopscotch) for doubling. She says, "*I remember speaking to them to actually relate with maths, to what they were playing, and I must also share with you the sooner they have these hopscotch rules, the more they were actually using that hopscotch game and doubling*." So, for Paddy, the integration of the mathematics concept of doubling with the Tsheretshere game was simpler when the learners used the rules of the game. Again, we see the teacher reflecting on how to make the integration easier to implement the mathematics concept.

Samuel used the Diketo game (stone throwing and collection). He commented, "*I did the Diketo stones, counting how many, not picking up like three stones, and then the multiples, and teaching them about directions, speed, all of that. I mean what I have done is from outside, brought the lesson back into the class and then taught the concepts to them and using the resources, like charts and worksheets, and all of that, so that made it easier and more fun for the kids.*" Samuel provided a detailed explanation of how he used Diketo, not only for counting and multiplying, but also to teach his learners about direction and speed. He worked with them while they played the games and then introduced the written work in class.

The mathematics teachers in the study demonstrated how they had integrated the mathematics concepts with the games they chose to use. They were able to find many concepts in a single game. This was also attested to by Meeran et al. (2022), Moloi et al. (2021), as well as Mosimege (2000).

6. Conclusions and Recommendations

In response to the first research question, "What were the initial experiences of using ethnomathematical games in the Intermediate Phase?", I found that the teachers were apprehensive because ethnomathematics differed from the usual teacher-centred approach they typically employed. However, the learners were excited about the games, as they were familiar to them. There were positive pedagogical experiences, such as using concrete objects to understand abstract concepts; teachers employing the games as diagnostic tools to identify student misconceptions; learners taking responsibility for their own learning; and the opportunity to use familiar games to learn new mathematical concepts. Regarding the second research question, "How were ethnomathematical games integrated with mathematical concepts in the classroom?", it was found that teachers utilised various games and successfully integrated mathematical concepts such as addition and subtraction, transformation, multiplication, factorisation, and quadrilaterals. The findings confirmed that using ethnomathematics supports a critical mathematics pedagogy in the classroom, as teachers can cater to the diverse learners in their classes through Africanised games that are relevant to the learners'; lives.

The myth that mathematics education should be confined to textbooks and traditional methods, as was instilled during the colonial era, must be re-examined to allow for alternative approaches, such as ethnomathematics, to provide a cultural context for learners to study mathematics. It is, therefore, recommended that policies include ethnomathematical indigenous games in the curriculum and that ongoing workshops and training be established to prepare mathematics teachers in alternative pedagogical practices that promote awareness of social justice and decolonisation. Hence, future research endeavours should focus on sustaining ethnomathematical indigenous games in the classroom.

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