Developing Teaching & Learning in Africa

Decolonising Perspectives

EDITOR
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Chapter Two

Indigenising Mathematics in Schools: Why Ethnomathematics Matters

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Ethnomathematics Changing the Culture of Teaching

The existence of ethnomathematics is a testimony that mathematics is not only from the Western epistemology. Katz (1994) argues that numerous mathematical ideas “grew out of the needs of various cultures around the world, it is vitally important that students in Western nations be exposed to the fact that mathematics is a universal phenomenon”. Mathematics grew out of the needs of the various kinds of people around the world over centuries. Additionally, Katz (1994:26) explains:

The mathematical ideas to be considered developed out of specific needs in the cultures involved and although the ideas were not developed by people we would call ‘mathematicians’, all of these concepts were explored further, either in the original civilization or in later ones, far beyond the immediate context of the original problem. Students also learn in this way, by beginning with the consideration of a specific problem and then following the ideas further to try to answer new questions [...] It is vitally important that modern curricula, particularly at the secondary level, the level at which most of the ideas here are first introduced, incorporate materials like the ones presented in order to broaden our students’ understanding not only of mathematics but of the world in which we live.

Eurocentrism has denied ethnomathematics its rightful place among other knowledges as learners in many African schools are underachieving in mathematics. Gerdes (1994) also contends that the current African education is elitist and tends to favour foreign knowledges. African classrooms are not using what Zaslavsky (1973) referred to as sociomathematics, which may be considered a forerunner of ethnomathematics. Gerdes (1994) traces the history of mathematical activity

in Africa and postulates that women were the first mathematicians, as they had to keep their cycle using the lunar calendar. Gerdes cites Zaslavsky who traced mathematics back to Ishango (the present day Zaire). Zaslavsky presented a bone dated between 9 000 and 6 500 BC that was used by the Ishango people to tally as it had notches as well as tallying marks. There were also several small mathematical instruments used by the San in South Africa around 3 500 BC. Gerdes also cites Bogoshi and others research which was reported in 1987 after they had discovered an older mathematical artefact. Gerdes (1994:348) quotes Bogoshi:

A small piece of the fibula of a baboon, marked with 29 clearly defined notches, may rank as the oldest mathematical artefact known. Discovered in the early seventies during an excavation of Border Cave in the Lebombo Mountains between South Africa and Swaziland, the bone has been dated to approximately 35 000 BC. They note that the bone “resembles calendar sticks still in use today by Bushmen clans in Namibia”.

The passion for mathematics can be traced in indigenous games around Africa long before the advent of the Western hegemony. African traditional games across the Continent demonstrate that indigenous people have used mathematics from time immemorial. Experts have questioned the reason why schools in Africa in particular do not use indigenous mathematics to enhance performance in mathematics. Forbes (2018) claims that there is alarming underperformance in mathematics worldwide and conscientious teachers and parents have searched for better pedagogical practices. Mathematics has the potential to marginalise many students who do not find their culture reflected in that learning area.

Furthermore, in an age of social justice education and inclusion, ethnomathematics is ideal because it expresses a relationship between mathematics and culture (Forbes, 2018). In line with social justice principles, the teaching of ethnomathematics introduces the idea of culturally sensitive teaching strategies. Around the world, research has shown how indigenous learners are failing mathematics because of alienating nature in classrooms. Forbes (2018:16) argues, “For example, the low achievement of indigenous (native, Aboriginal) students in comparison to their non-native counterparts within Canada and other countries such as Australia, America, and New Zealand is associated with a disconnection between indigenous and Western ways of knowing”. Tylenda (2015) cites Bremigan who also emphasises that ethnomathematics enables teachers to relate mathematical knowledge with their learners; furthermore, in classrooms the teachers can help learners make connections between mathematics and the world that surrounds them. This then means that when teachers are professionally developed to incorporate various

cultures into mathematics education, they will be encouraged to engage their learners in effective and meaningful relevant mathematical instruction (Tylenda, 2015). Francois (2009) states that initially ethnomathematics was reserved for the nonliterate people. However, today some Western classrooms have found it necessary to respond to cultural diversity occurring in every classroom (Francois, 2009). Ethnomathematics has been necessitated by the existence of classrooms that embrace ethnical, linguistic, gender, social and cultural diversity (Francois, 2009).

Sunzuma and Maharaj (2019) point out that geometry and culture are interrelated, and this makes school geometry linked to environment as well as culture in which it is taught. In fact, Sunzuma and Maharaj claim that teachers should not avoid geometry and that learners perform badly in mathematics because teachers have a lack of content knowledge. This chapter examines why ethnomathematics is crucial for (South) African schools today. Some of the subtopics that will be discussed are, Ethnomathematics – A Methodology for Decolonisation; Critical Indigenous Theory; Teaching Ethnomathematics; Challenges of Integrating Ethnomathematics; and The future of Ethnomathematics in South African Schools.

Ethnomathematics – A Methodology for Decolonisation

Colonial education marginalised African methodologies in all learning areas with no recognition of the fecundity of the traditional or indigenous cultures. Teacher education programmes ought to realise the potency of ethnomathematics in an attempt to decolonise mathematics. Schools around the world have become so heterogeneous as families migrate continuously. Shirley (2001:85) opines, “Intracontinental migration brings newcomers to African schools, east Asians and Latinos, in schools where sometimes as many as twenty languages are spoken by the students”. Like other countries of the world, South African schools are fast reflecting the diversity found in various African societies as families from numerous African states gravitate towards South Africa for economic reasons. Learners in numerous South African schools can speak up to 15 African languages. This means a richness of culture and history that has a potential to enhance teaching methodologies of learning areas, including mathematics. Such classrooms lead to diverse environments that is enhanced by a variety of values and cross-cultural communication. In such classrooms, teachers need to be open-minded and understand that mathematics is not the property of the West (Shirley, 2001). In ethnomathematics classrooms, the following are critical:

- o Multiculturalism,
- o communication,
- o connections, and
- o innovative teaching strategies such as traditional games.

Shirley (2001) highlights the first three and we have observed the last one on traditional games in South Africa. Below the focus is on each of the factors above.

Multiculturalism and Ethnomathematics Classrooms

Shirley (2001) argues that multiculturalism has become critical in diverse classrooms. Shirley adds that mathematics textbooks around the world use multicultural themes in expositions, examples, and regular exercises. The history of mathematics has magnified its scope to include mathematics from non-European sources. All these are aspects that teacher education programmes need to include. Multiculturalism is an effective concept to describe education that incorporates histories, cultures, texts, and practices. Ethnomathematics gleans from these various qualities. Multiculturalism can be perceived as a form of transformation in education, an education that seeks to include rather than exclude. Furthermore, the multicultural idea behind ethnomathematics alludes to equity and social justice in the teaching and learning of mathematics. School mathematics is likely to show more fragmentation in education as it specifically supports Western-oriented mathematics.

Gay (2004) asserts that a multicultural education boosts academic success and prepares learners for roles as productive citizens. Teachers in effective, diverse classrooms should use multicultural content to teach reading, mathematics, science, and social science (Gay, 2004). Furthermore, Gay (2004:33) argues:

For example, teachers could demonstrate mathematical concepts, such as less than/greater than, percentages, ratios, and probabilities using ethnic demographics. Younger children could consider the ethnic and racial distributions in their own classrooms, discussing which group's representation is greater than, less than, or equal to another's. Older students could collect statistics about ethnic distributions on a larger scale and use them to make more sophisticated calculations, such as converting numbers to percentages and displaying ethnic demographics on graphs.

The circumstances in these multicultural classrooms will enable the teachers to stimulate learners to use critical analyses during lessons as they appreciate different cultures. Gay also adds that in developing a curriculum for multicultural classrooms, two categories of curriculum development are critical, and these are reality/representation and relevance.

Communication in Ethnomathematics Classrooms

Shirley (2001) contends that there is much necessity for learners to communicate mathematics thinking vividly in multicultural classrooms. Shirley (2001:86) cites the National Council of the Teachers of Mathematics (NCTM), which argues that programmes should enable learners to “communicate their mathematical thinking coherently and clearly to peers, teachers, and others”. Furthermore, Shirley avers that teachers should encourage the participation of all learners and underscore the importance of every learners’ contribution to the learning process. Analysing what others say is critical in ethnomathematics classrooms. Widada, Herawaty, Yanti and Izzawati (2018) state that learning mathematics needs the learners to communicate effectively and this includes verbal as well as written communication. Looking closely at Widada et al.’s model of learning mathematics, these authors point out that “learning with an ethnomathematics-based realistic mathematical approach has been able to improve mathematical abilities, including mathematics communication” (Widada et al., 2018:881). In enhancing communication, the learners in multicultural classrooms will communicate or interact with one another. The learners can start with the local environment as a beginning of learning because local culture makes it easy for learners to engage in horizontal mathematizing (Widada et al., 2018). Widada et al. (2018) also point out that realistic learning model based on ethnomathematics helps learners in abstraction, idealisation, and generalisation.

Connections drawn in Ethnomathematics Classrooms

Making connections in ethnomathematics refers to finding links within mathematics, between mathematics and other subject areas, looking at mathematics as a learning area that is part of the learners’ everyday experience (Shirley, 2001). Le Roux (2002) emphasises the need for teachers to be culturally competent communicators. Effective ethnomathematics teaching will make teachers to be sensitive to several aspects, which include intercultural knowledge and mutual enrichment between culturally diverse learners. Ethnomathematics teachers ought to have the knowledge of culture to be effective in classrooms so that they could be able to make connections between mathematics with culture.

Anderson-Pence (2016) declares that teachers should always help learners make connections between different factors of mathematical thinking. This then means that opportunities presented for learners’ learning play a critical role in advancing mathematical competence (Anderson-Pence, 2013). Mathematics

should find these connections otherwise it will be divorced from real life – this interferes with meaningful problem solving. Naresh (2015) also maintains the need for a mathematics curriculum to empower learners through the promotion of meaningful connections designed between ethnomathematics theory and practice and demonstrate how this curriculum can help address the key areas of a critical ethnomathematics curriculum. Naresh (2015) also mentions several important connections in ethnomathematics classrooms and these include connections between culture, context and mathematics; mathematical tasks and local or global contexts; as well as contexts between everyday mathematics and academic mathematics.

Games as Innovation in Ethnomathematics Classrooms

Nkopodi and Mosimege (2009) state that it is important to include games when learning about mathematics, especially ethnomathematics. Nkopodi and Mosimege also maintain that learners find it easy to communicate in mathematics classrooms and this may work well in multicultural classrooms as well. Ethnomathematics and its rich methodologies are found in the community ceremonies and rituals, in story-telling, proverbs, folktales, recitation, demonstration, sport, reasoning, riddles, praise, songs, word games, puzzles, tongue-twisters, dance, music, and other education-centered activities (Ngara, 2007).

Games provide an opportunity for teachers to give learners a platform to present common games they play at home, bring them into the classroom, allow learners to play them then later introduce a topic that has concepts and relate them to those found in the games. In that fashion, learners will be able to understand the content in lessons since it will speak to their cultural background. According to Bruner (1990), constructivists encourage children to constantly use prior knowledge to understand new and complex experiences and information, which they scaffold into unique knowledge structures.

Before Rome, when there was no Greece and Europe was still in the stone age 4 500 years ago, Africans were practicing mathematics and making it part of their daily lives. For instance, countries in Southern Africa have mathematics that is imbedded in peoples' cultural practices. Such mathematics is in textile technologies, beadwork, rock art, mural art, and indigenous games. In South Africa, according to Grine, Henshilwood and Sealy (2000), the oldest ethnomathematical artefact is the red ochre which is engraved with geometric designs at Blombos outside Cape

Town, South Africa, dating between 80 000 and 100 000 years. The discovery at Blombos shows that the Sotho Africans were the first to invent the concept of symbolic behaviour, symbolic thought, and symbolic logic. Ethnomathematics can be further seen from the beadwork and mural art of the Ndebele, which is expressed, as symmetrical geometry. The Ndebele people started using symmetrical geometry as a way of communication after they lost the war to the Dutch speaking Boers in 1849-1883, and it is known that this was an instruction from the gods of the cosmos to use the geometric shapes as a form of communication. Since the 19th century, symmetrical geometry has been used for cultural significance in the Ndebele culture and used for communication, spiritual purposes, and symbolism.

Ethnomathematics amongst the Ndebele continues to be visible in their indigenous games. These indigenous games are common in other cultural groups of South Africa and they are identified with different names. Indigenous games like *diketo*, *morabaraba*, and *moruba* have an ability to teach people social skills and mathematics. It is estimated that the history of indigenous games in South Africa dates back to before the 19th century and the history of all games practiced in different ethnic groups differs with time. Indigenous people of South Africa have been migrating on the continent for decades and were separated from their initial cultural groups over time due to unavoidable external factors like weather conditions and colonialism, which makes it difficult to trace when they started practicing indigenous games. Over the years, indigenous games in South Africa have been used as tools of solving problems, counting, and tracking time by the old and young. Therefore, indigenous games have a potential to create a spontaneous interaction amongst learners as they communicate their activities to fellow participants. Interestingly, these games is that they are not restricted to a specific cultural group, which suggests that they can be used in a multicultural setting (Nkopodi & Mosimege, 2009).

Critical Indigenous Theory and Ethnomathematics

In an era of decolonisation there is more awareness about theories that challenge the Western ways of knowing and conducting research to position the indigenous people who have been denied power. Critical indigenous studies also have a potential to offer accounts of the “contemporary worlds of the indigenous people that centre our ways of knowing and theorizing” (Moreton-Robinson, 2009). Critical indigenous theorists use challenging and innovative writing and apply questions that concern our communities (Moreton-Robinson, 2009). Martinez (2015) cites

Brayboy who writes about critical Indigenous Knowledge Systems (IKS) and anti-colonial principles focused on the needs of communities. Indigenous values and knowledges guide the indigenous research paradigm. Martinez (2015:63) highlights Brayboy's key principles of critical indigenous research (CIRM). These principles are:

1. CIRM is rooted in Indigenous Knowledge Systems, is anti-colonial and is distinctively focused on the needs of communities.
2. CIRM is rooted in relationships, responsibility, respect, reciprocity and accountability.
3. Research must be a process of fostering relationships between researchers, communities and the topic of inquiry.
4. CIRM recognises the role of particular components that make it viable for communities.

Critical indigenous research, like Critical Indigenous Theory, alludes to communities and the focus is on community needs. Some have posed questions as to what the concept indigenous knowledge refers to. Lanzano (2013) states that this is contested and usually presents more contradictions than answers. Lanzano (2013:4) also points that the introduction of the concept indigenous knowledge was linked to "traditional and local knowledge. Anthropologists who were trying to ensure that there is recognition of cultural difference first used it". There has in many instances the subordination of indigenous knowledge to Western knowledge. Critical Indigenous Theory seeks to address such anomalies. Ermine, Sinclair and Jefferey (2004:29) state:

However, the continuing attempts to formulate research that is respectful to Indigenous Peoples still conform to the fundamental Eurocentric orientation of fitting Indigenous knowledge into Western frameworks and interests [...] Research conducted into Indigenous spaces, as a legitimized process of academic freedom, is seen as problematic process of ethics for Indigenous Peoples because of the latent biases, inherent misconceptions, and outstanding issues of power and control.

As pointed out above, D'Ambrosio (2001) posits that ethnomathematics expresses the relationship between culture and mathematics. D'Ambrosio (2001) goes on to separate the definition of *ethno* and *mathematics* when he points out that the term *ethno* describes "all of the ingredients that make up the cultural identity of a group: language, codes, values, jargon, beliefs, food and dress, habits, and physical traits". Mathematics expresses a "broad view of mathematics which includes counting, arithmetic, classifying, ordering, inferring, and modeling". Many educators may be unfamiliar with the term, yet a basic understanding of it allows teachers to expand their mathematical perceptions and more effectively

instruct their students. D'Ambrosio (1985) posits that ethnomathematics is the mathematics practiced among identifiable cultural groups such as national-tribe societies, labour groups and professional classes.

According to Naidoo (2010), for a long time in South Africa, mathematics has been considered as abstract, the result of a Western curriculum structuring that separated Ethnomathematics as a discipline from individuals' regular day-to-day existences. This approach to the classification of mathematics and ethnomathematical knowledge has had negative effects on how indigenous South African students learn and relate with mathematics in the school curricular. It is argued that the social cognition and intelligent behaviour of Africans lies in capturing shared routines and participatory learning, rather than in completing school-based instruments (Nsamenang, 2006). South Africa's National Curriculum Statement of 2005 and the current Curriculum Assessment Policy Statement (CAPS) fails to spell out comprehensive strategies for the proper integration of multi-cultural mathematics in mathematics lessons in schools. This status quo has contributed to the negative perceptions amongst educators and students thereby resulting in cosmetic changes to the integration process.

Furthermore, rural and economically disadvantaged communities fail to see the link between school mathematics and their reality. Rural communities have well-knit and solid cultural activities which possess intricate and diverse mathematical concepts, and as such, these cultural activities should be part of the curriculum in order to accommodate learners who are well rooted in the diverse cultures of South Africa. The guidelines of the National Council of Teachers of Mathematics (NCTM, 1991) highlighted why it was important to build integration between the daily life of a learner's culture and concepts taught in mathematics lessons. This approach has been seen by Rosa and Orey (2006:34) as effective as they affirmed "when practical or culturally-based problems are examined in a proper social context, the practical mathematics of social groups is not trivial because they reflect themes that are profoundly linked to the daily lives of students". Rosa and Orey (2011) further argue that culturally relevant mathematics curriculum should concentrate on the role of mathematics in a socio-cultural context that involves the ideas and concepts connected with ethnomathematics, utilising the ethnomathematical point of view for tackling contextualised problems that learners encounter in the learning process.

Naresh (2015:451) declares, “Ethnomathematics need to be used to advocate the ideals of culturally relevant Mathematics education”. Ethnomathematics should be included in the mathematics curriculum as its approaches are intended to make school mathematics more relevant and meaningful to the learners’ environment and cultural persuasions at large. In this point of view, if mathematics is considered as a cultural construct, then it becomes a product of cultural growth. It is indeed necessary to incorporate a culturally relevant curriculum in the existing mathematics curriculum. This point of view is an important component of making education culturally relevant and even goes further to provide decolonised content in the curriculum that has recently been a rallying point in higher education discourses across South Africa. Such an approach proposes that teachers should contextualise mathematics learning by relating mathematical content to learners’ culture and real-life experiences/situations.

Teaching Ethnomathematics

Teaching mathematics will be a challenge to teachers who were taught that it is only (Western) mathematics that matters. Apart from training in the application of ethnomathematics, they would also need a paradigm shift. To teach about the connection between culture and mathematics – teachers need to believe in it. This means that teachers should be able to mediate learning in diverse classrooms. All teachers who teach children from indigenous, indigent backgrounds should be able to understand the lack of social capital, their home life, their mother tongue, and culture to be able to understand how these learners can be effective in Mathematics classrooms. In this chapter, we have highlighted how Ndebele children can glean from their culture whose decorations and art are geometric. Sieman et al. (2012) underscore the need to appreciate the mathematics of non-Western peoples and how this has led to transformational geometry. All teachers should understand the role of various cultures to mathematics as they seek culturally responsive pedagogy. Meticulous educators will be able to teach mathematics in context and this can enhance the quality of learners understanding. Mullan (2015) lists four crucial factors that can be incorporated in ethnomathematics in the classrooms:

- o Create an indigenous perspective for lessons.
- o Integrate mathematics into a history lesson on culture.
- o Demonstrate mathematics from different cultures to show learners cultural differences in teaching and learning mathematics.
- o Demonstrate various cultural counting and number systems (e.g. Egyptian hieroglyphics number system).

Effective teachers will be able to rouse the interest of learners in mathematics as they demonstrate how it reflects culture thus raising awareness of its connectedness to the learners' lived reality. Teachers who use ethnomathematics can lower the learners' fear of mathematics. Yet, it is not always easy for teachers to incorporate ethnomathematics in their classrooms for several reasons. Sunzuma and Maharaj (2019) discovered in their study that there were major challenges that teachers encountered as they tried to teach geometry elements using ethnomathematics. The challenge teachers encountered included the following: lack of knowledge on ethnomathematics, approaches and how to integrate these approaches into the teaching of geometry; teachers' views of geometry taught in schools; teachers' competence in teaching geometry; teaching and professional experience; as well as resistance by teachers (Sunzuma & Maharaj, 2019:1). Therefore, as we contemplate the introduction of ethnomathematics subject advisors from districts should strategise ways in which mathematics teachers' pedagogy can be developed to be able to include ethnomathematics. This will require many to learn to unlearn their traditional ways of viewing mathematics as an unbending Western learning area. The infusion of ethnomathematics would help numerous teachers to be inclusive and learner-centred. They will also be able to appreciate learners' differences.

To overcome the challenges similar to the above, teachers should embrace critical pedagogy expatiated in several chapters in this volume. There is also a need to understand the nomenclature because this might bring ideas on how to utilise ethnomathematics in a progressive pedagogy in classrooms. Orey and Risa (2007) cite Gerdes who lists a number of concepts that express the nature of ethnomathematics and what they refer to as school mathematics. The concepts are: indigenous mathematics, socio mathematics, informal mathematics, spontaneous mathematics, oral mathematics and oppressed mathematics, hidden or frozen mathematics (Orey & Rosa, 2007). These authors state that Gerdes points out that all of these concepts are united under the huge concept – D'Ambrosio's ethnomathematics. Some of these concepts from various experts can help teachers understand the essence of ethnomathematics because they are themselves self-explanatory. They show the decolonial visage of the nature of ethnomathematics. Furthermore, teachers need to understand that school mathematics in ethnomathematics loses its purity. Ethnomathematics is a combination of mathematics, cultural anthropology and mathematical modeling (Orey & Rosa, 2007).

Teachers should always keep in mind the potential of ethnomathematics in raising the learners' self-worth, creativity, and enhancing cultural dignity (D'Ambrosio, 1990). Orey and Rosa (2006) state that educational processes should not hold learners in old ways of thinking such as idealising only Western knowledge systems. Orey and Rosa (2006:66) maintain that the process of introducing ethnomathematics is likely to succeed if ethnomathematics:

- o looks forward not backward; that is ethnomathematics as an expression of contemporary thought, is not just a recording of historical ideas and practices; and
- o assumes a sophisticated knowledge system because it is not just mathematical skills and drills.

Yet, Orey and Rosa (2006) are aware of some of the challenges of ethnomathematics curriculum and these include absence of university ethnomathematics course, for teachers and the danger of ethnomathematical being taught as 'folkloristic and primitivist' thus different from school mathematics.

South African Policies and the Integration of Indigenous Knowledge in Mathematics Lessons in the Foundation Phase

The CAPS curriculum (DoE, 2011) aims at ensuring that learners acquire and apply knowledge and skills in ways that are meaningful in their own lives. In this regard, the curriculum promotes the idea of grounding knowledge in local contexts and supports the indigenous approaches to be integrated in the school curriculum. This policy is training to build the fact that there are many ways of knowing. This policy highlights that learners must be exposed to the history of mathematics and indigenous knowledge from other times and cultures. Indigenous Knowledge Systems have their origin in different worldviews. The curriculum should accommodate different cultures in which indigenous knowledge were developed.

The IKS policy 2004 ensures that the national education strategy is synergistic with nurturing of indigenous knowledge. In the development of new Curriculum statements, there have been a strong drive towards recognising and affirming a critical role of indigenous knowledge. The IKS policy emphasises the relevance of having learner-centred curriculum because such a curriculum gives value to learners, previous knowledge, exposures and considers child as the center of interest, which is the most natural approach. The drafted Indigenous Knowledge Systems Bill of 2016 promotes public awareness and understanding of indigenous knowledge for the wider application and development in South Africa. The arts

and culture policy 2002 highlights that in the foundation phase, the arts and culture learning area should be integrated in all three programmes – numeracy, literacy and life skills. This policy promotes public awareness and understanding of indigenous knowledge for the wider application and development.

Challenges of Integrating Indigenous Knowledge in the Mathematics Curriculum

Naidoo (2010) states that policy makers have failed to develop a curriculum that clearly include IKS concepts that can be used in different schools. According to Grange (2012), calls for the integration of indigenous knowledge in school curricula are not peculiar to South Africa but also in all countries where knowledge systems were subjugated and displaced by colonial authorities. These calls have been made for education to include the different knowledge systems, and that the curricula to be designed in a way that acknowledge knowledge perspectives and languages of Indigenous peoples (Khupe, Keane & Cameron, 2012).

There are challenges of including different or competing knowledge systems in the curricula. One of the challenges is that there are hardly any noticeable practical steps taken by the Department of Basic Education regarding IKS integration in the school curricula, implementation has been left up to the teachers (Moyo, 2011). The visible absence of indigenous knowledge-related assessment undermines the position of indigenous knowledge as an underpinning principle of the curriculum (Gundry & Cameron, 2008).

Furthermore, Lebakeng (2014) argues that the South African teachers have been inundated with frequent curriculum changes, and this has caused problems coping with all of them. “The valuing and inclusion of IK [indigenous knowledge] is probably one of the ‘smaller’ curriculum changes that teachers can afford to ignore, especially when exams over the years have not singled it out as important” (Lebakeng, 2014). These challenges outlined here diminish the role of indigenous knowledge in learning in the classroom. The failure of integration of indigenous knowledge in the curriculum can be apportioned to the use of English as one of the only two languages of instruction other than Afrikaans. According to De Klerk (2006), “The medium of instruction, English, has been a contributory factor also, with only 0.4% and 1.0% of the population of Limpopo and Mpumalanga respectively being able to communicate in English”. The colonial and apartheid systems enforced monolingualism and a type of bilingualism, which favoured English and Afrikaans, while African languages were denied space to operate in official domains (Ndimande-Hlongwa & Ndebele, 2017:67).

South African legislation and education policy does not endorse which of the 11 official languages ought to be used as a language of instruction. The language policy statement leaves the decision to choose the language of instruction to school governing bodies, which are contained by a parent majority and additionally the school principal. As of now, most schools in which many learners are not L1 English or L1 Afrikaans speaking, choose to use their First Language in foundation phase and after that progress to English as the language of instruction in the fourth grade. This approach, however, though not overly mandatory, has been encouraged by the provincial departments of education. A few schools, nevertheless, have gone 'Straight-For-English' as the language of instruction from the first grade. The Curriculum and Assessment Policy Statements (CAPS) additionally endorses that in some schools, English ought to be the language of instruction, while in other schools Afrikaans is considered the language of instruction.

In spite of this, the fact that most of the learners in the school do not use English as their home language (DoE, 2011), the language policy still has to be upheld and this jeopardises learner concept formation from an early age. Subsequently, most schools use English medium as the language of instruction and this further alienates students from their mother tongue from as early as Grade 1. In schools, learners with an African home language have essentially continued to perform at worse than to those who have English as their home language.

In higher education institutions where teachers are trained, they receive their education and training based on Eurocentric approaches that trivialise their cultures and knowledge. The learners taught by these teachers are unfamiliar with the Western approaches of teaching and learning since they are from African cultural background. This fact is clearly illustrated by Gerdes (2009) who cites that the Kpelle people of Liberia who attended Western-oriented schools where they were "taught things that have no meaning within their culture. As such, it was difficult to comprehend the Mathematics taught". In most cases, this can result in the development of negative attitudes towards the subject, because it has no relevancy to learners' environmental experiences. Moloi (2016) elaborates further that the challenge that is faced by Mathematics teachers is that the culture of the teachers differs from that of learners.

Masola (2010) concurs with Moloi (2016) by pointing out that most of these teachers have been instructed to use mathematics textbooks, which are written in the European languages, style and illustrations. It is argued that some of the examples given in school textbooks are difficult to understand because the context

in which they are composed is new to both the educator and the learner (Masola, 2010). Some of these Mathematics educators neglect to think of the systems that can help learners to comprehend mathematics concepts, principles and build critical thinking and consequently we have the high failure rate in mathematics in South African schools.

It is one of these reasons that mathematics teachers should attend and understand the culture of their learners so that their teaching will be embedded in the culture of their learners as a means of enhancing the teaching and learning of mathematics. Therefore, there is a need for mathematics of Africa, which is embedded in culture to be part of the content in mathematics books (Lebakeng, 2014). This means that also having textbooks written in African languages will ensure that mathematics is firmly grounded within their environment of the learners (Gerdes, 2009). Furthermore, Masola (2010) suggests that teachers should capitalise on the background of learners for performance to be enhanced; children meet mathematical concepts every day and operate in rich mathematical contexts even before they set their eyes on a Mathematics worksheet.

The Future of Ethnomathematics in South African Schools

The introduction of ethnomathematics is one strategy that should be seen not only addressing decolonisation but also an attempt to redress past imbalances in South African education. The uneven unequal education disadvantaged blacks who were generally the underperformers in mathematics and science. Macrae (1994) traces the crisis in mathematics from apartheid legacy. "The legacy of apartheid for mathematical education includes the subordination of ethnocentric considerations to Eurocentric traditions and the exclusion of the majority of the population from access to and participation in the mathematics-related professions" (Macrae, 1994:271). In fact, right from its inception, apartheid education was meant to illustrate that black people would not have the same education as their white counterparts. The largely Eurocentric nature of education alienated many learners who would have benefited in studying through a system that also embraced the local content.

Macrae (1994) points out that underperformance in mathematics is evident in all levels of the South African society from primary school to higher education. Annually, South Africans see how grade 12 learners struggle in mathematics and the huge challenges are in historically black schools. Numerous schools still

have underqualified and unqualified mathematics teachers. There are very few black people in mathematics related professions and this is a manifestation of underperformance of learners at school. More than two decades after apartheid's demise, blacks are still few in the mathematics related professions.

Macrae (1994) also writes about how learners who fail mathematics become alienated to the subject and this means that the society loses from such an anomaly. The apartheid effect in South Africa is making it difficult to implement ethnomathematics to uphold a positive pedagogy for apartheid deskilled many black learners. Macrae (1994:278) contends:

In proposing social approaches to numeracy, Castle (1992) warns that in South Africa a mathematical agenda has now been set by race and culture, where Eurocentric mathematics is deemed valuable and superior and 'the mathematics generated in African cultures is considered inferior or negligible' (p. 14). Unfortunately, although questions about connections between aspects of numeracy and prevailing social conditions are easy to formulate, they are difficult to answer.

Ethnomathematics in South Africa could play a role in democratising mathematics. Among these are to consider the use of indigenous languages in the teaching of mathematics. Furthermore, more focus should be on content of mathematics. Brodie (2016) argues that experts should consider curriculum processes such as critical thinking, problem solving, and the issue of identity. The introduction of ethnomathematics is a positive move to transform mathematics where learners are able to critique mathematics for example "how algorithms structure our lives in ways in which reproduce inequality" (Brodie, 2016). The alienating manner in which mathematics has been presented to many people has made them not see its potential to transform the society.

South Africa's history of divisive, racial and, oppressive education may glean from the methodologies of pedagogies that seek to include those who were excluded in the past. However, several researchers have been opposed to the introduction of ethnomathematics for several reasons (Rowland & Carson, 2002; Horsthemke & Shafer, 2006). Domite and Pais (2009) point out that Horsthemke and Shafer maintain people should not politicise science, for mathematics like science, have very little to do with social justice. Laws and principles govern these. Rowlands and Carson as cited by Domite and Pais (2009:1475) claim that "rationality may be the preserve of an oppressive cultural system but that does not necessarily mean that rationality is in itself oppressive". Furthermore, the paradox of ethnomathematics raised by Horsthemke and Shafer (2006) is that the manner in which ethnomathematics applied into South African schools contributes to

the exclusion of learners rather than inclusion. They find that African learners or blacks may be excluded from studying school mathematics as their backgrounds are magnified in classrooms. Vithal and Skovsmose (1997) also maintain that ethnomathematics cannot work with the realities in South Africa. They state that the concept is itself problematic although it has achieved the purpose of establishing an understanding of mathematics and mathematics education as culturally and socially negotiated. Vithal and Skovsmose (1997) also question the debate on culture when it comes to ethnomathematics. The idea of infusing culture in mathematics is not necessarily leading to harmony in the classroom. Furthermore, in South Africa with its strong history of apartheid, concepts of culture, ethnicity, and race are enmeshed with potent divisive connotations (Vithal & Skovsmose, 1997).

Yet Domite and Pais (2009) point out that people should not merely regard ethnomathematics with ethnicity; they concur with ethnomathematics critics that ethnomathematics should not be only an emphasis on local knowledge and the valorisation of the learners' background. Domite and Pais (1997) point out that the challenge may be the school itself; schools as we have them today may not be ready for ethnomathematical methodologies. Domite and Pais (2009:1481) opine:

Preparing students to become participants in a society is also preparing them to assume critical points of view about society, different ways of thinking, acting and doing mathematics. Using the words of D'Ambrosio, we need to emancipate students by learning academic mathematics, but also by reinforcing its roots. If we analyse the role of school in modern societies, this is obviously a paradox.

Therefore, despite the insightful criticism against ethnomathematics, one cannot disavow the usefulness of ethnomathematics despite these contradictions and paradoxes. As we phase in ethnomathematics, we need to introduce new paradigms in schools where learners and their teachers will learn to embrace innovations in education as they change their view of schools and curricula. As pointed out above, there is some evidence from research, which specify that including cultural content within the curriculum will benefit learners because such cultural aspects contribute in the recognition of mathematics as part of daily life, enhancing the ability to make meaningful connections, and deepening the understanding of mathematics (Bishop, 1988).

In this regard, Chieus (2004) states that "the pedagogical work towards an ethnomathematics perspective allows for a broader analysis of the school context in which the pedagogical practices transcend the classroom environment because

these practices embrace the sociocultural context of the students". Damazio (2004) concurs with this perspective and suggests that the pedagogical elements necessary to develop the mathematics curriculum which are found in the school community. Therefore, the field of ethnomathematics provides some possibilities for educational initiatives that help to reach this goal.

It is assumed that an ethnomathematically-integrated curriculum motivates learners to recognise mathematics as part of their culture and "enhances students' ability to make meaningful mathematical connections by deepening their understanding of all forms of mathematics" (Rosa & Orey, 2011:32). The objective of developing an ethnomathematical curriculum model for classrooms is to assist students to become aware of how people mathematise and think mathematically in their cultures, to use this awareness to learn about formal mathematics, and to increase their ability to mathematise in any context in the future (Rosa & Orey, 2006). This ethnomathematical curriculum leads to the development of a sequence of instructional cultural activities that enables students to become aware of potential practices in mathematics in their culture so that they are able to understand the nature, development, and origins of academic mathematics (Rosa & Orey, 2007).

At the global level, it has become increasingly imperative that indigenous knowledge take centre stage in key development trajectories. Both the World Bank and United Nations have intimated the importance of indigenous knowledge in development issues in local communities for the enhancement of sustainable development. In South Africa, there are diverse indigenous cultures which are embraced differently. Including such cultures in the curriculum should be the priority of policy makers. The current curriculum policy needs to be carefully assessed and examined on whether it accommodates the diverse ethnomathematical cultures of South Africa. This will assist in developing critical ideas on how to improve future school curriculum policy statements. There is a call for the South African curriculum to accommodate learners who are from indigenous background (Gay, 2000). Such a curriculum will allow learners to value and appreciate their own indigenous mathematical knowledge, which will permit them to understand and experience these cultural activities from a mathematical point of view.

Conclusion

This chapter demonstrates how ethnomathematics can help bring historically marginalised learning areas in classrooms. The current education demands the inclusion of all learners as well as their reality in classrooms. Ethnomathematics

will not only address decolonisation and indigenisation; it also includes diversity and social justice. Ethnomathematics is critical because it infuses cultural aspects, which are sometimes manifested by mathematical artefacts of various groups. The discussion has also revealed how the use of concepts are related to the learners' cultural and daily experiences thus making it easy for the learners to elaborate meaningful connections and deepen their understanding of mathematics (Rosa & Orey, 2011). Evident in the research cited above, is that ethnomathematics can enhance understanding for African learners who struggle in mathematics classrooms. The Ndebele art geometric shapes can help Ndebele learners in understanding geometric concepts and angles. Ethnomathematics enables the learners to develop their intellectual, social, emotional and political learning as they use cultural referents (Rosa, 2011).

The role of ethnomathematics is huge when one examines decolonisation. For many centuries mathematics, like other sciences has been presented as a neutral subject; Western values have taught us that the facts in mathematics cannot be bent. Yet ethnomathematics demonstrates that mathematics is not value free and is influenced by cultures. Indigenisation of learning areas such as ethnomathematics opposes the Eurocentric view of mathematics in traditional classrooms as reflected by Western hegemony. Culture influences mathematics as does language. Ethnomathematics shows that cultural factors and the environment are bound to influence that way teachers teach and how learners learn mathematics.

Teachers who teach ethnomathematics should be prepared to see their subject as a decolonising approach that seeks to centre marginalised aspects of curriculum. Teachers in initial teacher education programmes as well as in-service teachers should learn about the methodologies of ethnomathematics and experiment ways that would liberate the mathematics learners.

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