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Integrating Indigenous Knowledge and Culturally based Activities in South African Mathematics Classrooms

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Abstract

Culturally based activities embedded within indigenous knowledge, in general, may be used to support the teaching of mathematics in multicultural classes. The article reflects on research that has been conducted with twenty-five post-graduate students studying Mathematics Education at one university in KwaZulu-Natal, South Africa. These post-graduate students were also practicing mathematics teachers at schools. The study explored the use of indigenous knowledge and culturally based activities by post-graduate students in schools while teaching mathematical concepts. The theory of Realistic Mathematics Education framed this qualitative, interpretive study which used a questionnaire, lesson observations and semi-structured interviews to generate data. Qualitative data were analysed inductively and thematically. The findings reveal that the participants needed to understand indigenous knowledge to integrate culturally based activities in mathematics lessons. Secondly, culturally based activities established on indigenous knowledge scaffolded mathematics lessons and promoted the understanding of mathematical concepts to make learning more meaningful and relevant. Thirdly, this study provides examples of good practice to support teachers in integrating classroom activities and activities outside the classroom, ensuring that mathematical concepts learned in classrooms are not done in isolation but take into account learners' authentic experiences in various settings. Finally, by integrating indigenous knowledge and culturally based activities in the mathematics curriculum, learners interacted and engaged more freely within the educational context. Similar studies could be conducted at universities internationally. Implications for mathematics teachers, mathematics teacher educators and mathematics curriculum developers globally are discussed.

Keywords: culturally based activities, curriculum, indigenous knowledge, integration, mathematics, teachers

Introduction

Before the advent of democracy[1], learners were exposed to an apartheid[2] regime (Naido, 2006); mathematics and science were not considered important subjects for Black, Indian, or Coloured[3] learners to pursue. Thus, most learners in South Africa experienced a substandard education system (Khuzwayo, 2005). Hence mathematics and science were seen as the gatekeepers to upward social mobility whereby global participation was encouraged for the privileged White race group. With one National Curriculum, all South African learners are required to learn the same mathematics regardless of the school they are attending, the colour of their skin or the background from which they come. The National Curriculum and Assessment Policy Statements (CAPs) creates a hurdle for learners who are not exposed to English as their home language or learners who rely on indigenous knowledge in their daily lives.

In South Africa, poor learning outcomes and dismal performance in mathematics (Moloi, 2013) appear to be immune to remediation. Adopting a democratic orientation to governance in the country and implementing numerous curriculum changes have not halted the recurring history of failure over the past two decades (Spaull, 2013). Many attempts have been made to improve educational outcomes: building more schools, improving amenities and access to schools, in-service training programmes, and redesigning the curriculum. However, the gains in black schools continue to be marginal. Statistics indicate that pass rates are improving, but the pass rate is disappointing when quality is factored in (Spaull, 2013). Unequally resourced schools (Adler, 2013) and inadequately qualified teachers (Sapa, 2013; Talbert-Johnson, 2006) are associated with poor learner performance. Also, impoverished home conditions (Kotze & Strauss, 2006), large class sizes (Khuzwayo, 2005) and second or third language learning (Alexander, 2005; Setati & Adler, 2001; Setati, 2005; Vandeyar, 2003) is associated with poor learner performance in mathematics.

Literature supports integrating culturally based activities and indigenous knowledge within school curricula (Bogopa, 2012; Mosimege, 2003; Paraide, 2005). These studies have

[1] Democracy refers to a form of government in which power is vested in the people and exercised directly by the people under a free and fair electoral system. A democratic society is characterised by the equality of rights and privileges for all people in that society.

[2] Apartheid was a system of racial segregation in South Africa enforced through legislation by the ruling National Party from 1948 to 1994. Under apartheid the rights of the majority Black inhabitants were partial and Afrikaner White minority rule was maintained.

[3] The apartheid legislation classified the people of South Africa into four racial groups: Black, White, Coloured and Indian.

exhibited the positive effects of teaching and learning through the use of culturally embedded activities. For example, Mosimege (2003) has shown that mathematical games embedded in local knowledge enhanced the teaching and learning of mathematics. In a study by Kaya and Seleti (2013), the power of using local expertise in promoting positive learning outcomes was revealed. As is evident, by considering the implications of blending culturally based activities and indigenous knowledge in education, teachers may create a platform for learners to construct knowledge that is meaningful and relevant to their lives (Van Wyk, 2002).

Additionally, research (Govender, 2019; Khupe, 2014; Moji & Hattingh, 2008; Mudaly & Ismail, 2013; Van Wyk, 2002) focusing on the strengths of integrating indigenous knowledge within science classrooms has been conducted. These studies have illustrated that learners successfully learned and understood complex science concepts and processes by drawing on indigenous knowledge in the science classroom. Furthermore, research (Bogopa, 2012; Moloi, 2013; Mosimege, 2003; Mudaly, 2018; Nkopodi & Mosimege, 2009) has been conducted on the use of indigenous knowledge and indigenous games in mathematics classrooms. Based on the findings of these studies, learners were more enthusiastic and motivated when drawing on indigenous knowledge to learn complex mathematical concepts. Other research (Moloi, 2013; Nyaumwe, 2006; Paraide, 2005; Seehawer, 2018) has exhibited that learners are exposed to educational contexts that are relevant by integrating indigenous knowledge within the school curriculum to their lives, thereby enriching teaching and learning. Nevertheless, there is still a need to explore if other forms of culturally based activities could be integrated with the mathematics curriculum to support mathematics learning. Hence, this study aimed to respond to the main research question: How is indigenous knowledge and culturally based activities integrated into South African mathematics classrooms?

Exploring Culturally based Activities

Educational contexts are fluctuating (Anthony & Walshaw, 2009; Pyper, 2017) due to teachers who are diverse in their backgrounds and learners who are diverse in their experiences, culture, needs and aptitudes. If teachers want to improve learner performance, there is a need to ensure that educational contexts and instruction are relevant to the learners. One way of doing this is to incorporate culturally based activities when necessary to complement the value added to education (Moloi, 2013). The growing need for educational access for all leads learners to expect the use of culturally based learning experiences within their educational contexts (Offorma, 2016).

Culturally based activities are embedded within the learners' culture (Doganay, 2013) to make lessons meaningful (Hand, 2012). Within diverse educational contexts, culture is an important component to consider. Culture has many definitions and affects everything one does in society. Due to the diverse nature of society, there are many cultures in one society. Thus culture is not necessarily genetically inherited, but it is a shared meaning of values, beliefs, attitudes and behaviour by members of a society (Idang, 2015; Imada, 2008; Matsumoto, 2007). The participants in this study included culturally based activities embedded in learners' indigenous and prior knowledge during their lessons. These activities were relevant and meaningful to the learners within their classrooms, enhancing learning (Moji & Hattingh, 2008).

Linking Mathematics Education, Indigenous Knowledge and Culturally based Activities

Mathematics is practised by all cultures as a human activity (Moloi, 2013), particularly in the 21st century, where classrooms are diverse concerning learning styles, race, culture and ability levels. Mathematics teachers must draw on a range of resources to support the development of mathematical concepts within their educational contexts (Anthony & Walshaw, 2009; Lipka et al., 2005; Umugiraneza, Bansilal, & North, 2018). One such resource is the use of prior knowledge. Including previous knowledge in any curriculum is important to bridge the gap between formal concepts and processes with concepts and processes learners already know (Moji & Hattingh 2008). Including culturally based activities within the classroom assists in exposing the value of culture to learners (McGlone, 2008; Samuels, 2018). Different mathematical concepts identified in various culturally based activities can be related to geometry and algebra in mathematics (Nkopodi & Mosimege, 2009). Research (Mosimege, 2003) has shown that most indigenous people are aware of mathematical concepts, for example, estimation, symmetry, patterns and geometry, since these concepts are used in various cultural artefacts[4] and activities. Artefacts are important tools that may link what is taught in formal contexts with what exists outside these formal contexts (Kaino, 2013).

Indigenous knowledge (IK) is the knowledge that is local and exclusive to a specific culture or society and is considered as valued knowledge by researchers in the field (Mosimege, 2003; Nkopodi & Mosimege, 2009). The interest in indigenous knowledge is growing internationally and nationally (Paraide, 2005). Nationally, policy documents have motivated for the inclusion of indigenous knowledge in the teaching of mathematics (Moloi, 2013).

[4] Artefacts in this study refer to cultural or historical objects made by people.

Internationally, research conducted in Alaska (Barnhardt, 2005); sought to restore a traditional sense of place while simultaneously widening and developing the educational experience for all learners. Other international research (Bruchac, 2014; Lilley & Paringatai, 2013; McGloin, Marshall, & Adams, 2009; Smylie et al., 2003) conducted in the United States of America, Canada, New Zealand and Australia; focus on understanding and debating the use of indigenous knowledge. These studies were conducted to show how indigenous knowledge increased learner participation, performance and interaction within classrooms.

At the same time, research (Kaino, 2013; Nyaumwe, 2006) conducted in parts of Africa; focused on using traditional artefacts to complement traditional and modern knowledge during teaching. In these African-based studies, mathematical concepts, such as numeric patterns, geometric patterns, and geometry concepts, were taught and consolidated through culturally based activities. These studies suggested that the successful teaching and learning of these mathematical concepts was enhanced by using learners' prior knowledge embedded within their culture. These studies illustrate how indigenous knowledge may be structured to demonstrate the relationship to mathematics school topics.

Moreover, research (Bogopa, 2012; Govender, 2019; Khupe, 2014; Moji & Hattingh, 2008; Moloi, 2013; Mosimege, 2003; Mudaly & Ismail, 2013; Mudaly, 2018; Nkopodi & Mosimege, 2009) has shown that integrating indigenous knowledge in the curriculum has had a positive, supportive role in both science and mathematics education. These studies have shown that learners can relate what they experience outside the classroom to concepts taught in class through indigenous knowledge. These studies have exhibited that when learners' traditionally acquired knowledge was valued in a formal educational context, they were more enthusiastic about learning new ideas and concepts linked to their prior knowledge. This approach to teaching means that learners reflect on traditional prior knowledge to enhance the learning of concepts taught in class (Kaino, 2013). In this way, learners feel that they are active contributors rather than passive receivers (Naido, 2006). Thus, using culturally based activities in mathematics classrooms increases the meaning and relevance of mathematical concepts for learners (McGlone, 2008).

Similarly, research within mathematics education has focussed on the use of games embedded within indigenous knowledge. However, there is a need to interrogate the use of culturally based activities more substantially within mathematics education. As is the case in science education, researchers (Khupe, 2014; Moji & Hattingh, 2008; Mudaly & Ismail, 2013)

have shown that tapping into learners' traditional knowledge of concepts, procedures and processes have complemented the learning of school science topics. So too, many multifaceted culturally embedded processes and procedures could complement the learning of school mathematics topics. For example, while embedded within African culture, basket weaving or hut building activities also incorporate ideas of school mathematics. These school mathematics topics include length, geometry, symmetry, volume, area and measurement. Thus, this article aims to enhance awareness of how post-graduate students used culturally based activities to strengthen mathematics teaching within their classrooms.

Using Realistic Mathematics Education as a Theoretical Framework

Realistic Mathematics Education (RME) is a framework for the teaching and learning of mathematics. Based on mathematics instructional theory and curriculum, this pedagogical framework was initially introduced and developed by the Freudenthal Institution in the Netherlands in the 1970s (Hirza, Kusumah, & Zulkardi, 2014; Stemn, 2017). RME uses real-world contexts to encourage and stimulate the effective teaching and learning of mathematics to become pertinent within the educational context (Arsaythamby & Cut, 2014). Thus, the principles of RME focus on the need for mathematics to be relevant and realistic to be of value to learners (Van Den Heuvel-Panhuizen, 2003).

The need to demonstrate the importance of learning mathematics is significant. For this to occur, mathematics teachers need to be encouraged to develop the necessary pedagogic skills required to relate mathematics and the specific educational context within which they teach (Barnes & Venter, 2008). So too, learners need to be encouraged to construct meaningful mathematical knowledge. Hence, within the ambits of this theoretical framework, the educational context requires supporting learners' active involvement in constructing significant mathematical knowledge instead of the passive acquisition of mathematical information (Stemn, 2017). Similarly, RME is entrenched in the understanding of mathematics as a human activity. Learners need to be provided with the opportunity to rediscover mathematics by creating real-world situations or mathematical associations and procedures that have meaning for them (Cobb, Zhao, & Visnovska, 2008). Hence, within the domains of RME, mathematical knowledge is viewed as a human construction. Mathematics learning is regarded as a cultural creation that advances from several activities (Cimen, 2014).

The RME framework was significant in this study since the participants valued indigenous knowledge, authentic, real-world contexts, games and cultural artefacts to

encourage learners to learn mathematics. The use of real-world objects and contexts that are familiar to learners can support the learning of mathematics (d'Entremont, 2015). The use of authentic indigenous games within the teaching and learning process allows learners to experiment with and combine regular processes and number skills in an encouraging educational context that is neither intimidating nor uninteresting (Barnes, 2005).

Research Methodology

This qualitative, interpretive study explored post-graduate students' integration of culturally based activities in mathematics classrooms. The interpretive paradigm is strengthened by observation and interpretation and attempts to understand phenomena through the meanings one assigns to them (Cohen, Manion, & Morrison, 2011). Thus, each participant's responses were interpreted to make meaning of the data produced. The study included a questionnaire administered to post-graduate students, lesson observations and semi-structured interviews to generate qualitative data. The study was based at one university in KwaZulu-Natal (KZN), South Africa. The participants were post-graduate mathematics education students and were also mathematics teachers at schools in KZN. Each participant differed concerning age, race, gender, teaching experience and professional development. Forty-two post-graduate mathematics students were invited to participate in the study. Twenty-five post-graduate mathematics students responded positively to the invitation. Eight participants were selected at random to participate in the pilot study, and for the main study, the remaining 17 (nine females and eight females) participated. The teaching experience of each participant varied from 5 years to 14 years of teaching at schools within different social contexts.

Issues of Ethics

Gatekeeper access was obtained from the participating university's research office. Each teacher who registered for a post-graduate programme in mathematics education (2014-2019) was informed about the processes involved in the study. The right to withdraw without prejudice from the study at any time was explained to all participants.

Data Generation

The questionnaire comprised section A which required the participants to provide their biographical data. Section B of the questionnaire consisting of four questions revolving around indigenous knowledge and the use of culturally based activities within the mathematics classroom. After analysing each questionnaire, ten participants were invited to participate in lesson observations and interviews. The ten participants were purposively selected because

they met various criteria. These criteria included context, teaching experience, professional development and pedagogic strategies used. Additionally, based on an analysis of the questionnaire, each selected participant had the knowledge, skills and experience of using culturally based activities in their mathematics classroom. The participants who were observed teaching and who were subsequently interviewed are shown in Table 1.

Table 1: Participants who were observed and interviewed

Number	Name	Number of years of teaching experience	Present qualification
1.	Collin	9	Honours in Education
2.	Dean	14	Master's in Education
3.	Fatima	8	Honours in Education
4.	Indira	6	Honours in Education
5.	Lungi	8	Honours in Education
6.	Musa	8	Post Graduate Certificate In Education
7.	Pam	11	Bachelor of Education
8.	Themba	9	Bachelor of Education
9.	Wanda	13	Master's in Education
10.	Xolani	10	Honours in Education

The lesson observations focussed on the different culturally based activities the participants used in their classrooms. Subsequently, a semi-structured interview was conducted in a location selected by each participant. The choice of the location was planned so that each participant would be at ease. Each interview started with similar questions, followed by questions probing individual responses to culturally based activities in the mathematics classroom. Each interview lasted approximately 45 minutes.

Data Analysis

The qualitative data gathered was analysed using thematic coding. Interviews and lesson observation schedules were transcribed, and data were coded into themes. Data analysis in the

form of coding and categorising themes was based on the study's theoretical framework, i.e. Realistic Mathematics Education (RME). The relationship between the data generated and real-world contexts to support the teaching and learning of mathematics within the educational context (Arsaythamby & Cut, 2014; Van Den Heuvel-Panhuizen, 2003) were examined. Data analysis included the following steps: firstly, open coding was used to ensure acquaintance with the data and classify codes after inspecting the qualitative data; secondly, all data were perused, and codes were processed into themes. The data that were related to each other were grouped into themes. Thirdly, the themes were scrutinised to warrant that all codes within each theme revealed a connection. Finally, member checking was undertaken to confirm the findings' accuracy and provide participants with the chance to clarify their responses.

Findings

Based on the data generated and analysed, it was noted that all participants used indigenous knowledge to develop culturally based activities for their respective lessons. Based on the analysis of lesson observation schedules and interview transcripts, five main themes were identified. The themes are reflected as follows.

Participants Understanding of Indigenous Knowledge

All participants exhibited knowledge of indigenous knowledge (IK) and reflected on how this knowledge assisted them in developing culturally based activities for their mathematics lessons. Collin indicated that IK is

> *. . .local knowledge possessed by a particular [people] group in a specific area. . . [which is] . . . not learned at school. . . .[and is] . . . passed on from generation to generation…*

Indira mentioned the value of IK for teaching and learning as

> *. . . undocumented knowledge used by different people [groups that is] passed to the next generation [and that] is related to one's culture [and they] can be helpful in [planning] lessons. . .*

Indigenous knowledge is perceived to be knowledge gained from experiences, as claimed by Lungi,

> *. . . [IK is] learned from the culture and traditions over time. . . [It is knowledge taken from the experiences of people and their interaction with the environment. . .*

Musa maintained that indigenous knowledge is important and relevant for contemporary classrooms as it was

> *. . .used in the past by our ancestors. . .[and is] still applicable in our classrooms. . .*

Pam supported the notion that IK instilled good values and morals, that IK helps in

> *. . .understanding the world through folktale, games and drawing. . .[and in] inculcating morals and values. . . .[IK is] knowledge unique to a culture. . .*

These findings are significant since they reveal the participants understanding of IK. Based on their knowledge of IK, the participants valued and encouraged the use of IK in their mathematics classrooms. This exhibited that the participants believed that using IK supported the teaching and learning of mathematics.

The Importance of Using Indigenous Knowledge in the Mathematics Classroom

The participants were observed using indigenous knowledge (IK) in the classroom during the lesson observations. The use of IK assisted in making the mathematics being taught more understandable to the learners, as indicated by Collin,

> *[using] examples with indigenous knowledge [in the class room]…engage[s] learners [and helps learners to] apply the knowledge in the academic context. Beadwork can be used to study patterns in mathematics. The counting of cattle using stones [is another example of how IK can be used in the classroom]*

Each participant developed and used culturally based activities established on IK to supplement the lessons being taught, as is evident in Dean's response that

> *. . .learners from different cultures. . .share their knowledge. . .this helps with understanding…*

Lungi supported this view and provided an example from her teaching,

> *. . .when teaching geometry. . .indigenous knowledge [is] used [as a] starting point. Learners share their traditional knowledge. [When] teaching them new applications for maths in life, [we discuss] shape and structure of dwellings. [Examples of IK we discuss includes] Indian rice art as well as henna [and] African games. . .*

Moreover, Pam used IK when introducing new topics in mathematics

> *I use IK to introduce new topics. . . [We use] African games, Dibeke, Morabaraba. . .*

Wanda used IK to show the link between IK and school knowledge

> *. . .to demonstrate lines of symmetry, tessellations, properties of 2D and 3D objects [and] to link [with] school knowledge. [I show] the relevance of mathematics. . . [i.e., that] maths is all around us. [We discuss the] traditional ways of telling time [by using IK] games. . .*

For these participants, it was important to use IK to support their teaching of mathematics. In addition, the participants made the mathematics being taught relevant and fun for their learners by using IK games and real-world examples of what learners experience in their contexts.

The Importance of Integrating Indigenous Knowledge in the Mathematics Curriculum

The participants agreed that integrating indigenous knowledge in the mathematics curriculum assisted in teaching key mathematical concepts. This is evident in Xolani's response,

> *[IK] must be incorporated in teaching and learning, [Using IK] help[s] learners and teachers to start from what they know to [move] to the unknown. . .*

The participants acknowledged the importance of introducing sections with the knowledge that learners already possessed. Indira remarked,

> *it [using IK] can open the mind of the learner. . . mathematics is not foreign. . .we usually do [mathematics] in our everyday life . . . [I] start from the known and then move to the unknown. . .IK is the building block of our day to day learning*

Collin also indicated that

> *the class was more talkative [interactive] because they knew the mathematics being taught. . .*

The responses from the participants provided valuable information on the importance of integrating IK in mathematics classrooms. The findings showed that using IK bridges the gap between existing knowledge and new knowledge. Moreover, a more interactive and engaging mathematics educational context emerged by integrating IK in the mathematics classroom.

Using Indigenous Knowledge to Develop Culturally based Activities for the Mathematics Classroom

Each participant developed their own culturally based activities when teaching mathematics. Collin reported,

> *my class is aware of how their family counts the village cattle using stones…I came up with a class task based on this way of counting. . .I extended this activity to discuss place value and placeholders in algebra…*

Fatima valued the use of IK games and indicated,

> *[In the classroom we discuss]many indigenous games that [the learners] are aware of. . . .We use this knowledge to formulate our class activities together. . . .I used this when teaching measurement. . .*

Lungi used indigenous art and other resources to support her culturally based activities for mathematics

> *African art have lots of mathematics. . . .[In class, we] use pictures and videos when looking at and comparing the properties of different maths shapes in the classroom. . .*

Pam used indigenous jewellery when teaching geometry activities:

> *African and Indian jewelry [we] use . . . as our basis for discussing the orientation and naming of geometry shapes or patterns in mathematics. . . . Sometimes, they [the learners] bring things from their own home . [Our] discussions [are] based on these objects. . .*

What was evident from the findings was that using IK to develop culturally based activities supported the teaching and learning of mathematics. Through the use of these activities, mathematical concepts were not abstract; they became meaningful. Mathematical concepts became more relevant, and learners linked everyday objects embedded in their culture with the mathematics taught.

The Benefits of Using Culturally Based Activities in the Mathematics Classroom

The ten participants (See Table 1) were observed teaching in their classrooms. Subsequently, each of these participants was interviewed. The interview focussed on the participants' use of culturally based activities in their teaching of mathematics. What was evident was that the use of learners' own examples and experiences assisted in the understanding of mathematical concepts. Collin explained that

> *examples were provided by the learners. . .place value and place holders were discussed. . . different size stones were used. . .to show tens and units. . .We discussed how beadwork is done [by] identifying patterns [and]developing rules for number*

> *patterns in maths. . .[The whole] class participated [and]they understood the content and related [them] to their own experiences. . .*

IK and culturally based activities in the mathematics classroom were appreciated since learners could relate to what was being taught because they had prior knowledge of this content. Dean used cultural objects that learners brought from home to support the teaching and learning of mathematics. He indicated that

> *learners discussed geometric patterns and shapes [and] line of symmetry. . . . [they] rotated the shapes on a Cartesian Plane [they] translated [and] shapes were transformed. . . . [L]earners could identify with the concepts [by] using their examples and their artefacts. . .*

When teachers used real-world examples founded in the learners' cultural contexts, there was more interaction in the mathematics classroom. This notion is supported by Themba

> *[We discussed] how they plant and how they know when to plant. . . .I gave them problems to solve based on using time in mathematics. . .*

In addition, games embedded in culture was beneficial when teaching concepts in data handling in mathematics. Fatima indicated that

> *for the data handling lesson, the class provided examples of their games. . . . Rules were explained by the learners, tally tables were introduced to record scores, [and] the final scores for each team were tabulated, and then graphed by using a bar graph. . .*

Using culturally based games is equally important when teaching problem-solving in mathematics. Lungi indicated

> *they [learners] like playing their own games [for] problem-solving in maths. . . . They first played the game [and] then worked on writing down steps for problem solving. . . . The contexts of each problem were also relevant to the class; real-world contexts were used. . .*

Pam similarly used culturally based games for teaching measurement in mathematics. Pam reported:

> *we spoke about hopscotch. [This game helps with] judging distances and measuring. . .[Hopscotch] relates directly to measurement in the curriculum. . . .[The whole] class could relate to the maths content, [hence,] they were active in the lesson. . . . We moved*

to a discussion on area and perimeter of the geometric shapes that are used when playing hopscotch. . .

From these findings, it was evident that there were benefits to using culturally based activities in mathematics classrooms. Culturally based activities supported the teaching and learning of mathematics and encouraged an interactive mathematics educational context. Through discussions founded on culturally based activities, learners related their existing knowledge to new knowledge. In this way, the abstract nature of mathematical concepts was removed, mathematics became meaningful and relevant to these learners.

Discussion

The qualitative findings provide evidence of the integration of culturally based activities in mathematics lessons by post-graduate students. Firstly, to integrate culturally based activities in mathematics lessons, the participants needed to understand indigenous knowledge. In this study, the participants understood indigenous knowledge and culturally based activities. They valued the use of learners' prior and indigenous knowledge in the classroom so that the mathematics being taught was realistic and relevant to the learners (Hand, 2012; Moloi, 2013). Thus, these participants embraced the views of RME by focusing on using practical, real-world examples embedded within the learners' culture as they taught mathematics (Van Den Heuvel-Panhuizen, 2003). Secondly, the participants acknowledged the importance of using indigenous knowledge in the mathematics classroom since they used culturally based activities established on IK to support the teaching and learning of mathematics. This notion is supported by research (Doganay, 2013). The use of activities embedded in the learners' culture promotes understanding concepts and makes learning more meaningful (Hand, 2012).

Thirdly, the importance of integrating indigenous knowledge and culturally based activities in the mathematics curriculum allowed learners to interact and engage more freely within the educational context. This social interaction supported the learners' active involvement in constructing meaningful mathematical knowledge instead of passively acquiring mathematical information (Stemn, 2017). The learning of mathematics became realistic and relevant for the learners. Mathematical knowledge became a social construction, and mathematics learning was a cultural creation that progressed from several interactive activities (Cimen, 2014). Fourthly, the participants discovered that using indigenous knowledge to develop culturally based activities for mathematics supported learners in mathematics learning. Culturally based activities enriched the meaning and relevance of

mathematical concepts for the learners (McGlone, 2008). Also, it was evident that by constructing culturally based activities, the participants had the necessary pedagogic skills to make mathematical concepts relevant for their learners (Barnes & Venter, 2008). Finally, the benefits of using culturally based activities in the mathematics classroom assisted learners in demonstrating aspects of their culture that were relevant to each mathematics lesson. Learners felt valued because the teacher actively involved them when choosing examples to use in the class. The culturally embedded games assisted learners in demonstrating aspects of their culture that were relevant and realistic to each mathematics lesson. Similarly, research (Nkopodi & Mosimege, 2009) has shown that integrating indigenous games in the classroom supports the teaching and learning of mathematics.

Conclusion

This qualitative, interpretive research was conducted at one university in KwaZulu-Natal, South Africa. Participants were observed teaching mathematics and were subsequently interviewed to respond to the main research question: How is indigenous knowledge and culturally based activities integrated into South African mathematics classrooms? Participants in this study understood what indigenous knowledge meant; they valued integrating indigenous knowledge in the mathematics classroom and curriculum; they successfully developed culturally based activities for mathematics. Also, participants appreciated the benefits of using culturally based activities in the mathematics classroom. What was apparent in each participants' classroom was that their learners were actively participating in the lessons. Additionally, the learners worked collaboratively during each lesson.

The findings of this study have implications for mathematics teachers, teacher educators and curriculum developers. Further studies on a larger scale for exploring the integration of culturally based activities in mathematics classrooms are needed. Opportunities for future research could include qualitative studies conducted at several universities within different provinces in South Africa. Similar studies could also be conducted at universities internationally. Further quantitative studies could also be undertaken nationally and globally to explore the integration of culturally based activities in mathematics classrooms. This would be beneficial for increasing the knowledge base in the field in South Africa and globally.

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