



Mathematics teachers' knowledge of indigenous games in teaching mathematics

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Abstract

The purpose of this study was to explore junior high school teachers' knowledge and the impact of indigenous games in teaching basic mathematical concepts. The researchers employed the qualitative phenomenological design to address the purpose, objectives and research questions. The accessible sampling was used to sample 70 teachers (65 males, 5 females) for phase one of the study. Out of 70 teachers, five (three males and two females) were purposively sampled for the study's second phase. Two instruments, a semi-structured interview guide and an observation checklist were used to collect data. The data was analyzed thematically to reflect the research questions. The findings of both phases revealed that most teachers had adequate knowledge of indigenous games and knew the impact of indigenous games on students' learning of mathematics. In particular, the observation checklist showed that some teachers still adhered to the traditional approach (a direct teaching method) and required the knowledge of indigenous games to enhance their teaching skills and techniques. Therefore, in-service training, workshops and other continuous professional development should be organized to update teachers' knowledge on the effective use of indigenous games in the teaching and learning of mathematics.

INTRODUCTION

Research Akayuure & Ali, (2016) and Mpofu, (2016) has shown that the cultural placement of an educational system is probably the most appropriate way in modern educational development in the undeveloped part of the world. Therefore, mathematics teaching must be related to the cultural and geographical context. Moloi (2015) note that indigenous games are part of indigenous knowledge systems. International world organizations have recently established these indigenous knowledge systems as a top global priority for empowering traditional and local communities in their quests toward sustainable development. Chahine (2011) opines that the over-marginalization of the contributions of indigenous communities to the development of mathematics and scientific knowledge remains a threat to the teaching and learning of mathematics. When one considers the nature of mathematical knowledge and who produces it, one will enter into an ambiguous realm of doubts. This historical reduction has been partly due to a rather limited view of what counts as mathematics on the one hand and to a lack of understanding of living indigenous practices on the other hand. Harmonizing indigenous community knowledge with contemporary ideas in our formal education should be the best method and technique for teaching mathematics (Machaba, 2013).

Ali (2021) contends that many developing countries have indigenous resources that could be explored to teach mathematics. However, little literature has been conceptualized, concretized and indigenized mathematical conceptions. Games as indigenous resources are

usually viewed from the narrow perspective of play, enjoyment and recreation. Even Moloi (2015) outlines how indigenous games create meaningful and practical situations for applying mathematical skills. Since most children enjoy playing games, they could unintentionally develop intrinsic motivation for mathematics through these indigenous games. Games have the potential to demystify mathematics as an abstract and a challenging course of study (Nabie, 2011). This also addresses Mutema's (2014) concerns of making mathematics classroom activities exclusively abstract, remote and mostly detached from the children's experiences. For effective teaching and learning of mathematics, efforts should be made toward reintroducing and reincorporating culturally informed mathematics (ethnomathematics). Thus, adding African mathematics into the educational curricula and boosted by the modern technological knowledge are borne out of the indigenous knowledge systems (indigenous games) (Dewah & Van Wyk, 2014). This technological knowledge has been metamorphosed into digital knowledge in online teaching and learning (Akayuure, 2021). This makes teaching and learning more fun and enjoyable (Kazima, 2013; Moloi, 2013).

The introduction of indigenous or cultural games in the 1987 education reforms was deliberately intended to help transform and contextualize mathematics teaching and locate mathematics instruction in the social domain of the child (Nabie, 2015). The 2020 educational reform policy document repeated the inclusion of indigenous knowledge and artefacts in the teaching and learning of Mathematics (Ministry of Education, 2020). These moves aimed at contextualizing mathematics within students' socio-cultural domain seek to make mathematics more meaningful and relevant. These have underscored the potential of games and located mathematics within the social domain of the child as alternative instructional tools for classroom interactions (Nabie, 2011). These eventually impact several socio-economic issues, such as African identity, cultural diversity, education and training, accessibility to resources, international relations and economic growth (Tachie & Galawe, 2021).

Moloi (2015) opines that although the idea of using indigenous games to teach mathematics is not familiar to most basic mathematics teachers, they need to be encouraged to utilize learners' culturally related games as a vehicle for learning to make education relevant and meaningful. So, using indigenous games to teach mathematics would not only arouse the child's interest but also demystify the perceived difficulty of learning mathematics. This devastating effect of not using indigenous games has the potential of always resurfacing its ugly heads on generations yet unborn.

The study was anchored on Piaget's constructivist theory to help understand how mathematics teachers teach children to actively construct new knowledge and make meaning from their co-constructed knowledge. Knowledge is constructed through accommodation and assimilation. When individuals assimilate, they incorporate the new experience into an existing framework without necessarily changing it, and accommodation is the process of reframing one's mental representation of the external world to fit new experiences (Piaget, 1983). In particular, the study was situated on Vygotsky's (1978) social processes between people (inner psychological) and then inside the child (intra-psychological). In this Vygotsky's perspective, learning as a social activity is the collectivity, communication and social rationality (Amr, 2012). As applied to indigenous games, students may seize the opportunity to analyze, think critically, synthesize, and arrive at a meaningful solution.

Even though there exist quite several indigenous games and the fact that many of these indigenous games play a significant role in the academic development of the child (Nabie, 2011), it is not too clear how many teachers know the use of these games and how the games impact on the teaching and learning of mathematics. The study aimed to explore how junior high school mathematics teachers know the indigenous games and how the games impact teaching basic mathematics. This purpose activated the following thought-provoking research questions:

1. What knowledge do mathematics teachers have of indigenous games?
2. How do indigenous games impact the teaching and learning of mathematics?

METHODS

The Design

The present study sought to explore teachers' knowledge of indigenous games to teach mathematics and how the indigenous games impact students' learning of mathematics. Specifically, the qualitative phenomenological design was adopted. The phenomenological design describes the relations between the phenomena that mathematical concepts represent and the concepts themselves. The design allowed the researchers to transcribe students' accounts and transform mathematization approaches into procedural, conceptual, and dual processes (Ali, 2020). In this design, data were collected and analyzed in two phases. After that, data on qualitative variables were collected and analyzed through teachers' descriptions of their knowledge of using indigenous games for teaching and learning. This design strengthened the research and made the results and findings more credible, reliable and valid (Kumar, 2016).

Participants and Context

The participants consisted of 70 teachers (65 males, five females) professionally trained mathematics teachers who were selected based on their access to the researchers in phase one. After that, the number was scaled down to 5 (three males, two females) teachers who were purposively selected based on their own interesting and captivating responses.

Data Analysis

The phase one data based on teachers' knowledge of indigenous games were transcribed and analyzed. These descriptions of statistics emerged from three themes. Phase two data based on the impact of indigenous games on students' learning outcomes were equally categorized according to three themes to reflect on research question two and the purpose of the study (Ormston, Spencer, Barnard & Snape, 2013). In both analyses, the researchers ensured a systematic process of coding, categorizing and interpreting data to provide clarifications about the research questions.

Ethical Considerations

The researchers abided by numerous ethical considerations in carrying out this research. First and foremost, permission was sought from the Department of Education, where the teachers were the primary respondents. Afterwards, each teacher was contacted to consent to participate in the data collection. The researchers assured the teachers of non-disclosure of information on their data. The following important ethical considerations were considered:

1. *Voluntary Participation*: Voluntary participation on the part of those requested to be part of the data gathering process will be sought after. Participants were informed that they could voluntarily leave the project whenever they chose to, which was without penalty.
2. *Informed Consent*: The researcher sort for the participants' consent. This included the district education director and school heads. In this case, they were informed of the research and how they could participate.
3. *Confidentiality and Anonymity*: Confidentiality and anonymity were assured in the researcher's and the participants' contracts. For this study, the participants were allocated code names as Teacher 1, Teacher 2 and so on.
4. *Providing Feedback*: Feedback regarding the results and findings of the research was given to the study participants. For this study, as soon as the results were certified as valid, the participating teachers were informed of the study's outcomes.

RESULTS AND DISCUSSION

The Results of the Research

1. Research Question One: *What knowledge do mathematics teachers have of indigenous games?*

Interviews were conducted on 5 (three males, two females) teachers who were purposively selected to gain in-depth knowledge and understanding of their knowledge of indigenous games and were used in the mathematics classrooms to augment the teaching and learning process. For confidentiality purposes, pseudonyms such as Teacher 1, Teacher 2 ..., and Teacher 5 were used throughout this work. Three themes were prominent in this research question. These were the commonest game, commonest topics and use of the game.

On commonest games, participants were asked to mention some common indigenous games and describe how they can be used to teach any named topic(s) in mathematics:

Teacher 5: *You know, the structure of the gollaa takes several shapes, such as; squares and rectangles. So, as a mathematics teacher, you can ask students to measure the length and breadth of these shapes using a tape measure or other instruments. The teacher can later guide students to calculate, for example, the area and perimeter* (Source: Teachers 5).

On the commonest topic(s), participants were further probed to name one commonest topic the game could be used for, and the following statements were transcribed:

Teacher 4: *Arrrrr] to use the game gollaa to teach the concept of probability, just ask two or four students who know how to play this game to decide between or among themselves who will play first. You will notice that they will compete among themselves to determine who will play first. As a teacher, you ask them why they are competing. They will say that you, the first to play this game, have more chances of winning several "wives or die" as all the spaces would be available to him/her. Hence the concept of probability can be introduced or built at this stage. In short, the first player would have all the boxes 8/8 at his or her disposal. If the first player wins a box, the second player will have 7/8 chances* (Source: Teachers 4).

In commonest use, the transcriptions circulate the following area:

Teacher 3: *You can let students play the game (biloo/bize) by picking the stones in twos, threes, fours and so on. This can be used to introduce the concept "set of numbers. Again, you*

can ask them to play the game and pick the stones in twos, fours eights in that order. That can also be used to address the concepts multiple of numbers (Source: Teachers 3).

The responses of the three teachers on the three themes show they have an idea of indigenous games in the area. Particularly, they knew that several mathematical concepts could be taught or introduced using indigenous games such as *baa*, *mullaa*, *gollaa*, *bibore*, and *biloo/bize* to enhance students' understanding of mathematics.

2. Research Question Two: *How do indigenous games impact the teaching and learning of mathematics?*

In the first part of this research question, three Likert scale items ranging from "Agree", "Disagree", and "Uncertain" was designed to get teachers' knowledge on the impacts of using indigenous games in teaching mathematics.

Table 1: Impact of integrating indigenous games into teaching mathematics

Impact indigenous games	Agree	Disagree	Uncertain	Total
The indigenous games enhance understanding	61 (87.1%)	7 (10.0%)	2 (2.9%)	70 (100%)
The indigenous games bridge the gap between the home and the school	48 (68.6%)	9 (12.9%)	13 (18.6%)	70 (100%)
The indigenous games increases retention memory of the students	63 (90.0%)	5 (7.1%)	2 (2.9%)	70 (100%)
The indigenous games help students develop problem solving skills.	66 (94.2%)	2 (2.9%)	2 (2.9%)	70 (100%)
Indigenous games provide a framework for creativity among students	61 (87.1%)	3 (4.3%)	6 (8.6%)	70 (100%)
The indigenous games promote mathematics group work	63 (90.0%)	4 (5.7%)	3 (4.3%)	70 (100%)
The indigenous games save a lot of times.	36 (51.4%)	32 (45.7%)	2 (2.9%)	70 (100%)
The indigenous games motivate students	57 (81.4%)	12 (17.2%)	1 (1.4%)	70 (100%)
The indigenous games make students active throughout the lesson.	53 (75.7%)	8 (11.4%)	9 (12.9%)	70 (100%)
The indigenous games relate real life situations.	49 (70.0%)	9 (12.9%)	12 (17.1%)	70 (100%)
The indigenous games introduce the perception	59 (84.3%)	8 (11.4%)	3 (4.3%)	70 (100%)

Source: Field Survey, May 2019

It was generally evident from Table 1 that the majority (61) of the respondents representing 87.1%, agreed that the use of indigenous games in teaching mathematics enhances students' understanding, while 7 of the respondents representing 10.0 %, disagreed with the statement and two respondents representing 2.9% were uncertain. This affirmed that when indigenous games are used appropriately in the teaching and learning process, students' understanding in the classroom is enhanced (Tachie & Galawe, 2021). Therefore, this suggests that mathematics teachers must integrate games to boost learners' understanding in their mathematics classroom.

Similarly, 48 (68.6%) of the respondents agreed that the use of indigenous games in teaching mathematics bridges the gap between the home and the school, even though 9 (12.9%) of the respondents disagreed with this assertion and 13 (18.6%) of them remained uncertain. This overwhelming endorsement affirmed the proposition that using indigenous games bridges

the gap between the home and the school (Nabie, 2015). Mathematics teachers are therefore advised to encourage students to attend traditional festivals in their communities where many of these games are played and demonstrated.

It was also evident from Table 1 that 63 (90.0%) of the respondents agreed that using indigenous games increases the retention memory of the students. However, 5 (7.1%) of the respondents disagreed, and 2 (2.9%) were uncertain. This was in line with Ali (2021), who noted that when children engage in meaningful play, it reduces boredom and increases their retention memory. Also, in Item 24, the majority (66) of the respondents representing 94.2%, agreed that using indigenous games in teaching mathematics helps students develop problem-solving skills. In comparison, 2 (2.9%) of the respondents disagreed, and 2 (2.9%) were uncertain. This directly supports the assertion that using the indigenous game is seen as very resourceful in teaching and learning mathematics, especially in problem-solving (Tachie & Molepo, 2019).

The findings, to a very large extent, agreed with (Akayuure & Ali, 2016) assertion, which revealed that in constructivism, we could not teach children by telling them everything. Rather, we must help them construct their own ideas using what they already know. Again, 61 of the respondents representing 87.1%, agreed that using indigenous games provides a framework for creativity among students, even though 3 of the respondents representing 4.3%, disagreed and 6 of the respondents representing 8.6%, were uncertain.

Furthermore, the study revealed that as many as 63 of the respondents, representing 90%, thought that using indigenous games in teaching and learning mathematics promotes group work. In comparison, 4 (5.7%) of the respondents disagreed with the assertion, and 3 (4.3%) remained uncertain. On item 27, 36 (51.4%) of the respondents were of the view that using indigenous games for the teaching and learning of mathematics saves a lot of time, though 32 (45.7%) disagreed and 2 (2.9%) were uncertain.

In addition, even though 57(81.4%) of the respondents agreed that using indigenous games in the teaching and learning of mathematics motivates students, 12 (17.2%) of the respondents disagreed with the proposition, and one respondent represented (1.4%) remained uncertain. This was in support of the fact the use of indigenous games attracts and gains students' attention, contributing to their increase in motivation and engagement with mathematics (Moloi, 2015).

Moreover, it was thought by the majority (53) of the respondents representing 75.5%, that the use of indigenous games makes students active throughout the lesson, while eight respondents representing 11.4%, disagreed and 9 of the respondents representing 12.9% were; however not certain. Additionally, as many as 49 of the respondents representing (70.0%) thought that the use of indigenous games in teaching mathematics helps students relate to real-life situations in the mathematics classroom, even though nine respondents representing (12.9%) disagreed with the assertion and 12 respondents representing (17.1%) remained uncertain. This means the link between mathematical content and indigenous games offers students the opportunity to see and appreciate the relevance of mathematics in their day-to-day experiences. For this reason, mathematics teachers as much as possible must integrate indigenous games into the teaching and learning of mathematics (Akayuure & Ali, 2016).

Subsequently, the study revealed that the majority (59) of the respondents representing 84.3%, thought that indigenous games could be used to introduce difficult topics, as 8 (11.4%)

of the respondents disagreed with this proposition and 3 (4.3%) of the respondents were uncertain. Furthermore, findings from the interview guide support that of the questionnaire survey. As respondents could justify what they said, they knew, as noted on the questionnaire survey (Akayure, 2021).

The above responses notwithstanding, three themes emerged when participants were asked about the impact of using indigenous games on students' learning outcomes in mathematics. These themes were interactions, interest and time. On positive classroom interaction, the following statements were transcribed:

Teacher 5:*[Hmmm] You see, the use of indigenous games in teaching mathematics will allow students to interact among themselves and share ideas on the topic under discussion. Again, as students play these games, they will learn to be tolerant toward one another, which can bring about teamwork among them* (Source: Teacher 5).

Teacher 2, in response to the same question, opined that:
[Ammm] for me, the use of indigenous games in teaching mathematics will offer the timid students in the class the opportunity to interact and share ideas with their colleagues (Source: Teacher 2)

The following statements were transcribed to arouse and sustain interest in the mathematics classroom. Teacher 4, in response to the same question, argues that:

[Errrr] for me, I think the use of indigenous games arouses the child's interest and also can increase the retention memory level of the child, which is one of the attributes of a mathematician (Source: Teacher 4).

Teacher 3 response to the theme:
[Arrrr] actually, using indigenous games in the classroom offers parents the opportunity to play a key role in the child's academic endeavour since most parents are believed to be knowledgeable in many of these games (Source: Teacher 3).

The following statements were transcribed to save time and maximize teaching and learning time. Teacher 1 response to the time-saving gain was transcribed as below:

Using indigenous games saves a lot of time, thereby maximizing and creating the opportunity to cover several topics within a short time. In addition, indigenous games are full of rules which are not peculiar in the case of problem-solving in mathematics (Source: Teacher 1).

In the same vein, Teacher 3 explained that:
You know, there is a saying that a sound mind recites in a healthy body, and some of these indigenous games involve the use of motto skills which have the potential of developing them mentally and psychologically ready to learn in the class (Source: Teacher 3).

The participants' responses revealed that the teachers were not oblivious of the numerous impacts of integrating indigenous games in teaching mathematics, as the use of indigenous games helps children to interact well, develop interest, save time as well as offer teachers and students to play, make fun and enjoy mathematics. The findings affirmed that teachers are aware of the many advantages associated with using games (Tachie. & Molopo, 2019).

The Discussion

The following findings emerged from the study:

1. Mathematics teachers can group students in pairs and ask them to play *biloo/bizean* indigenous games and pick the stones in twos, in threes or in fours to address the concept set of numbers.
2. Children who are good at mathematical-related indigenous games can be called upon to demonstrate to their peers using practical examples of indigenous games such as *gollaa*, *bibore* and *Biloo/bize*.
3. Most of the indigenous games can be video-recorded and replayed in the classroom. At the same time, the teacher pauses the video intermittently and guides students to elicit the mathematical concepts embedded in these games.
4. The use of indigenous games helps children to construct knowledge on their own. This supports the constructivist proposition that in teaching, one of the major roles of the teacher is to create an enabling environment that encourages students to interact, think (reason) and explore knowledge themselves.
5. The indigenous games in all forms use indigenous languages, which enables quick understanding of some mathematical concepts and skills among children.
6. Using indigenous games demystifies the myths associated with mathematics, which helps eliminate mathematics phobia (Sansome, 2016).

It was recommended that teachers explore more knowledge and skills in indigenous games through workshops, seminars and conferences. Once teachers get acquainted with the indigenous games, they can use them to enhance the learning outcomes of mathematics and help salvage the ever-souring performance of students in mathematics. Again, the impact of the knowledge of indigenous games cannot be over-emphasized. It was recommended that teachers partition each of the domains of mathematics, and *baa*, *mullaa*, *gollaa*, *bibore*, and *biloo/bize* best suit particular domains of mathematics. In doing so, students can easily associate particular indigenous games with particular domains of mathematics.

In addition, factors that impede the effective use of indigenous games in the teaching and learning of mathematics can be identified by local authorities. This would help improve teachers' knowledge of indigenous games and transcend to teaching and learning mathematics at the Basic Levels.

CONCLUSIONS

Indigenous games are part of the culture and provide kinds of informal schools. It was revealed that teachers could use *baa*, *mullaa*, *gollaa*, *bibore* and *biloo/bize* to teach mathematics through discovery and trial and error methods. And Mathematics is the foundation of all other indigenous subjects. More so, these indigenous games have been seen as an alternative teaching strategy that can be used to harness mathematics understanding. The impact of indigenous games like *baa*, *mullaa*, *gollaa*, *bibore*, and *biloo/bize* intrinsically motivated and sustained the learners' interest in the classroom and thereby demystified the abstract nature of the subject.

AUTHOR CONTRIBUTIONS STATEMENT

MT conceived the problem, reviewed the literature, collected the data, and came to the conclusion. He was a graduate student. He is now a junior lecturer in mathematics education. MJN supervised the work, made corrections, and guided the graduate student through the study.

CAA helped to get the research topic, supported the graduate student and analysed the results. Clement looked for the appropriate journal and prepared the manuscript. He is a Senior Lecturer in Mathematics Education.

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