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In-service Secondary Teachers' Teaching Approaches and Views Towards Integrating Ethnomathematics Approaches into Geometry Teaching

Enfoques y puntos de vista de los profesores secundarios en servicio hacia la integración de enfoques etnomatemáticos en la enseñanza de la geometría

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Abstract

Geometry teaching and learning ought to mirror and embrace the social diversity found in the geometry learning environment as well as the increasingly connected world. For that reason, ethnomathematics approaches that relate geometry teaching and learning to the learners' cultural experiences and background should be used when teaching geometry. The aim of this study was to find out the teachers' teaching approaches in geometry as well as their views towards the incorporation of ethnomathematics into the geometry teaching. A convergent mixed methods design was used in this study. Focus group discussions and questionnaires were used as data gathering instruments. The sample comprised of 40 in-service mathematics teachers. Findings show that both teacher-centered and learner-centered approaches were used in geometry teaching and learning. The study also revealed that teachers had the opinion that ethnomathematics approaches should be integrated into geometry teaching. The study recommends that teachers should be trained to use ethnomathematics approaches when teaching geometry.

Keywords: Ethnomathematics approaches. Geometry. Teaching. Teacher.

Resumen

La enseñanza y el aprendizaje de la geometría deben reflejar e incluir la diversidad social que integra el aprendizaje de la geometría en el contexto de un mundo cada vez más conectado. Por esa razón, enfoques etnomatemáticos que vinculan la enseñanza y aprendizaje de la geometría con las experiencias culturales y los antecedentes de los alumnos deben ser utilizados. El objetivo de este estudio fue conocer las perspectivas de enseñanza de los profesores en geometría, además de sus concepciones hacia la incorporación de la etnomatemática en la enseñanza de la geometría. Para hacerlo, se utilizó un diseño de métodos mixtos convergentes. Los debates y cuestionarios de los grupos focales fueron utilizados como instrumentos de recopilación de datos. La muestra consta de cuarenta

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profesores de matemáticas en servicio. Los resultados demuestran que tanto los enfoques centrados en el maestro, como aquellos centrados en los estudiantes se utilizaron en la enseñanza y el aprendizaje de la geometría. El estudio también reveló que los maestros opinaron que los enfoques etnomatemáticos debían integrarse en la enseñanza de la geometría. El estudio recomienda que los profesores deben ser entrenados para utilizar enfoques etnomatemáticos en la enseñanza de la geometría.

Palabras clave: Enfoques de etnomathematics. Geometría. Enseñanza. Maestro.

1 Introduction

Learners' performance in mathematics has been worrisome for parents, teachers, and policy makers in Zimbabwe. The Nziramasanga commission (1999) cited in Mashingaidze (2012) bewailed the miserable state of mathematics instructional approaches used in Zimbabwe and asserted that the hitches of quality of mathematics teaching and learning are from various sources. With regard to the teaching and learning of mathematics, numerous researchers relate the learners' poor performance in mathematics to poor pedagogical practices employed in the classroom (D'AMBROSIO, 1985; BOALER, 2016). In Zimbabwe, the mathematics teachers have been held responsible for the learners' poor performance in mathematics (Curriculum Team Research report, 2010 cited by MASHINGAIDZE, 2012). Foster (2007) pointed out that if geometry is taught as an abstract topic without meaning, then the learners would not understand the geometry concepts such as geometry. Researchers such as Mashingaidze (2012) and Telima (2011) highlight that the problems that the learners face in geometry are due to the instructional approaches used by their teachers that do not nurture conceptual understanding. The traditional approaches that focusses mainly on providing learners with previously prescribed repetitive tasks or activities do not enhance deep-connected comprehending as well as meaningful geometry learning (BOALER, 2016).

For that reason, for countless years, researchers have been exploring diverse approaches and tactics to improve geometry teaching and learning in particular and mathematics in general. Of the numerous studies on geometry teaching, some involve making use of current technologies (JONES, 2011), applications of geometry history with appropriate historical sources including the incorporation of ethnomathematical approaches (GERDES, 2008; D'AMBROSIO, 2001). Researchers believe that ethnomathematics approaches are the most effective teaching methods (MOGARI, 2002). For instance, Kurumeh (2009) cited by Aikpitanyi and Eraikhuemen (2017), found out in her study that the ethnomathematics approach enhances understanding and efficient learning resulting in higher achievement of learners in geometry. Effective teaching of geometry consists of the processes of knowing how to come up with thought-provoking geometrical problems, appreciating the history and social context of

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geometry, as well as comprehending the different uses of geometry. Effective teaching of geometry to learners is important in order to ensure that they understand geometry concepts they would be learning and the processes that are involved, instead of just memorizing rules.

Zimbabwe's mathematics education has been experiencing a number of reforms. Presently, the new mathematics curriculum included as key points the need to demonstrate knowledge and appreciation of diverse Zimbabwean culture as well as relating cultural practices to the mathematics curriculum. The new curriculum also expects teachers to be knowledgeable about the teaching approaches that are receptive to the learning qualities and requirements of learners from assorted linguistic, social, religious, and socio-economic backgrounds. The resolution to develop the new mathematics curriculum was made with regards to the government's emphasis on getting Zimbabwean learners ready for the necessities of the 21st century, developing worries among key partners and policy makers in regard to the relevance of the education system and the progressions in worldwide education guidelines. Traditionally, the Zimbabwe education system, similar to others all over the world, put more emphasis on the development of strong geometry content knowledge to the detriment of critical skills and capabilities. As pointed out by Sunzuma, Ndemo, Zinyeka and Zezekwa (2012) the teaching of mathematics in Zimbabwe was teacher-centered, where the teachers were sources of geometry knowledge and information. Similar findings were reported by Telima (2011), who found out that geometry teaching was too theoretical and bookish and it lacked practical activities and real-life experiences and examples. In addition, the horrible impact experienced by learners while learning mathematics through the traditional approaches frequently keeps them from exceeding expectations, resulting in poor performance (BOALER, 2016). Such teaching approaches do not inspire learners to make logical connections as well as explaining their reasoning and geometry content knowledge mastery is inadequate as an exit trait. In Zimbabwe, there was a general outcry that school graduates were not able to apply the mathematics learned in the classroom in real-life situations (MASHINGAIDZE, 2012).

In light of the above, a new mathematics curriculum was developed in response to the poor performance and the non-utilization of the learnt mathematics concepts in real-life situations. The Zimbabwe new mathematics curriculum supports a competency-based methodology which is acknowledged through situated learning. It is perceived that the curriculum shifts from being content-based (examination bound) to a competency-based (results situated) curriculum which centers on the learners' ability to apply knowledge, skills, and attitudes in a free, hands-on, and responsive manner. Teaching approaches such as ethnomathematics enable learners to recognize the relation between various methods of

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representing geometry ideas as well as their connection to mathematics concepts. Such approaches are expected to help learners in retaining geometry knowledge and skills as well as enabling them to approach geometry tasks and activities confidently (JONES, 2002). Teachers are expected to help learners create capabilities to access and process geometry information freely and responsibly, as well as develop extensive life skills. The changing role of teachers was accommodated for in the new curriculum where the teachers are expected to be facilitators to the learning process. The new curriculum stresses learner-centered approaches, where learners take part in the search and discovery of new geometry knowledge. The teacher acts as a co-explorer and facilitator in the discovery of geometry knowledge in order to arrive at an objective comprehension of content and application of the skills so gained. The focal point of teaching and learning is involving the learners in dealing with real-life problems through engaging them in meaningful activities. The construction of knowledge is through social negotiation and an emphasis on problem-solving using real-life application of geometry skills.

From the above sentiments, the new mathematics curriculum is underpinned by the social constructivist viewpoint, which proposes that the construction of knowledge and meaning is done by learners through the experiences and activities they engage in. Geometry/ mathematics is a human intervention. Geometry is a cultural product and is dynamic and socially constructed. From the social constructivist viewpoint, knowledge is constructed through numerous social interactions with the environment. Therefore, geometry teaching and learning should be contextually and culturally bound. In addition, Vygotsky (1978) suggested that construction of knowledge should be done through active participation and engagement.

D' Ambrosio (2001), regarded ethnomathematics as a teaching and learning approach, that builds on the learners prior knowledge, experience, the role played by the environment in terms of content and technique as well as their historical and current experiences of their immediate surroundings. Ethnomathematics is the association between mathematics and culture (IZMIRLI, 2011). Numerous benefits have been recognized for incorporating ethnomathematics approaches into mathematics teaching in general and geometry specifically. These include improving school mathematics learning content including geometry and promoting higher levels of intellectual skills; enabling learners to be creative; improving the learners' ability to solve geometry problems; improving the learners' tactics for obtaining information; boosting the learners' self-esteem; improving the learners' ability to work with others in the classroom; helping the learners to experience self-reliance; allowing the learners' to make their own decisions; increasing the learners' ability in making links between daily practices and school geometry; improving the learners' ability in discovering important

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meaning to countless complex geometry concepts taught in schools (GERDES, 1999; ADAM, 2004; ANCHOR; IMOKO; ULOKO, 2009; ROSA; OREY, 2010; IZMIRLI, 2011).

Additionally, numerous researchers (D'AMBROSIO; D'AMBROSIO, 2013; NARESH, 2015) reported that an ethnomathematics approach, in which learners use their sociocultural background to scaffold geometry concepts would assist them in seeing the applicability of mathematics to real-life situations, thus extracting the learners' creativity and critical thinking skills.

Despite the numerous benefits of integrating ethnomathematics approaches into geometry teaching, there is also some criticism labelled against such approaches. Bridge, Day and Hurrell (2012) reported that, in a classroom where geometry teaching was dominated by prescribed textbooks, and where lessons were benchmarked against mandated mathematics curriculum, teachers found it challenging to use ethnomathematics approaches in such scenarios.

However, teachers are the most important variable in the implementation of such teaching approaches in geometry teaching and learning. Teachers are responsible for creating an exciting mathematics learning environment, providing learners with positive messages they require as well as taking any mathematics tasks and provoking the learners' interest and curiosity (BOALER, 2016). The use of ethnomathematics approaches in geometry teaching and learning has significant implications for the teachers. Thus, the purpose of this study is to find out the teaching approaches being used in geometry teaching as well as the teachers' views about the integration of ethnomathematics approaches into geometry teaching.

1. What are the teaching approaches used in geometry teaching and learning?
2. How do in-service teachers view the integration of ethnomathematics approaches into geometry teaching?

2 Methodology

This section focuses on the context of the study and its participants, design, data gathering instruments, and data analyses procedures.

2.1 Context of study and Participants

The current study was conducted in the Faculty of Science Education, Department of Sciences and Mathematics Education at a conveniently located university in Zimbabwe. The

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mandate of the selected university is to train both in-service and pre-service Sciences and Mathematics teachers in Zimbabwe. The university offers both in-service and pre-service programs for teachers from honors degree level up to the doctoral level. For that reason, researchers assumed that the in-service teachers who participated in the current study had experience in teaching geometry and were able to provide important information concerning the teachers' geometry teaching and their views on the integration of ethnomathematics approaches.

The study population was 80 (50 men and 30 women) in-service mathematics teachers. The sample comprised of 40 in-service mathematics teachers (25 men and 15 women) who were enrolled in the Bachelor of Mathematics Honors degree at the university under study. Proportional stratified random sampling was used for the quantitative phase to ensure the in-service mathematics teachers' proportionate representation in the sample. Gender was used as the stratification variable, where the in-service mathematics teachers were divided into two groups; one for men and another one for women. Two random samples were selected independently from each group (female and male) proportionately to the gender balance in the population (CURTIS; CURTIS, 2011) by means of a simple random sampling procedure. The joined random samples of men and women in-service mathematics teachers all in all comprised the sample (40 teachers) of the current study.

We used a research-based recruitment, whereby the same in-service mathematics teachers (40 teachers) who completed the questionnaires also took part in focus-group discussions, in keeping with the view of Hennink (2014). The 40 in-service mathematics teachers who completed the questionnaires after being selected through proportional stratified random sampling techniques were also randomly chosen to take part in the focus-group discussions. The focus group discussions involved five groups, each comprising of three female and five male in-service mathematics teachers. Despite the fact that proportional stratified random sampling and research-based recruitment were used to select the in-service mathematics teachers, their involvement in this study was voluntary.

The 40 in-service mathematics teachers were Degree holders who were teaching mathematics at the secondary school level in Zimbabwe. With regarding to the teaching profession, (37.5%, n = 15), had 2-5 years of teaching experience, (50%, n = 20) had 6-10 years of teaching experience, and 12.5% (n = 5) had between 11-15 years of teaching experience. In-service mathematics teachers are only enrolled for the program if they have two years of teaching experience in secondary schools.

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2.2 Design

We used a convergent mixed methodological approach combining both quantitative and qualitative data gathering and analysis. The rationale for combining qualitative and quantitative data was to triangulate the data (GRAY, 2011). The convergent mixed method approach involved gathering both qualitative and quantitative data simultaneously and then merging the data in the analysis and interpretation stages (CRESWELL; PLANO CLARK, 2011).

2.3 Instruments

Focus group discussions were used to generate qualitative data as well as questionnaires that generated both quantitative and qualitative data (MCMILLAN; SCHUMACHER, 2010), which is an important element of convergent parallel mixed-methods design that allows for data triangulation. The questionnaire comprised of closed items and open-ended questions to enable the teachers to express their views on the integration of ethnomathematics approaches into geometry teaching and learning and how they teach geometry. The closed questions provided the quantitative data in form of frequencies and percentages while open-ended questions gathered qualitative data. Questionnaires were employed as they were capable of providing information about views on the integration of ethnomathematics approaches into the teaching geometry as well as on how they teach geometry (GRAY, 2011). Nonetheless, the use of questionnaires only hampers their aptitude to provide in-depth and thick descriptions, hence, the use of focus group discussions. Data from the focus group discussions provided supplementary ample information on teachers' views on integration of ethnomathematics approaches into the teaching and learning of geometry.

The validity and reliability were accomplished predominantly through methodological triangulation which made use of two data gathering methods on the same research question. In addition, both focus-group discussion items and questionnaire items were content-validated by three specialists in mathematics education. Their comments and suggestions were used to improve the items.

2.4 Procedure

In order to conduct the study, the university gatekeeper granted us permission in accordance with research policy. The participants signed an informed consent letter before they

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took part in the study. To enable a high response rate and a shorter period of gathering data, the questionnaires were self-administered to the teachers in a lecture room. A box was placed near the room exit for dropping in the questionnaires, which helped in ensuring confidentiality as well as maximizing the response rate (GRAY, 2011). Focus-group discussions were conducted immediately after the teachers completed the questionnaires.

2.5 Data Analysis

The researchers transcribed the audio-recorded focus group discussions. An 'inductive' (CRESWELL, 2015) data analysis process, which involved code creation by the authors through direct interaction with the data, was used for qualitative data from both the open-ended questionnaire questions and focus-group discussions. Inductive data analysis is a process that entails the identification of patterns and themes in the data (CURTIS; CURTIS, 2011). Interpretive data analysis which provide meanings that go beyond direct description of the statistical data was employed for the quantitative data. For the quantitative component, descriptive statistical visual strategies were employed to analyze as well as to interpret the data (COHEN; MANION; MORRISON, 2015). In the current study, the quantitative data was presented as frequencies and percentages (COHEN et al., 2015).

3 Research findings and discussion

This section focuses on the findings and discussion based on the two research questions: (1) What are the teaching approaches used in geometry teaching and learning? (2) How do in-service teachers view the integration of ethnomathematics approaches into geometry teaching?

3.1 Instructional practices for teaching geometry

This section focuses on the teachers' instructional practices for teaching geometry. From the teachers' explanations, two broad categories of teaching approaches have been identified. The approaches were categorized as teacher-centered approaches and learner-centered approaches.

3.1.1 Teacher-centered approaches

The focus group discussions generated data which indicated that about 60% of the

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teachers used teacher-centered approaches that did not engage learners greatly in the teaching and learning process. Their reason for using such approaches were content coverage, time, lack of geometry content knowledge and this is the way they were taught. This is what they said:

> *"Teacher exposition is being used because the approach is fast in covering the syllabus that is too long. In order to finish the syllabus. If methods such as guided discovery were to be used it would be challenging because the learners' operation rate is slow." (Group B)*
> *"Demonstration method is used because learners are not knowledgeable, lack of time and this is the way we were taught. "We use teacher demonstration, a procedural approach, pose questions and let them research because we too lack knowledge. We don't know the adequate content to teach geometry" (Group D & E).*

Teacher-centered approaches, for instance, demonstration, and exposition were mentioned by the teachers and were useful in covering the syllabus because their goal of teaching was to finish the syllabus. Furthermore, the demonstration method was used due to lack of time, inadequate geometry content knowledge and this is the way they were taught. Teachers made use of demonstration method due to limited time in order to cover all syllabus topics. Content coverage is crucial for both the teachers and the learners for examination purposes so that learners would be able to answer the examination questions in order to get good examination grades. This is driven by the education system that is academic and examination-oriented (KAPUNGU, 2007). Teacher-centered methods such as demonstrations are useful where more content is be covered within a short period of time. The teachers' inadequate geometry content knowledge make them resort to the demonstration method. This finding concurs with Aslan-Tutak and Adams (2015), who pointed out that a lack of subject matter knowledge affects teachers' teaching approaches and their use of pedagogical tools. In addition, teachers pointed out that they use demonstration in geometry teaching because this is the same way they were taught. This finding is in line with Ferner's (2013) observation that teachers teach in the same manner they were taught. Therefore, we can argue that the teaching methods teachers encountered during their training were passed on to their classroom practices.

3.1.2 Learner-centered approaches

On the other hand, teachers reported that they used approaches such as discovery, dramatization, role play, and field work. Teachers who claimed that that they use learner-centered approaches had this to say:

> *"We use guided discovery, dramatization, and role play for shapes. For instance, the learners can be asked to stand in such a way that they form a triangle. We also make use of real objects and three-dimensional examples. For instance, a round hut is useful in teaching the measurement of solid shapes, in particular cones and cylinders, with the base of the round hut representing a cylinder and its roof top representing a cone with a vertex at the top. For learners*

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to understand the concepts, motivation, usefulness to content, to enjoy geometry, appreciate the geometry in the environment, remove the geometry phobia." (Group A)
"We use fieldwork when teaching angles of elevation, for example, learners are put into groups and are asked to bring three long straight sticks. Each group will be asked to go outside to the flagpole. Each group will be provided with a protractor to measure the angles. One learner will hold the stick horizontally to the flagpole and mark where it rests on the flagpole and measure its height from the ground. Another learner will measure the elevation angle and the depression angle. From these activities, learners are required to calculate the flagpole height (a) Using the bottom triangle to calculate the length of the horizontal X distance from the flagpole. (b) And then use the top triangle to find the other flagpole height. By adding the two heights of the bottom and top triangles you will have the height of the flagpole (see Figure 1)." (Group A)

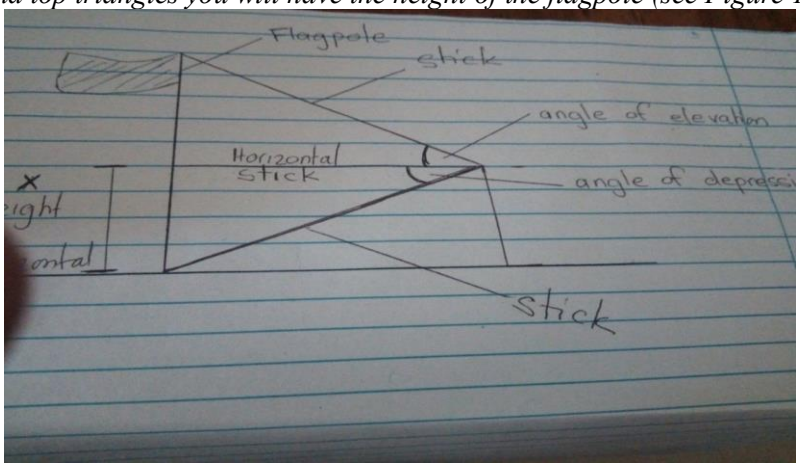

Figure 1 Example of a Geometry Activity
Source: Research Data – Group A's response

"We use guided discovery. We involve the learners, hands-on, and it's a practical topic especially the building part of it. Learners build different angles of 120°, 60°, 45°, 30° and 90° using geometrical instruments. We use the learners' prior knowledge because they are not empty vessels or tabula rasa. Prior to teaching geometry, we ask the learners to identify different shapes in the classroom, and we even measure the length and width of various object in the classroom and then find the area of these objects." (Group C)

The responses revealed that learner-centered approaches were used by the teachers. The learner-centered approaches were in line with ethnomathematics approaches that involve strategies which would allow the learners to be active during the learning process, practice-oriented and project-oriented (D'AMBROSIO, 2001). Similarly, their reasons for using learner-centered approaches such as capability to motivate learners, helping learners understand geometry concepts, enjoy geometry, appreciate the geometry in the environment, and remove the geometry phobia were in line with the benefits of using ethnomathematics approaches (MATANG, 2002; MADUSISE, 2015; ROSA; OREY, 2010).

Findings showed that both learner-centered and teacher-centered approaches were employed by teachers when teaching geometry.

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3.2 Teachers' views on incorporating ethnomathematics approaches into geometry teaching and learning

Teachers' opinions on incorporating ethnomathematics approaches into geometry teaching were also considered, because they influence their decision on whether to use these approaches or not. Data from focus group discussions showed that most of the teachers thought that ethnomathematics approaches should be integrated into geometry teaching. A representative statement of Groups A, B, and C was presented by Group A who said that ethnomathematics approaches should be incorporated into geometry teaching.

The above finding is consistent with findings from earlier studies (KANG, 2004; KANU, 2005; HARA-#GAES, 2005) in terms of incorporating ethnomathematics approaches in teaching. The research findings give an insight into the views teachers hold about the integration of ethnomathematics approaches into geometry teaching. Themes emerged related to the following codes: relevance of geometry, motivation and interest, promoting understanding of geometry concepts and application of geometry concepts.

3.2.1 Relevance of geometry

Data from the closed end questionnaire questions in Table1 shows teachers' views on integrating ethnomathematics approaches into geometry teaching.

Table 1 – Teachers' responses on integration of ethnomathematics approaches (n=40)

Statement	N	(%)
This will encourage learners to take pride in their own cultural heritage and value their culture	9	(22.5)
This will encourage the learners to respect their cultural activities and practices	7	(17.5)

Source: teachers' responses

The data from the closed end questionnaire in Table 1 was supported by the data from the focus group discussions. In this perspective, teachers stated that:

> *"Learners will appreciate the usefulness of geometry. It should be incorporated for learners to see the relevance of geometry, to enable learners to link previous learning with the new knowledge being taught." (Group A & C).*
> *"It is good in the sense that the learners will own the subject. They would say" this is our own geometry" and this could improve their passing rate. "It's good for the learners to understand geometry because of the link between mathematics from home and the school." (Group D & E).*

From the above comments, ethnomathematics approaches would enable the learners to appreciate the importance and usefulness of their cultural geometry knowledge in their life. The findings concur with Rosa and Orey (2016), who assert that the intention of integrating ethnomathematical approaches into geometry teaching was that of making it more meaningful

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and relevant to the learners.

3.2.2 Motivation and interest

Teachers appreciated the motivational aspect of ethnomathematics approaches. Data from closed-ended questionnaire questions showed that 52.5% of the teachers held the opinion that the integration of ethnomathematics approaches could motivate the learners to learn geometry. This was supported by the data from the focus group discussions. Typical responses of teachers from Group B and D were:

> *"It is important in motivating the learners to learn. "It is very important as it motivate learners as they learn concepts related to their culture and they will be interested in learning geometry" (Group B & D).*

The responses from the teachers showed that they felt that the integration of ethnomathematics approaches into geometry teaching might make the learners motivated and interested in learning geometry. If learners are highly motivated they will be in a better position to benefit from the integration of ethnomathematics approaches because these approaches allow the learners to discover patterns and relationships during geometry knowledge construction, which requires interested learners (ZASLAVSKY, 1973).

3.2.3 Promoting understanding of geometrical concepts

Not only could ethnomathematical approaches motivate learners to learn geometry, but also assist in their understanding of the school geometry. The closed-end questionnaire data showed that 77.5% of the teachers thought that the use of ethnomathematics approaches in teaching would improve the quality of geometry education and only 20% indicated that cultural content would not be a hindrance to geometry teaching.

The data from the open-end questionnaire questions supported the view that ethnomathematics approaches facilitate the understanding of geometry as shown in Table 2.

Table 2 – Ethnomathematics approaches facilitate understanding (n=40)

Representative quotes
It helps simplify abstract geometry concepts by relating them to the real-life situations.
It is easier to use real life examples when teaching geometry.
Learners understand better when the learning encompasses indigenous knowledge that they are familiar to.
Ethnomathematics approaches help the learners understand geometry better.

Source: teachers' responses

These were further supported by the data from the focus group discussions as noted from the following comments:

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> *"Yes, it should be integrated as it helps in conceptualization of concepts, retention/remembrance, and removes geometry phobia. It also makes abstract concepts easy to understand, learners will be in a position to use the words that are familiar to them." (Group A)*
> *"It is of paramount importance that we incorporate our cultural settings to our teaching. We start from what they know and move on to complex conceptions. It's inevitable that we incorporate it. Yes, we support it as it is a problem-solving approach that is incorporated in teaching, a lot will be learned by incorporating it. It helps clear misconceptions and abstractness of the topic. Useful for learners as they grasp better what they see and do. Good idea that makes learners pass if properly integrated." (Group B)*
> *"Yes, it affects our everyday life feel at home. It is very important, because it, remove abstractness of geometry. It improves learners' performance since they learn using known objects and understand concepts easily." (Group D)*
> *"Yes, it helps in understanding concepts especially when they visualize, for example, choto (cooking fire place) the center of the hut and the radius from the center. Retention is high and learners easily recall what they have learnt." (Group E)*

Teachers' responses showed that they thought that the integration of ethnomathematics approaches helps simplifying the abstract concepts through connection with familiar cultural examples, which would make the learners understand the geometry concepts. This view is in line with (ROSA; OREY, 2010, 2016; ADAM, 2004; MADUSISE, 2015; GERDES, 1999), who pointed out that when ethnomathematics approaches were integrated into geometry teaching, the school geometry would become more significant and meaningful for learners, in addition to promoting the general quality of mathematics education. Teachers felt that retention would be very high and learners' performance in geometry would improve if ethnomathematics approaches were used in geometry teaching. The finding concurs with Anchor, Imoko, Uloko (2009), who reported that if the geometry content is taught using ethnomathematics approaches, learners would be able to retain the information as well as improve their performance.

3.2.4 Application of geometry

The application of knowledge is viewed as successful learning by the humanistic teachers (FERNER, 2013). The application of geometry in real life even after graduating from school was mentioned by some participants (40%) from focus group discussions as one of the benefits of integrating ethnomathematics into geometry teaching. Teachers from Group C and D made the following remarks:

> *"To some extent, yes for application purposes, useful in self-employment, identification of talents, developing nature talents for carpentry and construction industry and perfect skills for them to work in the industries, it's a good idea. Yes, it is good for applying the skills in everyday life, useful approach." (Group C & D)*

From the teachers' responses, the integration of ethnomathematics into geometry teaching had the potential of facilitating self-employment or good skills in the learners' lives.

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Their responses also showed that ethnomathematics approaches could provide learners with opportunities to apply the geometry knowledge and skills acquired in the classrooms to their cultural context.

Even though, findings show that most of the teachers thought that ethnomathematics approaches should be integrated into geometry teaching, data from closed-end questionnaire showed that a minority of the participants (2.5 %) thought that the quality of geometry education would deteriorate. This view was also supported by data from the focus group discussions. The teachers from Group D said that if cultural examples are used, learners will not concentrate and this will reduce the passing rate.

Ethnomathematics approaches could be considered equally negative if they appear to "water down" the geometry content taught in schools (OREY; ROSA, 2006). The view held by the teachers that the learners would not concentrate concurs with Orey & Rosa's (2006) findings that pointed out that a lot of teachers felt that their learners would not learn mathematics/geometry if ethnomathematical approaches are incorporated into geometry teaching.

This section dealt with the teachers' views on the integration of ethnomathematics approaches into geometry teaching. What was evident from the results is the positive views held by most of the teachers on the integration of ethnomathematics approaches into teaching geometry.

4 Conclusion

The findings showed that both teacher-centered and learner-centered approaches were being used by the teachers in geometry teaching and learning. These findings also showed that most of the participating teachers thought that cultural examples and activities should be incorporated into geometry teaching. Furthermore, as highlighted by the findings, the benefits of integrating ethnomathematics approaches into geometry teaching were relevance of geometry, motivation and interest, facilitating the understanding of geometry concepts and application of geometry concepts. Findings on such benefits are in line with those of other researchers (ADAM, 2004; KANG, 2004; ANCHOR et al., 2009; ROSA; OREY, 2010) in terms of enabling learners to comprehend, understand, and appreciate as well as apply geometry concepts, ideas, processes, and practices in solving practical problems in their societies. Furthermore, the findings showed that this approach to geometry teaching would motivate learners to learn geometry and to recognize geometry as part of their daily lives, enhance their

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ability to make meaningful geometrical links and deepen their understanding of all forms of geometry, which concurs with Boaler (1993), Ernest (1998) and Adam, Alangui and Barton (2003).

Furthermore, very few teachers (2.5%) from the closed end questionnaire data thought that the quality of geometry education would deteriorate if ethnomathematics were integrated into geometry teaching.

5 Recommendations

The study recommends that seminars and workshops should be organized for mathematics teachers in order to train them on how to use ethnomathematics approach in the mathematics teaching. Mathematics teachers should not be static implementers of the curriculum but rather be involved in designing the curriculum. In addition, curriculum planners and developers should include ethnomathematics approach in the curriculum of all institutions that offer educational courses.

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