REDIMAT Journal of Research in Mathematics Education
Hipatia Press www.hipatiapress.com

Instructions for authors, subscriptions and further details:

http://redimat.hipatiapress.com

Incorporation of Indigenous Knowledge in the Mathematical Geometry Discipline at a TVET College

Makhosi P. Mademabe[1], Bunmi Isaiah Omodan[2] and Cias T. Tsotetsi[3]

1) Nelson Mandela University, South Africa
2) Walter Sisulu University, South Africa
3) University of the Free State, South Africa

Date of publication: October 24th, 2022
Edition period: October 2022-February 2023

To cite this article: Mademabe, M.P., Omodan, B.A., & Tsotetsi, C.T. (2022). Incorporation of indigenous knowledge in the mathematica geometry discipline at a TET college. *REDIMAT – Journal of Research in Mathematics Education*, *11(3)*, 296-312. doi: 10.17583/redimat.7890

To link this article: http://dx.doi.org/10.17583/redimat.7890

PLEASE SCROLL DOWN FOR ARTICLE

REDIMAT, Vol. 11 No. 3 October 2022 pp. 296-312

Incorporation of Indigenous Knowledge in the Mathematical Geometry Discipline at a TVET College

Makhosi P. Mademabe
Nelson Mandela University

Bunmi Isaiah Omodan
Walter Sisulu University

Cias T. Tsotetsi
University of the Free State

Abstract

Mathematical geometrical (MG) concept is often perceived as abstract and difficult to understand by students at the TVET College. Students are unable to perform well in Mathematic Assessments Tasks specifically on this concept. Drawing from this is the declining percentages of student enrolments in mathematics at National Qualification Framework (NQF) level 2. The aim of this study was to enhance the teaching and learning of Mathematical Geometry through the integration of indigenous knowledge in the form of a pilot-practical assessment task (PAT). The research team made use of focus group discussions to gather empirical data. Students were given the practical assessment task that incorporated indigenous knowledge to close the gap of students being unable to relate the mathematical geometry taught in the classroom to their everyday lives that seemed to prevail amongst mathematics students at a TVET College. Ten co-researchers were homogeneously selected based on their level of experience in teaching mathematical geometry at a TVET college located in the Afromontane communities of Thabo Mofutsanyane municipality, South Africa. The result indicated that indigenous knowledge can be utilized as an effective way of learning and teaching mathematical geometry at the TVET college.

Keywords: Indigenous knowledge, mathematical geometry, teaching and learning, TVET college, Afromontane communities.

2022 Hipatia Press
ISSN: 2014-3567
DOI: 10.17583/redimat.7890

Hipatia Press
www.hipatiapress.com

REDIMAT, Vol. 11 No. 3 Octubre 2022 pp. 296-312

Incorporación del conocimiento indígena en la disciplina de Geometría Matemática en un centro de FP

Makhosi P. Mademabe
Nelson Mandela University

Bunmi Isaiah Omodan
Walter Sisulu University

Cias T. Tsotetsi
University of the Free State

Resumen

El concepto de geometría matemática (MG) suele ser percibido como abstracto y difícil de entender por los estudiantes. De ello se desprende el descenso de los porcentajes de matriculación en matemáticas en el nivel 2 del Marco Nacional de Cualificación (MNC). El objetivo era mejorar la enseñanza y el aprendizaje de la Geometría Matemática mediante la integración de los conocimientos autóctonos en forma de una tarea de evaluación práctica (PAT). El equipo de investigación usó discusiones en grupos de discusión para recopilar datos empíricos. La tarea de evaluación práctica que incorporaba el conocimiento autóctono se realizó con el fin de cerrar la brecha de los estudiantes que no podían relacionar la geometría matemática enseñada en el aula con su vida cotidiana, que parecía prevalecer entre los estudiantes de matemáticas de un centro de formación profesional. Se seleccionaron diez coinvestigadores de forma homogénea en función de su nivel de experiencia en la enseñanza de la geometría matemática en un centro de EFTP situado en las comunidades afromontanas del municipio de Thabo Mofutsanyane (Sudáfrica). El resultado indicó que el conocimiento indígena puede utilizarse como una forma eficaz de aprender y enseñar geometría en la escuela de formación profesional.

Palabras clave: Conocimiento indígena, geometría matemática, enseñanza y aprendizaje, escuela de formación profesional, comunidades afromontanas.

2022 Hipatia Press
ISSN: 2014-3567
DOI: 10.17583/redimat.7890

After two decades or more since South Africa has endured and experience democracy South African institutions persist in the utilization of colonial principles, especially through education and the curricula at large (de Beer & Petersen, 2016; Fataar, 2018). According to Mudaly (2018), there has been a lack of cultural mathematics in the South African education system, where knowledge is harvested from outside the national context. The purpose and mission of South African Technical and Vocational Education and Training (TVET) colleges are to respond to the country's human resources needs for personal, social and economic development. A transformed, high-quality, responsive TVET system is an important investment in the future of South Africa and its people (DoE, 1998). According to the Department of Higher Education and Training (DHET, 2010), the National Certificate Vocational Level 2-4 Qualification currently offered at TVET colleges are not achieving the curriculum objectives as envisaged by the FET Act of 2006 (DOE, 2006) and the national plan for FET (DOE, 2008). Likewise, Terblanche (2017) verified this by expressing that in the previous decade, NCV has experienced poor certification and retention rate. This has tarnished the image of the quality of programme delivery in TVET colleges as South African TVET colleges attract a large number of academically under-performing students from the school sector, and this contributes to the high failure rate of students enrolled in NCV programme in subjects such as mathematics.

The difficulty level in the NCV curriculum of mathematical geometry coupled with abstract teaching prevailing in the colleges is not in sync with the educational level of the underachieving students (Moleko, 2014), hence the study aims at bridging this gap using the indigenous knowledge approach. Attesting to this are Nkopodi and Mosimege (2009), who state that education in South Africa has been largely centered on western values. According to these authors, this has consequently led to the circumstance of having students from disadvantaged backgrounds being unable to see the link between the education they receive at school and their everyday experiences, as teaching and learning of mathematics in TVET colleges are still subjected to a teacher-centered and textbook oriented teaching approach (Özerem, 2012).

For many African learners, European knowledge constitutes a significant barrier to education. In some cases, this also applies to educators (Nkopoli

& Mosimege, 2009). Students find geometrical concepts abstract and difficult to understand, resulting in low performances, thus contributing to the declining interest in geometry (Bhagat & Chang, 2015). In concurrence with these authors, we agree that by seeing mathematical geometry as a discipline that represents objective facts, the discourses of teaching and knowledge remain unchallenged. Mascarenhas (2004) defines indigenous knowledge as the overall sum of the knowledge, language, and skills that individuals in a specific geographical area possess, enabling them to get the most out of their natural environment. Mathematical geometry is a branch of mathematics concerning the study of space and relationships between points, lines, surfaces, and higher dimensional analogs (Bhagat & Chang, 2015). Moloi (2013) suggests that African mathematics practitioners need to take the initiative to integrate mathematics teaching with indigenous cultural morals and values. The findings of this study are likely to build on Moloi's (2014) findings by focusing on mathematical geometry at a TVET college, explicitly using the practical assessment tasks (PAT) as means of integrating indigenous knowledge into the MG curriculum and simultaneously fostering the culture of student-centered learning through student interaction in the classroom.

Considering the challenges mentioned above, we believe that indigenous knowledge can uphold the teaching and learning of mathematical geometry in multicultural classrooms. Various tribes worldwide possess indigenous knowledge that can be integrated into college curricula (Chahine, 2013). Such knowledge includes indigenous music, architecture, mural decorations, indigenous games, beadwork, weaving, and social activities (Chahine, 2013). This knowledge can be an essential tool to bridge the gap in understanding the connection between the mathematical geometry taught in the classroom and students' everyday life (Chabari, 2013; Mwakapenda, 2008). This means lecturers should provide students with concrete learning materials, such as indigenous teaching aids, assisting them in exploring geometrical patterns and using them in their ways of understanding and rationalizing angles (Gordon & Browne, 2014). With this being said, this study intends to bridge this gap by incorporating indigenous knowledge in teaching mathematical geometry.

Theoretical Framework

Critical emancipatory research (CER) is the theory that couched this study. CER is a paradigmatic approach that embodies a perception of knowledge production that can benefit disadvantaged people, such as mathematics students in rural South Africa (Noel, 2016). According to Wellmer (2014), CER upholds that social reality is historically destined and continuously changing, depending on factors emanating from various points of view, namely, social, political, cultural, and power-based. This theory maximizes the perspective of those who are minoritized and researched to remain voiceless with its ontological position of empowerment and liberation (Behar-Horenstein & Feng, 2015). It assists lecturers in creating inviting academic settings in the classroom that will place students at the center of their learning process, directly involve them and relate the mathematical geometry they learn in the classroom to their environment.

According to Behar-Horenstein and Feng (2015), CER relates to this study because it compels lecturers to become aware of the indigenous knowledge that is taken for granted, which can be used in the classroom to enhance students' assimilation, geometrical analysis, and problem-solving skills. As Esau (2013) indicated, critical emancipatory research is a participatory, democratic process concerned with developing concrete knowledge to pursue worthwhile human purposes grounded in a participatory perspective. The central role of this approach is to help lecturers create an authentic representation of mathematical geometry, which can catalyze students' cognitive levels of thinking throughout their learning process. The selection of this theory was informed by its optimum contribution to student empowerment, affording students a platform of being active participants in their various academic settings as opposed to the key assumption that knowledge is only possessed by the dominant powers possessed by the lecturers (Noel, 2016). It is an ideal framework as it unceasingly attempts to stimulate social justice throughout the research. It is permeable to this research as it guides the important and effective ways of creating conditions under which the distorted consciousness can be challenged and the refinement of positive academic identity is achieved (Mahlomaholo, 2009). Thus, this paper's overall envisaged objective is to improve the human condition through CER engagement.

The following question will pilot the study:

Research Question

How can indigenous knowledge be integrated into teaching and learning mathematical geometry at NQF level 4 at a TVET college?

Research Objectives

Based on the aim of this study, the following research objectives have been formulated:

- To determine the challenges prevailing in teaching and learning mathematical geometry, which necessitated the integration of IK.
- To determine possible solutions to the identified challenges in teaching and learning mathematical geometry.

Methodology

Participatory Action Research (PAR) was adopted as the research design for this study. There is diversity in the meaning of PAR, comprehensibly ranging from the descriptors of “participatory research” and “action research” to “participatory action research” (McTaggart, 1991). However, this study will best define it as a framework for creating knowledge. The guiding principle is that the people most affected by an issue will be directly involved with the design and process of research on the issue (Caswell, 2011). PAR, thus fits the study because it allows us to become immersed in the context of teaching and learning mathematical geometry by involving co-researchers in identifying the issues of concern and with its collaborative elements on how to solve the problem by empowering them (Caswell, 2011). As a form of generating data, the research team critically engaged in discourses through focus group discussions (FGDs) in the form of meetings. The research team comprised NQF level 4 students of Campus A, lecturers, and mathematics subject specialists. The role of the FGDs was to critically discuss how the teaching and learning of mathematical geometry can be enhanced and what could be the benefits of indigenous knowledge in the Afromontane communities of Thabo Mofutsanyane municipality of South

Africa. The research was conducted in the TVET sector of the Department of Higher Education and Training. The research sample constituted the following: four mathematics lecturers, individually drawn from four different campuses of the TVET college, namely Campuses A, B, C and D, based on their level of experience in offering mathematics; the research team consisted of ten co-researchers, namely: two heads of department (HODs 1/2), two mathematics lecturers (ML 1/2), one former teacher (FL), one mathematics specialist (MS), one Senior lecturer (SL), one mathematics tutor (MT) and two mathematics students (S1 /2). All were selected from the TVET college campuses in the Afromontane communities of Thabo Mofutsanyane municipality of South Africa. The following section will discuss the methodology of this study.

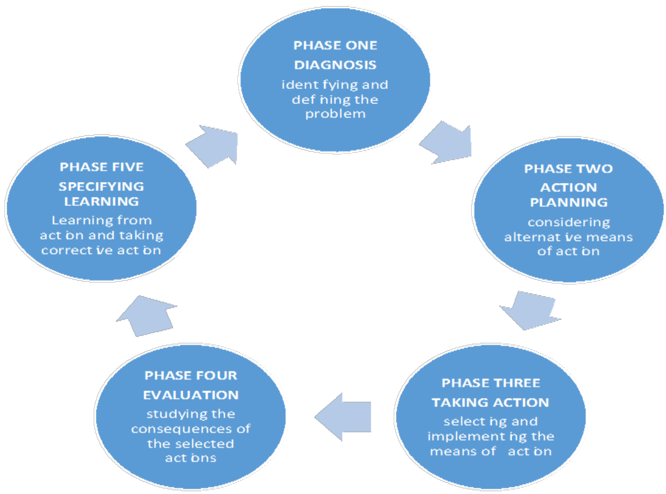

Figure 1. Gerald's PAR Model (1983)

Data collection was aligned with Gerald's PAR model (1983). Gerald (1983) described the PAR model in five subsequent phases. Thus, the data collection process of this study was guided by these five phases of Gerald's PAR model: Phase 1, Diagnosis; Phase 2, Action Planning; Phase 3, Taking Action; Phase 4, Evaluation and Phase 5, Review. This PAR model approach is a cyclic collaborative research process that expects co-researchers to be active throughout the research process (McNiff & Whitehead, 2006). The purpose of this meeting was for the research team to diagnose the challenges experienced in the teaching and learning of MG, providing a clear understanding of the problem at hand through the aid of SWOT analysis. This analysis was identified as a traditional form of brainstorming because of its positive reputation in strategic plantings (Phadermrod *et al*., 2019). In this phase, the team established the dire need for enhancing the teaching and learning of MG. This was complemented by the rate of student enrollment in mathematics. From the deliberation, it was agreed that the agenda of the next meeting was to do action planning. The subsequent phase describes the action planning of the proposed approach in detail. The purpose of this meeting was to establish possible solutions on how the identified challenges could be addressed to enhance the teaching and learning of MG. The team proposed a strategic plan to investigate how the integration of indigenous knowledge in the teaching and learning of mathematical geometry can be actively explored to yield the outcomes of a pilot-practical assessment task (PAT) as an initial attempt to integrate indigenous knowledge into the mathematical geometry content. Phase 3, the action-taking phase, was the administration of PAT to the identified population, and phase evaluation presented the outcomes as illustrated in Fig.1 below. In contrast, the phase 5 review is based on the students' submissions (Fig. 1) and the administration of the PAT successful process that managed to enhance parental involvement in their children's learning process. This feedback was done to ensure that all the valuable aspects of the study were covered and monitored correctly. Thus, the study was consistent.

Discussions to enhance the teaching and learning of mathematical geometry were done with the study's objectives outlined above. The discussion was amongst the selected co-researchers of the study. The principles of PAR guided the discussion throughout, and co-researchers participated by embracing the research principles of participation and reflection, empowering and emancipation as a team with a solidified aim to incorporate the indigenous knowledge present in the community in the teaching and learning of MG. The three features of PAR were applied: a segment possession of the research process, analysis of the teaching and learning of MG at a TVET college, and the integration of indigenous knowledge in the teaching and learning process of MG (Molaodi, 2013). PAR allowed co-researchers in the study to segment possession of the research process in identifying the challenges experienced in the teaching and learning of MG, and co-researchers explored the possible means by which indigenous knowledge can be integrated into the teaching and learning of MG.

Data were analyzed using thematic analysis. Thematic analysis is an encoding process whereby qualitative information is analyzed. This encoding process is mainly based on categorical codes. In this study, Braun and Clarke's six phases of thematic analysis were adopted to make sense of what the study intends to achieve, namely: (1) Acquaintance of data by the researcher, (2) Generating initial codes throughout the transcript, (3) Searching for themes (4) Reviewing and evaluation of themes, (5) Defining and refining themes and (6) Producing the report. These steps were also conjoined by Wolcott (2008) to give meaning to the data description, analysis, and interpretation. It is in connection with the utilization of this method of analysis and the methodology (PAR) of this study that there was an understandable relationship between discourse and power. The recorded discourses and transcriptions were the primary data source for answering the research question and the above-set objectives of this study. Permission to conduct this study was sought under the Ethics Committee of the Free State with approval number UFS-HSD2019/0040/0207.

Findings of the Study

Challenges Prevailing in the Teaching and Learning of Mathematical Geometry

This section analyzed and discussed data based on understanding the challenges: visualization skills and students' socio-cultural context in learning.

Visualization skills

The first challenge discovered during the FGD meeting was the students' lack of visualization skills. According to the literature, visualization of geometrical shapes and/or figures (making mental pictures and drawings) also can lead to the selection of appropriate operations and the attainment of the correct solutions to the problem (Moleko, 2018). During our discussion, although the co-researchers believed that visualization is essential when dealing with this mathematical concept, they acknowledged that it is a skill most students lack. See the statement below:

> MS1: Pictures are important in imprinting knowledge in one's mind. Students' inability to identify various orientations of geometric figures affects their performance because they cannot interpret questions on their own.
>
> HOD1: Lecturers do not have enough resources to teach MG in the classroom. MG is a practical topic; hence, lecturers and students must always engage in visual and tactical teaching and learning when dealing with this concept.

The above excerpts seem to align with the research findings of Yilmaz and Argum (2018, p. 53) when emphasizing that visualization has a solid complementary role in the teaching and learning of MG. Thus, the excerpts indicate that students lack the skill to visualize mathematical geometry shapes (internal visualization). MS1's statement shows the importance of visualization in the teaching and learning of MG. It outlines that in absentia, not only are these statements, but the literature also highlights that lack of this skill is a challenge for this study. However, HOD1 has revealed the reason for this challenge. According to his statement, MG is a practical topic. Hence lecturers and students must always engage in a visual and tactical style of teaching and learning when dealing with this concept. MG necessitates lectures to bring teaching aids or, to a more significant extent, encourage students to interact with each other through the engagement of practical activities that will assist students in recalling MG shapes and their properties, respectively, because of being physically exposed to them.

Our analysis of the above excerpt is that the failure to visualize MG shapes and figures internally makes it difficult for students to understand the various properties associated with these shapes and figures respectively, and this consequently leads to students mixing up the essential and relevant information expected to be presented during assessments and not perform well in the mathematical concept in general. Furthermore, the teaching of MG is presented traditionally, whereby students are given problems and expected to provide answers only. Students are not asked to apply their prior knowledge; prior knowledge is not even elicited from them. PAR, in this regard, contributes to the democratization of the research procedure and the development of social change as it allows the co-researchers to describe the challenges democratically, being free to air their views from their perspective.

This facilitated a deeper meaning of what was deemed to be the challenge and its causes. Moreover, CER endorses the notion that the problem must be understood for sound solutions to be devised for a problem to be addressed. With this in mind, our personal interpretation from the above conversation is that students' inability to visualize the MG shapes and figures is a challenge that needs to be addressed. The next subsection adds to this by describing the challenge retrieved from the discussions as students cannot relate the mathematical geometry taught in the classroom to their everyday lives.

Students' socio-cultural context in learning

The research team identified the second challenge as the inability of students to relate the MG taught in the classroom to their everyday lives. This involves engaging students in activities designed to bring abstract mathematical geometry concepts home. With the indigenized approach to teaching and learning of MG, students can retain what they learn in the classroom and recognize the impact of what they learn at the institution, as confirmed by the comments below.

> HOD2: It is due to the abstractness of MG that students cannot see the link between what is taught in the classroom and what they see or do in a real-life situation (Cognitive levels of thinking).
>
> ML1: Lecturers appear to have more trust in the textbook and have resorted to its utility holistically.
>
> S2: When teaching MG, lecturers tend not to use practical examples that apply to our local homes (geographical area),

like the various types of roofing present in their communities, to demonstrate the different angles in our real-life situations.

Lack of resources, such as basket weaving techniques, arithmetic, local languages, children's self-made toys, Sona drawings, traditional architecture, and traditional games whereby lecturers only rely on a textbook as the only source of information is evidence enough that there is a need for indigenous knowledge to be incorporated into the teaching and learning of mathematical geometry. The need for lecturers to bring indigenous teaching aids to the classroom cannot be overemphasized, as deduced from ML1's statement. Concerning these utterances, a lecturer must prepare each lesson with this knowledge in mind. My understanding of these deliberations is that, through a proper understanding of the concept of thought, students will be able to take what they have learned in the classroom and relate it to their everyday lives.

Possible Solutions to the Identified Challenges in the Teaching and Learning of Mathematical Geometry

According to the data generated, the following are the suggestible solutions: learning through concrete pictorial abstracts and practical assessment tasks as strategies to improve visualization skills and assist students in relating the mathematical geometry taught in the classroom to their everyday lives.

Learning through concrete pictorial abstracts

The first solution discussed as possible strategies to improve students' visualization skills in the teaching and learning of MG was concrete, pictorial abstract (CPA), and technological aspects in the form of indigenous artifacts. Concerning literature, mathematical visualization is the process of creating images or constructing mental representations and using such local images effectively for mathematical discovery and understanding (Scriven & Paul, 2005). Campbell (1995) further encourages the development of culturally related visual images and intuitive skills in all the developmental processes. Not only that, but the data generated during the team discussion also reflects the above suggestion by the literature. Some of the co-researchers said the following:

> HOD1: Since we are in the 21st century, this generation of students is more interested in technology. Imagine if MG was taught using technology, as opposed to the old-school way? If the technology incorporating local knowledge were integrated into the teaching and learning of MG, this would assist in eliminating the abstractness of the concept of geometry.
> HOD2: "Lecturers must use different teaching methods. Alternative teaching methods, such as the concrete, pictorial abstract (CPA) method, employ indigenous teaching aids.

In line with the above statement, it indicates a solution derived from both the students' and the lecturers' sides of teaching and learning. We agree with HOD1's statement that times have changed, and development is continuously occurring. This generation of students is digitally inclined. For lecturers to entice students' interest in MG as a concept, amongst the indigenous teaching aids or resources, we can utilize in the lessons, and technology takes the first seat.

Our reflection on these statements is that resources can assist lecturers in presenting the various geometric shapes and figures, visibly displaying their properties using cultural artifacts and the connection thereof. These could be done in a simplified manner, such as using PowerPoint slides to display the indigenous information that is no longer prevailing in the communities that will serve as a significant contribution to the teaching and learning of MG, coupled with the CPA method mentioned by HOD2. From the textbooks, geometry is abstract, but it could be easier for students if a lecturer could apply the CPA method as uttered by HOD2, supported by literature, Leong *et al*. (2015) state that most students prefer a visual learning style, which utilizes characteristics maximized by a concrete pictorial and abstract approach (CPA). We, therefore, summarize this section by noting that the strategy firmly believes that indigenous teaching aids are significant and relevant in improving students' visualization skills. The following subsection discusses students' interaction in the classroom to enforce positive attitudes and beliefs in the teaching and learning of MG.

Practical assessments tasks

An additional possible solution suggested by the research team in responding to the need to address the challenges identified is the integration of practical assessments into the college mathematics curriculum to assist students in learning and understanding mathematical concepts through hands-on activities. In other words, a productive disposition is reached when students see sense in mathematics. This can be enhanced using practical assessments, as alluded to in the statements from the co-researchers:

> MSL: Students need to identify the concepts done in class in their real-life situations to use their different methods of understanding these concepts. Practical visible examples and tangible cultural activities such as beadwork can make students understand this concept better and easier.

According to MSL's utterances, lecturers must develop complementary teaching methods that enable students to understand mathematical geometry using their traditional and cultural materials to retrieve hidden moments of geometrical thinking. This will assist them in connecting the MG taught in the classroom and their everyday lives, like what was done in the PAT, whereby students were supposed to construct geometric circle theorems using indigenous teaching aids in the form of beads. This is coupled with the historical presentation that students must do in class (See Figure 2 below).

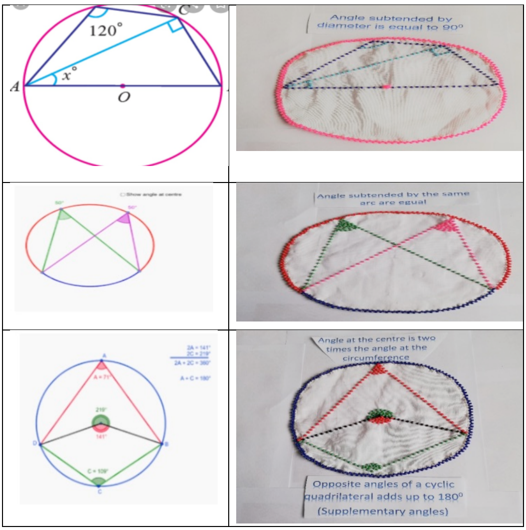

Figure 2. Circle Theorem Geometry (Practical Assessment Task Evidence)

Figure 2 is an illustration of what can be characterized in many geometrical forms and patterns of traditional objects like baskets, mats, pots, houses, fish traps, and others.

Introducing practical and visible examples in teaching and learning mathematical geometry can bear positive results, as these traditional artifacts reflect accumulated experience and wisdom. It was deduced from the students that the acknowledgment of the different lines present in the circle geometric theorems leads to a clear understanding of the various angles subtended by each, such as the radius, diameter, arc and chord.

Our analysis of the above accomplishments is that learning is a social activity. This implies that learning is closely associated with our connection to the environment, which is the students' everyday lives, lecturers, peers, family, as well as casual acquaintances. CER has effective ways of creating conditions under which the distorted consciousness can be challenged and cultivating a positive academic identity. The above discussion indicates the significance of using tangible and practical assessments which incorporate local knowledge will enable students to relate the mathematical geometry they learn in the classroom to their everyday lives.

Conclusion and recommendation

This study has shown that the rich indigenous knowledge present in local communities is not put to good use, especially in Afromontane communities. This outcome resulted from the PAT assessment that requested students to research the communities involving their parents. This gesture made students realize that mathematical geometry is not confined to westerners. Through this task, it became evident that elders in the community know and understand mathematical geometry and have had the opportunity to use it in their vicinity without referring to it as MG. Nonetheless, with all these said, it is distinct that this approach has managed to arouse students’ interest in MG, closed the gap that seemed to be prevailing of students being unable to relate the MG taught in the classroom to their everyday lives, and emphasized the difference indigenous knowledge can bring in the teaching and learning of MG and mathematics in general. Based on the overall findings of this study, there is a need for

South Africa to indigenize the curriculum along with Westernized and Eurocentric content. The Department of Higher Education and Training should create curriculum materials that guide lecturers through this process of indigenizing the curriculum.

Acknowledgment

This work is based on research supported by the Afromontane Research Unit (ARU) of the Free State, QwaQwa Campus. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and the university and ARU does not accept any liability in this regard.

References

Behar-Horenstein, L. S., & Feng, X. (2015). Emancipatory research: A synthesis of quantitative evidence. *IOSR Journal of Research & Method in Education*, *5*(3), 46-56. https://doi.org/10.9790/7388-05334656

Bhagat, K. K., & Chang, C. Y. (2015). Incorporating GeoGebra into geometry learning: A lesson from India. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(1), 77-86. https://doi.org/10.12973/eurasia.2015.1307a

Caswell, B. (2011). *Teaching toward equity in mathematics*. University of Toronto.

Chabari, P. K. (2014). *Determinants of inbound tourism to Kenya* (Doctoral dissertation, University of Nairobi).

Chahine, I. C. (2013). Mathematics teachers' exploration of indigenous mathematical knowledge systems through immersion in African cultures. *I CEMACYC, 3*(2), 1-10.

Department of Education. (1998). Education White Paper 4- A Programme for the Transformation of Further Education and Training, Department of Education, Cape Town.

Department of Education (DoE). (2006). *Education statistics in South Africa at a glance in 2005*. Pretoria: Government Printing Works.

Department of Education (DoE). (2008). *Education Statistics in South Africa at a glance in 2006*. Pretoria: Government Printing Works.

Department of Higher Education & Training. (2010). Report of the Ministerial Committee on the Review of the National Student Financial Aid Scheme. Pretoria.

Esau, O. (2013). Preparing pre-service teachers as emancipatory and participatory action researchers in a teacher education programme. *South African Journal of Education*, *33*(4), 1-10. https://doi.org/10.15700/201412171327

Gerald, I. S. (1983). *Action Research: A sociotechnical systems perspective.* Sage Publications: London.

Gordon, A. M., & Browne, K. W. (2014). *Beginnings and beyond: Foundations in early childhood education*. Wadsworth Cengage: Learning Publishers.

Leong, Y.H., Ho, W.K. & Cheng, L. P. (2015). Concrete-pictorial-abstract: Surveying its origins and charting its future. *The Mathematics Educator, 16*(1), 1-18.

Mahlomaholo, S. (2009). Critical emancipatory research and academic identity. *Africa Education Review*, *6*(2), 224-237. https://doi.org/10.1080/18146620903274555

Mamali, N. R. (2015). *Enhancement of learner's performance in geometry at secondary schools in Vhembe District of the Limpopo Province* (Doctoral dissertation).

Mascarenhas, A. (2004). Knowledge, indigenous knowledge, peace and development. *Indilinga African Journal of Indigenous Knowledge Systems*, *3*(1), 1-15. https://hdl.handle.net/10520/EJC61437

McNiff, J. & Whitehead, J. 2006. All You Need to Know About Action Research. London: Sage, 274 pages, ISBN 1-4129-0806-X (pbk), £19.99

Molaodi, T. (2013). Participatory action research and the construction of academic identity among postgraduate research students. TD: *The Journal for Transdisciplinary Research in Southern Africa*: Sustainable Learning Environments and Social Justice, 9., 401-429. https://doi.org/10.4102/td.v9i3.188.

Moleko, M. M. (2014). Enhancing the functionality of supplemental instruction for first-year mathematics students at a higher education institution (Doctoral dissertation, University of the Free State).

Moloi, T. (2013). The teaching of mathematics in rural learning ecology using Morabaraba game (board game) as an example of indigenous games. *International Proceedings of Economics Development and Research*, *60*, 124-129.

Mudaly, R. (2018). Towards decolonizing a module in the pre-service science teacher education curriculum: The role of indigenous knowledge systems in creating spaces for transforming the curriculum. *Journal of Education* (University of KwaZulu-Natal) 74, 47-66. http://dx.doi.org/10.17159/2520-9868/i74a04

Mwakapenda, W. (2008). Understanding connections in the school mathematics curriculum. *South African Journal of Education, 28*(2), 189-202.

Nkopodi, N. & Mosimege, M. (2009). Incorporating the indigenous games of Morabaraba in the learning of mathematics. *South African Journal of Education, 29*(3), 377-389.

Noel, L. (2016). Promoting an emancipatory research paradigm in design education and practice. In P. Lloyd & E. Bohemia (Eds.), *Proceedings of DRS 2016*: Design + research + society: Future-focused thinking (pp. 455-470). Loughborough University, London: Design Research Society.

Omodan, B. I., Ekundayo, H. T. & Bamikole, O. I. (2018). Enhancing students' academic performance in secondary schools: The vicissitude of classroom management skills. *The International Journal of Business & Management*, 6(11), 106-112.

Özerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *Procedia-Social and Behavioral Sciences*, *55*, 720-729. https://doi.org/10.1016/j.sbspro.2012.09.557

Phadermrod, B., Crowder, R. M., & Wills, G. B. (2019). Importance-performance analysis based SWOT analysis. *International journal of Information Management*, *44*, 194-203. https://doi.org/10.1016/j.ijinfomgt.2016.03.009

Sharma, S., & Sharma, P. (2015). Indian higher education system: Challenges and suggestions. *Electronic Journal for Inclusive Education*, *3*(4), 1-4.

Terblanche, T.E. (2017). Technical And Vocational Education And Training (Tvet) Colleges In South Africa: A Framework For Leading Curriculum Change, Phd Thesis, Stellenbosch University.1-327.

Wellmer, A. (2014). On critical theory. *Social Research*, *81*(3), 705-733. https://www.jstor.org/stablee/26549646.

Makhosi P. Mademabe is a Professor in Faculty of Education at Nelson Mandela University, South Africa.

Bunmi Isaiah Omodan is a Senior Lecturer, CAPTD, Faculty of Education, at Walter Sisulu University, Republic of South Africa.

Cias T. Tsotetsi is a Senior Lecturer and Assistant Dean in Faculty of Education, at University of the Free State, South Africa.

Contact Adress: Direct correspondence concerning this article, should be adressed to the autor. **Postal Adress**: Faculty of Education, Walter Sisulu University, Butterworth Campus, Republic of South Africa.
Email: bomodan@wsu.ac.za