Article

An Exploration of the Use of Indigenous Material in Learning Geometric Concepts: The Case of Eastern Cape Primary Schools

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Abstract

The knowledge of basic concepts in geometry is crucial for the visualisation and comprehension of properties of geometrical figures. This article reports on how foundation phase learners in disadvantaged communities improved their understanding of geometric concepts using indigenous materials. The study aimed to address the gap incurred in mathematics learning because of the absence of grade 1 and 2 teachers in a primary school in the Eastern Cape province of South Africa. The study posed the question: How can the use of indigenous material enhance the learning of geometric concepts by foundation phase learners? Twenty-one learners in grades 1–5 participated in the study. In the first activity learners were asked to bring items from home of different flat shapes. The proposed theme was "Bring it, name it, and tell us about its use and properties." The next activity was to sort the objects and 2-D specimens according to their shapes. The results indicated the significance of practical support from the learners who were taught in neighbouring schools in the group, which enhanced their knowledge of constructions and understanding of geometric concepts. The results indicated that in cooperative social environments, the use of indigenous materials assisted the learners to observe, imitate each other, develop higher mental skills, develop types of thinking, and develop their understanding, description, and representation of objects found in their proximity. This study contributes to existing literature and highlights how indigenous knowledge can sustain geometry understanding.

Keywords: indigenous material; geometry; peer learning; mathematics

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Introduction

Many schools in the Eastern Cape province in South Africa are battling a shortage of mathematics and science teachers (Ndeleni 2018). In many schools in the province, learners are taught mathematics by teachers who visit from other schools, or learners are assisted by tutors in camps during weekends to catch up with the syllabus. The lack of qualified teachers for both mathematics and science has contributed to the Eastern Cape's poor matric results compared with other provinces in the country in past years.

Galileo Galilei pronounced that mathematics is written in mathematical language, and that the letters are triangles, circles, and other geometrical figures without which it is humanly impossible to comprehend a single word (quoted in Gordon and Sorkin 1959). This implies that to understand the operations of the environment around us, we need to understand the language of science, mathematics. Therefore, learners will not be able to read and understand their everyday life situations until they have learnt the language of mathematics and become familiar with the characters in which it is written. The basics of the language of mathematics are taught in the foundation phase.

It is thus crucial that primary school learners have teachers with a very strong command of mathematics. Helmenstine (2019) mentions the following three reasons why mathematics is a language: (i) it has vocabulary, grammar, syntax, and people who use and understand it; (ii) it is a written form of communication; and (iii) it has symbols and organisations to form equations that are used throughout the world. For example, numeracy, which forms part of foundation phase mathematics, uses a vocabulary of words and symbols with certain meanings and employs grammar which is a set of rules of how the symbols and vocabulary of words can be used. In addition, it has a syntax which organises those symbols into linear structures or propositions that can form a narrative or discourse made up of strings of syntactic propositions.

For example, in the foundation phase the necessary vocabulary may include numbers, equations like $4 + 6 = 10$, read as "four added to six equals ten." At this level, those number sentences form the foundation of number combinations. When learners move to higher grades, they learn to use other operations like number multiplications, division, fractions, and number sentences. It is therefore crucial that mathematics teachers nurture the skill of mathematics language so that learners are familiar with word problems. Learners should interpret word problems as translating a foreign language into a known one. While most studies suggest the use of mother tongue when teaching mathematics in the foundation phase (Cekiso 2024; Esuong et al. 2024; Shuukwanyama et al. 2023), most of them highlight the teachers' experiences in teaching the subject using home language. Some studies have investigated code-switching when teaching mathematics (Coetzer et al. 2023; Iñigo and Loquias 2023; Malindi et al. 2023), focusing on teaching mathematics as a subject. This study is different and will add to the literature that addresses the use of indigenous material in learning geometric concepts.

Literature Review

Studies have emphasised that teachers must understand that learning should be directed at a learner's level of thinking, with the aim of moving them to a potential level (Clements and Sarama 2014; Munna and Kalam 2021; Vygotsky 1978). This implies that the learner must master operations at one stage before they are ready to think and operate at the next level. This is aligned to Piaget's (1976) theory of intellectual development which claims that the learning of mathematics is hierarchical, meaning that there are items of knowledge and skill which are necessary prerequisites to the learning of subsequent items of mathematical knowledge. Consequently, to ensure that the grade 1 and 2 learners who were combined in one grade 3 classroom in the school in which this study was conducted do not miss the basic mathematics, a homework club was created. This was a supportive environment created in the area where the school was situated outside of school hours for grade 1 to 5 learners to assist each other with mathematics worksheets and basic skills. Brodie (2022) asserts that mathematics clubs usually support learners to develop relationships with mathematics through engaging with challenging mathematics problems, exploring mathematical ideas, and communicating and sharing their ideas. Furthermore, Lampen and Brodie (2020) add that homework clubs provide a complementary space for different kinds of mathematical relationships. In this study, the homework club created a platform for learners who were taught mathematics in other schools to share their knowledge with those from underprivileged schools taught under multigrade structures.

Clements and Sarama (2011) aver that young children have the potential to learn mathematics that is complex and sophisticated. While mathematics thinking is cognitively foundational, their potential is left unrealised owing to a lack of human, physical, and social resources in many schools. In schools situated in under-developed and disadvantaged communities, human capital is either lacking or represented by non-trained underqualified teachers, especially in mathematics (Tlou and Feza 2016). This was the case in the school in which this study was conducted. The available mathematics physical resources provided by the Department of Basic Education (DoBE) in that school lay gathering dust because of the absence of trained and qualified mathematics teachers to teach in the foundation phase. In addition, Clements and Sarama (2011) contend that the quantitative, spatial, and logical reasoning competencies of mathematics may form a cognitive foundation for thinking and learning across all other subjects. In particular, this article explores how indigenous materials were used in learning geometric concepts through peer learning in a homework club. Peer learning in this article is defined as productive learning that connects behaviours with foundation phase curriculum content by actively applying relevant strategies during the peer cooperative learning session in the homework club (Gillies et al. 2023).

Henschen et al. (2020) argued that diverse mathematical content emerges in peer interaction. Peer learning in mathematics classrooms is characterised by an educational practice in which learners interact with other learners to understand mathematics concepts. It is a cooperative learning strategy that usually affects mental processes like attention, language use, memory, perception, problem solving, creativity, and thinking. It has often been observed that while interacting in groups, children sometimes switch between playing the role of a teacher or that of a learner. This usually results in the co-construction of knowledge that involves learning with and from each other among peers (Henschen 2020). The peer-to-peer learning in the homework club was all about learners teaching each other. Henschen et al. (2022) refer to this as a symmetrical relationship in which the children negotiate their thoughts and plans through different knowledge constructions.

The advantage in this study was that learners who had a better explanation of geometric concepts were familiar with the mother tongue and used it to describe the shapes of various artefacts both in the workbooks and immediate environment. The knowledge was not shared by an instructor or other person of authority, but freely amongst themselves. It is all about people on the same level teaching each other what they know such that each one of them understands geometry (Luneta 2024). Through peer learning the contribution was that learners shared experiences, including one-on-one learning, encouraged social learning, and it was a win for everyone.

This study reports on research conducted with children in a disadvantaged community whose life possibilities are far from reaching the promises of globalised mathematics discourses and of social and economic democracy. Famewo et al. (2024) view peer cooperative learning environments as characterised by positive interdependence, individual accountability, interpersonal communication, and cooperation. When learners connect and form partners with their peers, they learn by imitating and copying all that they do. This interdependence of learners from schools lacking proper instructions with those that received instruction from trained teachers broadened their horizons and widened their perceptions. The homework club activities provided a natural and convenient setting for the children to socialise while learning mathematics (Wang et al. 2023). They could easily explain and articulate their construction of mental representations and how they make meaning of mathematics concepts without fear of being judged right or wrong. Peer-assisted learning and the role of language in supporting children's numeracy development is not discussed in this article; such information is available in studies by, for example, Cheng and Walters (2009) and Graven (2012), respectively. This article addresses the gap in the literature of how indigenous material can be used to enhance the learning of geometric concepts especially in under-resourced rural schools.

Theoretical Underpinnings

The study was conceptualised and underpinned by the van Hiele theory of geometric thought. Showers (2015) is of the view that a person's way of seeing or experiencing a particular object or concept follows contrasting what is from what is not, being able to discern critical features of the concept learned. Ling and Marton (2012) note that the learner must separate the critical features of the concept itself from the others, and lastly the learner must be able to fuse all the properties and critical features of a particular object to understand the object of learning. This became an essential skill when learners brought cultural artefacts even before they classified them. The van Hiele theory of geometric thinking expected for learners in the foundation phase includes (i) visualisation, in which learners recognise figures by appearance alone, and (ii) analysis, in which learners can recognise and name properties of geometric figures (van Hiele 1986, 1984).

Children learn to represent and make sense of the world in which they live through geometry. As Freudenthal (1973, 56) contends, "Geometry is grasping that space in which the child lives, breathes and moves. The space that the child must learn to know, explore, conquer, to live, breathe and move better in it." This implies that geometry is essential for children at the foundation phase to interpret the immediate environment surrounding them and be able to describe it. Moreover, Leonard (2018) asserts that mathematics represents symbols and numbers that express the science of mathematics from a multicultural, societal, as well as cultural point of view and exposes how various cultures communicate mathematics thinking. Cimen (2014) opines that along societal practices, different cultures used different symbolisations and ways to express counting, numbers, and arithmetic. Despite the importance of geometric contents, and the fact that geometric objects in the form of models exist in the child's surroundings as different objects and phenomena, that the child is in the situation to manipulate their models on a daily basis, observe them, and use them in games, geometric concepts are abstract and complex to adopt. With this study, I hope to contribute to the literature that illuminates the successful participation of marginalised learners in disadvantaged communities in geometric concept construction through peer learning. Within the South African context, the Curriculum Assessment Policy Statement (CAPS) prescribes that learners in the foundation phase should explore properties of 3-D objects and 2-D shapes by sorting, classifying, describing, and naming them (DoBE 2011).

Methodology

A qualitative research approach from an interpretive paradigm was followed in which indigenous artefacts were used as reference for the learning of geometric concepts. A sample of 21 learners participated in this study on shifts in learners' understanding of geometric shapes. This study reports on the data collected during the first intervention intended to address the gap incurred in the foundation phase mathematics learning because of the absence of grade 1 and 2 teachers in a primary school in the Eastern Cape province of South Africa. This intervention was directed at exposing learners to working with basic shapes in geometry known as space and shape at their level. The intervention classes were conducted once a week every Wednesday afternoon from 4 p.m. to 5 p.m. This is where they met, played. and shared numerical competence skills with their peers. Learners were committed to these classes to the extent that they would attend the homework class even though they were not at school on that particular day. It is where they experienced peer learning and restoration of their interest with respect to gap closure in their mathematics skills. The facilitator was a retired teacher who monitored the learners' progress.

During the visits to one of the schools in the district, it was observed that the grade 1 and 2 learners had no teachers and were sharing the same classroom with the grade 3 children. This indeed compromised their confidence in learning since they did not understand most mathematics content taught at that level. This is a characteristic common to many rural schools in the country. Most learners are left to wonder in those under-resourced classrooms without proper instruction. I argue in this article that the void incurred in mathematics knowledge stains them with poverty of the mind. In the first activity learners were asked to bring items from home of different flat shapes. The proposed theme was "Bring it, name it, and tell us about its use and properties." The next activity was to sort the objects and 2-D specimens according to their shapes. This was based on the principle that when children play with objects and draw them, they learn to understand geometry better. Also, this strengthened the fact that indigenous materials are often tied to learners' cultural backgrounds and everyday experiences (Kudumo and Ngcoza 2023).

Twenty-one learners in grades 1–5 who resided in two locations in close proximity participated in this study. Fifteen of the participants attended classes in a local school with no grade 1 and 2 teachers. Among the other six learners, two were in grade 5 and attended school in town, about six kilometres away from their location. The four others were in grades 3 and 4 in the neighbouring location. Of the 21 participants, seven were boys.

Findings and Discussion

Learners who participated were coded as L1 to L21 and were given pseudonyms. After they had been issued with different shapes cut out of paper some learners immediately assumed the instructor's role.

> Busie: *Yintoni le oyiphetheyo, kwaye yeyokwenzani?* (What did you bring from home and what is it used for?)

Busie showed her.

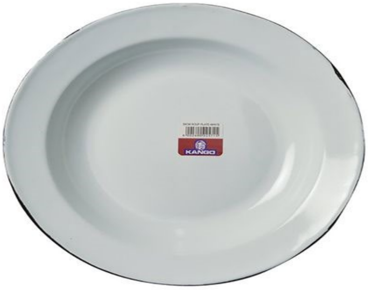

Figure 1: L11's enamel plate

Then Luvo said:

Nam ndize ne plate kubandingafuni kuthatha into enzima. (I also brought a plate because I did not want to carry a big object.)

Busie: *Masibone le yakho uba iyafana na?* (Let us see if yours is the same as that one.)

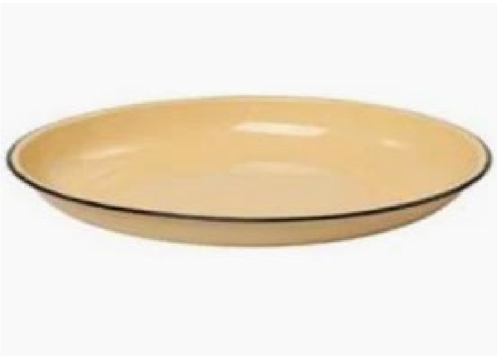

Figure 2: L2'S plate

L2: *Hayi ke tana azifani.* (No, they are not the same.)
Busie: *Uqinisekile uba azifani tu, anditsho ngombala mna.* (Are you sure that they are not the same, I don't mean with colour.)
L20: *Ziyafana kuba zezokutyela zombini, futhi zi roundi kodwa le yesibini ithe gongqo*. (They are the same because both are used for eating and they are both round, but the second one has depth.)
L3: *Zinoo round ababini zombini, kodwa azifani.* (They both have two circular shapes but are not the same.)

At this time, Busie was one of the grade 5 learners who had assumed the role of a teacher and instructor.

Busie: *Ja, nobabini ke ngoku dwebani ezi plate zenu nizi treyise kulaa cudbox, ndizonibonisa izinto se circle*.

She then picked up cudbox and gave it to L11 and L3 to cut out 2-d circular shapes from their plates. Then Zintle said:

> *Kuba ke uthetha ngezinto ezi round, ndilibele mna, andizanga nanto, kodwa singathetha nankuya uronta wasekhaya uround nawo.* (Just because you are talking about round things, I had forgotten to bring something, but we can talk about that rondavel in my home, it is also round.)

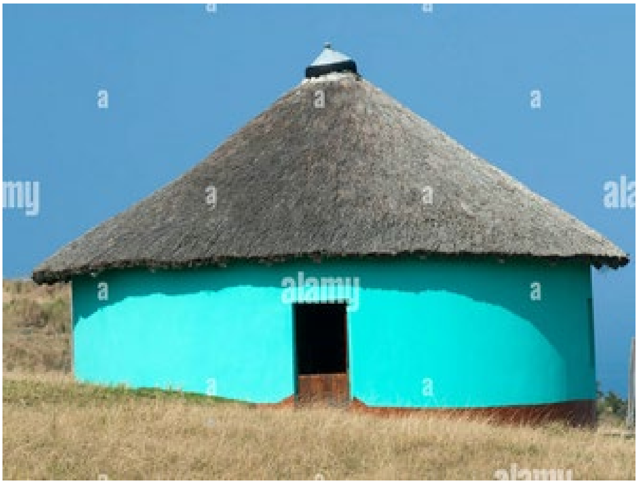

Figure 3: Zintle's rondavel at home

At this stage that Busie started to explain to Zintle and the rest of the learners that the rondavel is round but there are many other shapes that make it. He pointed to the cap on top of the roof and asked the learners its shape.

> L12: *Yi Pontshi* (It is a ponch/cap). *Kodwa andiyazi ishape yayo.* (But I do not know its shape.)
> Busie*: Yi cone, ifana nalento yokugalela I ice cream.* (It is a cone, looks like the ice cream cone.)
> L15: *Engathi le othetha ngayo ifana nale ngobozi ndiyiphetheyo mna.* (I think what you are talking about has a shape like this basket [he said, showing them the basket].)

Figure 4: Basket

> Busie: *Ja icone injena ke, qha laa ndawo engaphatsi*, (pointing at the bottom part) *maybe sharp njenge pontshi.* (Yes, the cone is like this, but the bottom part should be sharp like that one of the rondavel cap.)

Busie's role in this conversation has been that of a teacher. In conjunction with the first three van Hiele levels of geometric thought, the growth of space and shape knowledge construction in this study was monitored. The importance was to expose them through peer learning and set their minds free while they own and experience learning. L15's response indicated not only the mathematics applications displayed by the learner but the excitement and the anticipation the learner had to knowing the names of the shapes and why they were named that way. He showed the ability to compare shapes and could discern that although the basket had a conical shape, its bottom had to be sharp. Clearly Zintle operated on the third level of van Hiele's levels of geometric thinking. She showed evidence of being able to perceive relationships between properties and figures to create meaningful definitions. This concurs with Haviger and Vojkůvková (2014) who assert that the van Hiele theory can help improve the geometric thinking amongst learners. It is only through abstraction that she argued that although she forgot to bring an item to the classroom, she was able to point to standing shapes in her immediate environment. She also justified her reasoning of associating the roundness of the different plates displayed by her peers to a fixed object like the rondavel.

The freedom given to the learners to bring objects of their choice and affording them their own ways and descriptions of how they see things without intimidation of being right or wrong indicated to them that their views are important. This concurs with Sugiarto et al. (2012) who claim that creative thinking abilities in geometry can be fostered by instruction in class that involves the use of attractive, iconic, symbolic, and practical learning tools when teaching. While they brought some items from home to identify not only their usefulness but also their different shapes, their mathematical conceptual understanding was strengthened. It is therefore highly likely that as they participate in cultural practices and while interacting with each other, through inquiry-based learning which Gholam (2019) defines as including (i) constructivism, (ii) conceptual understanding rather than procedural efficiency, (iii) responsiveness to what learners already know, and (iv) connections to the world outside of schools, they will realise the geometry in their surroundings (Nickerson 2013).

This afforded them a chance to share ways in which geometric concepts can be understood. Of significance was the opportunity given to them through the intervention classes to learn concepts in space and shapes. These findings concur with Letseka et al. (2013) who argued that integrating indigenous knowledge systems within South Africa's schooling system will contribute to providing context-relevant education that is accessible to learners and their caregivers in rural and under-resourced settings. The peer support they got from the learners who were taught in other local schools in the group, together with those in higher school grades, added to their knowledge constructions. This also enhanced their interpersonal and interdependence relations while they were held accountable to their peers on the geometric concept knowledge gained in the homework club. Usually, learners in primary schools struggle with visualisation skills. This was emphasised by Yilmaz (2022) who highlighted that visualisation has a solid complementary role in the teaching and learning of mathematical geometry. This was not the case in this study because learners went beyond abstractions in the van Hiele geometric thinking levels. This also concurs with Gula and Jojo (2024) who indicated that teachers' use of artefacts, activities, and indigenous knowledge enhanced learners' comprehension of geometry.

Conclusions

Even though geometric concepts exist in the child's surroundings and are encountered on a daily basis during various activities, from studying to playing, they are still abstract and complex to adopt. It is my contention that almost every artefact can be used to decolonise mathematics if teachers can try to connect mathematics prescribed in various textbooks to the learners' everyday contexts. Indeed, learners' understanding of mathematical concepts through the inclusion of indigenous knowledge in the mathematics curriculum transformed learners' understanding and made it interesting and relevant. Learners' exposure to artefacts that are relevant to their immediate environment can make them value what they know and apply it in mathematics classrooms.

It is recommended that teachers should use context-specific and context-relevant forms of indigenous knowledge to teach content, and to incorporate indigenous methodologies into their teaching methods. Learners in this study were observed to be more engaged when lessons used materials that were familiar and culturally significant. It is anticipated that this increased engagement will lead to better participation and a more positive attitude towards learning geometry. The peer cooperative learning environments that prevailed amongst the learners were characterised by positive interdependence, individual accountability, open communication, and cooperation. The gap in their knowledge was closed as they learnt to share what they knew with fellow learners. Peer learning reinforces the co-construction of knowledge and learning from peers creates environments where knowledge is constructed collaboratively, enhancing the learning experience for everyone involved. Teachers are encouraged to consider this approach because it can foster a sense of pride and respect for one's heritage while also broadening learners' understanding of geometry. It is advised that mathematics teachers can harness peer learning to contextualise mathematical space and shape teaching, as well as how to use available indigenous aids that differ based on the learning style of the learners. Mathematical discourse, active involvement, and learner motivation were all improved by engaging learners to talk about and describe artifacts so that their geometry language improves.

References

Brodie, K. 2022. "Learning Mathematics in an After-School Mathematics Club." *African Journal of Research in Mathematics, Science and Technology Education* 26 (3): 237–247. https://doi.org/10.1080/18117295.2022.2131267

Cekiso, M. P. 2024. "Students' Reading Self-Concepts at an Institution of Higher Learning in South Africa." *Reading and Writing* 15 (1): 1–10. https://doi.org/10.4102/rw.v15i1.509

Cheng, D., and M. Walters. 2009. "Peer-Assisted Learning in Mathematics: An Observational Study of Learner Success." *Australasian Journal of Peer Learning* 2 (1): 23–39.

Cimen, O. A. 2014. "Discussing Ethnomathematics: Is Mathematics Culturally Dependent?" *Procedia-Social and Behavioral Sciences* 152: 523–528. https://doi.org/10.1016/j.sbspro.2014.09.215

Clements, D. H., and J. Sarama. 2014. "Early Childhood Teacher Education: The Case of Geometry." *Journal of Mathematics Teacher Education* 14: 133–148. https://doi.org/10.1007/s10857-011-9173-0

Coetzer, T., C. Livingston, and E. Barnard. 2023. "Using Visual Representations to Enhance isiXhosa Home Language Learners' Mathematical Understanding." *South African Journal of Childhood Education* 13 (1): 1–8. https://doi.org/10.4102/sajce.v13i1.1297

Department of Basic Education. 2012. *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa*. Department of Basic Education.

Esuong, Uwase Uwase, Ofonime Friday Udo, and Item Asuquo Effiong. 2024. "The Use of Mother Tongue in Communicating Mathematics: Implication for Teaching and Learning of Mathematics." *British Journal of Education* 12 (2): 45–51. https://doi.org/10.37745/bje.2013/vol12n24551

Famewo, B. G., P. O. Abiodun, G. B. Oguntimein, and O. A. Owolabi. 2024. "Impact of an Experimental Centric Learning on Peer Learning and Collaboration among Environmental Engineering Undergraduates in a Historical Black College and University." Paper presented at the 2024 ASEE Annual Conference and Exposition.

Freudenthal, H. 1973. *Mathematics as an Educational Task*. Reidel. https://doi.org/10.1007/978-94-010-2903-2_2

Gholam, A. P. 2019. "Inquiry-Based Learning: Student Teachers' Challenges and Perceptions." *Journal of Inquiry and Action in Education* 10 (2): 112–133.

Gillies, R., B. Millis, and N. Davidson. 2023. *Contemporary Global Perspectives on Cooperative Learning*. Routledge. https://doi.org/10.4324/9781003268192

Gordon, I. S and Sorkin, S. 1959. *The Armchair Science Reader*. Simon and Schuster.

Graven, M. 2012. *Numeracy Chairs Programme: Final Report: School Functionality (Submitted to Tshikululu Social Investments)*. Khulisa Management Services.

Gula, Z., and Z. Jojo. 2024. "Harnessing Indigenous Knowledge for Teaching of Mathematics for Sustainable Development in Rural Situated Primary Schools." *African Journal of Research in Mathematics, Science and Technology Education* 28 (3): 404–421. https://doi.org/10.1080/18117295.2024.2424696

Haviger, J., and I. Vojkůvková. 2015. "The Van Hiele Levels at Czech Secondary Schools." *Procedia-Social and Behavioral Sciences* 171: 912–918. https://doi.org/10.1016/j.sbspro.2015.01.209

Helmenstine, A. M. 2019. "Why Mathematics is a Language." Thought Co., last updated 27 June 2019. https://www.Thoughtco.com/whymathematics-is-a-language-4158142.

Henschen, E. 2020. *In Bauspielen Mathematik entdecken. Aktivitäten von Kindern mathematikdidaktisch analysieren und verstehen* [Discover mathematics in construction games. Analyzing and understanding the activities of children in mathematics education]. Springer VS. https://doi.org/10.1007/978-3-658-31741-6

Henschen, E., M. Teschner, and A. M. Vogler. 2022. "Peer Interactions and Their Role in Early Mathematical Learning in Kindergarten Discourses." *International Electronic Journal of Mathematics Education* 17 (4): article em0709. https://doi.org/10.29333/iejme/12362

Iñigo, M., and A. Loquias. 2023. "Code-Switching and Mother-Tongue-Based Instruction in Grade One Mathematics: A Comparative Analysis." *Psychology and Education: A Multidisciplinary Journal* 15: 366–374.

Kudumo, P., and K. M. Ngcoza. 2023. "Prospects of Using Indigenous Knowledge as a Culturally Responsive Pedagogy to Teach Science Concepts Regarding Iron Smelting." *Indilinga African Journal of Indigenous Knowledge Systems* 22 (2): 204–221.

Lampen, C. E., and K. Brodie. 2020. "Becoming Mathematical: Designing a Curriculum for a Mathematics Club." *Pythagoras* 41 (1): a572. https://doi.org/10.4102/pythagoras.v41i1.572

Leonard, J. 2018. *Culturally Specific Pedagogy in the Mathematics Classroom: Strategies for Teachers and Learners*. Routledge. https://doi.org/10.4324/9781351255837

Letseka, T., L. Wiebesiek-Pienaar, and T. Meyiwa. 2013. "The Development of Context-Relevant Teaching Tools Using Local and Indigenous Knowledge: Reflections of a Sociologist, a Sociolinguist and a Feminist Scholar." Paper presented at the 5th World Conference on Educational Sciences, Rome, 5th–8th February.

Ling, L., and F. Marton. 2012. "Towards a Science of the Art of Teaching: Using Variation Theory as a Guiding Principle of Pedagogical Design." *International Journal for Lesson and Learning Studies* 1: 7–22. https://doi.org/10.1108/20468251211179678

Malindi, Z., C. Ndebele, and B. Z. Gobingca. 2023. "Examining Teachers' Views on the Adoption of Mother Tongue-Based Bilingual Education in Mathematics Teaching and Learning: A South African Context." *South African Journal of Education* 43 (si2): S1–S12. https://doi.org/10.15700/saje.v43ns2a2242

Munna, A. S., and M. A. Kalam. 2021. "Impact of Active Learning Strategy on the Student Engagement." *GNOSI: An Interdisciplinary Journal of Human Theory and Praxis* 4 (2): 96–114.

Ndeleni, Z. 2018. "Teaching Electrostatics in Grade 11 Physical Sciences using a Conceptual Change Approach." MA diss., University of the Western Cape. https://uwcscholar.uwc.ac.za/items/4a364d3d-5665-4922-8265-9a7f27dfa377

Nickerson, R. S. 2013. "Technology in Education in 2020: Thinking About the Not-Distant Future 1." In *Technology in Education*, edited by Raymond S. Nickerson, and Philip P. Zodhiates. Routledge. https://doi.org/10.4324/9780203052235

Piaget, J. 1976. "Piaget's Theory." In *Piaget and His School*, edited by B. Inhelder, H. H. Chipman, and C. Zwingmann. Springer. https://doi.org/10.1007/978-3-642-46323-5_2

Shuukwanyama, T. T., C. Long, and J. S. Maseko. 2023. "Novice Teachers' Use of the Mother Tongue in Mathematics Junior Primary Multilingual Classrooms in Northern Namibia." In *Multilingualism in Mathematics Education in Africa*, edited by Anthony A. Essien. Bloomsbury. https://doi.org/10.5040/9781350369238.ch-004

Sugiarto, I., S. T. Junaedi, and B. Waluya. 2012. "Pembelajaran Geometri Berbasis Enaktif, Ikonik, Simbolik Untuk Menumbuhkan Kemampuan Berpikir Kreatifpeserta Didik Sekolah Dasar." *Journal of Primary Education* 1 (1): 23–29.

Van Hiele, P. M. 1984. "English Summary." [The problem of insight in connection with school children's insight into the subject matter of geometry.] In *English Translations of Selected Writings of Dina van Hiele-Geldorf and Pierre M. van Hiele (237-241)*. ERIC Information Analysis Center for Science, Mathematics, and Environmental Education (ERIC Document Reproduction Service No. ED 287 697).

Van Hiele, P. M. 1986. *Structure and Insight: A Theory of Mathematics Education*. Academic Press.

Vygotsky, Lev Semenovich, and Michael Cole. 1978. *Mind in Society: Development of Higher Psychological Processes*. Harvard University Press.

Wang, H., Y. Chen, X. Yang, et al. 2023. "Different Associations of Parental Involvement with Children's Learning of Chinese, English, and Math: A Three-Wave Longitudinal Study." *European Journal of Psychology of Education* 38 (1): 269–285. https://doi.org/10.1007/s10212-022-00605-0

Yilmaz, D. 2022. "Art-Related Mathematics: Applications of 4th Grade Students." *Cukurova University Faculty of Education Journal* 51 (1).