THE USE OF INDIGENOUS GAMES IN THE TEACHING OF GEOMETRIC PATTERNS IN MATHEMATICS IN THE INTERMEDIATE PHASE

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Declaration

I, **Busisiwe Faith Galawe**, declare that the master's degree dissertation that I herewith submit for the master's degree qualification **Master of Education: Specialisation in Subject Education in Mathematics** at the University of the Free State is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education.

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Abstract

The study investigated the use of indigenous games in teaching geometric patterns in mathematics in the Intermediate Phase. The current research aimed at providing findings to using indigenous games in teaching geometric patterns in the intermediate phase. The Motheo Education District served as the site for this investigation that was guided by a method known as the explanatory sequential approach. Questionnaire were distributed to at least fifty educators during the qualitative stage. The findings were identified and categorised. The second stage of study conducted interviews with five educators. The interviews focused on investigating whether educators apply indigenous games in teaching geometric patterns. During the last stage of the research, the researcher observed the lessons of educators to determine whether educators integrate indigenous games as a teaching strategy.

The conclusion of the research discovered that methods currently used by educators in teaching geometric patterns were teacher-centred rather than learner-centred. Conventional practice, known as the *chalk and talk* (or *chalk talk*) method, were still embraced in mathematics classrooms to teach and geometric patterns. The prior knowledge of learners was hardly prioritised by the educators'. However, this is problematic and can impede the performance of learners. The study revealed that the participants, when they were informed, enjoyed the use of indigenous games in teaching geometric patterns in the Intermediate Phase. Recommendations of the study were made concerning the above findings, particularly regarding further investigation.

Keywords: Indigenous games, geometric patterns, mathematics, play, games, chalk and talk

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Acronyms and Abbreviations

A MESA	Association for Mathematics Education of South Africa
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
ICT	Information and Communication Technology
SAME	Southern and Eastern Africa Consortium for Monitoring Educational Quality
TIMSS	Trends in International Mathematics and Science Study

Chapter 1
Orientation of the Study

1.1. Introduction

The following study investigate the use of indigenous games in teaching geometric patterns in the mathematics class in Intermediate Phase. The incorporation of indigenous games in mathematical classroom can promote a relationship between classroom activities and indigenous games (Leonard, 2018). Indigenous games can be used as an educational tool to improve the performance of learners by adapting games with mathematical concepts. This chapter covers the following issues: Background of the research, theoretical framework, problem statement, main research question, sub-research questions, aim of the study, research objectives, research methodology, data collection, instruments and data analysis, significance of the research, delimitations of the research, definition of key terms, and chapter structure.

1.2. Background

Mathematics is referred to as a discipline that can be applied in both classroom and real-life situations to support problem-solving activities in life (Jardine, 2017). Through this discipline, elements such as concepts and practices are developed. According to Leonard (2018), 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. Generally, the study of mathematics can be viewed as quantitative in nature, previously developed through human experiences (Burton, 2003).

The South African Curriculum and Assessment Policy Statement, known as CAPS (Department of Basic Education [DBE], 2011), defines mathematics as a form language that makes use of notations and symbols that describe numerical, geometrical and graphical relationships. It further explains that mathematics is the activity that revolves on patterns and qualitative connections between physical and social phenomena as well as mathematical objects themselves are seen, represented and investigate. Taking this definition of mathematics into account it means that

mathematics in the current education system cannot be detached from how educators interact with learners in lessons of mathematics in the classroom. Knowledge of mathematics is essential to participate fully in economic processes, to be flexible in pursuing a profession of their choice, personal development and to execute their daily activities with ease. Evidence indicates that it is necessary to understand and apply mathematical concepts to solve everyday problems (Tajudin and Chinnapan, 2016). Mathematical applications are being used in people's and communities' socio-economic and political lives in the contemporary age, both directly and indirectly. Despite this fact, as well as the obvious importance of mathematics to human and socio-economic growth had made many to believe that the subject is too difficult to master. Despite its importance, learner success in mathematics has been low, even at international level (Bereczki and Karpati, 2018). China, as in several other Asian countries, has consistently been leading in learners' mathematics achievement as evidenced the international studies including the Programmes for International Student Assessment and Trends in Mathematics and Science study (TIMSS) (cited by Csapó, 2022). Low learner achievement has not only been recorded in developing countries but also in some developed countries such as the United States, Canada and Australia. The negative view instils in the minds of learners which cause majority of learners dislike mathematics(Kunwar and Sharma (2020). Teachers may formulate instructional strategies that render subject learning more realistically, less frustrating, and enjoyable in order to dispel this negative perception.

Various factors influence learners' poor performance in mathematics. Tachie and Chireshe (2013) revealed that learners' performance is interlinked with both external and internal factors. Poor teaching methods and lack of teaching materials are factors that contribute to the poor performance of learners. In addition, they indicated that learners' attitudes towards the subject determines their level of performance. This is supported by Blaise (2018), who indicated that poor performance in mathematics become a major concern in the country. According to the Annual National Assessment results in the National Senior Certificate curriculum (DBE, 2014), the poor performance in mathematics among learners continues to reveal itself in the country's public examinations. Ahiaku (2017) reported similar results on learner's performance in mathematics. Reports of the Southern and Eastern Africa Consortium for Monitoring Educational Quality – SACMEQ II 2000 and SACMEQ III 2007 (cited by Charamba,

2021) – indicated that the South Africa Grade 6 literacy or numeracy performance between 2000 and 2007 has not improved. The TIMSS report (cited by Spaull, 2013) indicated that between 1995 and 2002 there was no improvement in Grade 7 mathematics or science achievements. SACMEQ (cited by Paul, 2013) also identified the issue of teachers' content knowledge and found that many South African mathematics teachers have below basic levels of content knowledge, with high proportions of teachers being unable to answer questions aimed at their learners. The findings of Arends, Winnaar and Mosimege (2017) support the above-mentioned that learner performance is significantly influenced by teachers' classroom practices; therefore, it is important to identify these practices and put in place support systems for instructors who use them. Research has also indicated that poor performance in mathematics is affected by internal aspects such as teachers' inability to apply applicable pedagogy in the intermediate classroom (Gay, 2018). Mathematics is regarded as one of the most important subjects and, therefore, teachers need to be qualified and well trained before they can give lessons of mathematics effectively (National Professional Teachers' Organisation of South Africa, 2014).

The disparity between the Western learners and African learners in developing countries continues (Sanusi, Oyelere and Omidiora, 2022). Research in foundation phase mathematics learning shows that learners from low socio-economic backgrounds and other disadvantaged backgrounds have a lower level of performance in mathematics than their peers when entering formal schooling (Geist, 2015). This highlights the need for teachers to know the background of their learners. Dole (2014) suggested that teachers should implement effective strategies in an integrated manner when teaching mathematics. This implies that educators are expected to apply various teaching styles in order to cater for the socio- economic background of learners. To promote effective teaching and learning in classroom context.

According to Moss (2022), the cultural approach examines an organisation from a humanistic perspective by taking into account the artifacts, values, and presumptions that result from member interactions. Thus, in teaching mathematics, teachers ought to endeavour to utilize a cultural approach to help learners understand and grasp the mathematics concepts taught, since learners' performance in mathematics continues to decline (Adolphus, 2011).

Mathematics teachers in South Africa can use indigenous cultural practices set up as games to be a creative teaching strategy to improve the teaching of mathematics, especially in the foundation phase, in order to elevate learners' interest and motivation in the subject. This is affirmed by Sibaya (2019), who claimed that giving lessons of mathematics from the cultural context would be a great gain, because learners would learn mathematics from within two familiar environments, namely home and school. This is an important issue, as South African teachers are faced with the multicultural diversity of racial and ethnic groups. Brahier (2020) indicated that good performance in mathematics could be achieved through incorporating of indigenous games in the mathematics classroom.

Sibaya (2019) claimed that once learners integrate their play with mathematical ideas, the mathematics teacher has properly disseminated mathematics skills. This means that concepts or mathematical terms presented by educators is then integrated play. This develop mathematical skills of learners to identify mathematical terms through. McKinney and Tyler (2019) argued that in many postcolonial schools, the confluence between school and indigenous knowledge is rarely the object of importance in science classes. The shift of indigenous knowledge obtained by the learners in their daily lives to their schoolwork is not always respected or promoted, and some teachers do not understand indigenous ways of knowing. As a result, few studies have been conducted on using indigenous games to teach mathematics for better understanding of mathematical concepts (see Cullen, 2013). Simple mathematical concepts could be learned through using indigenous games, making learning more interesting and culturally important. Cullen (2013) assumed that indigenous games can be used in the lessons of mathematics in schools. Hence, the current research aimed to identify the methods currently used by teachers in teaching mathematics in general and establish how the application of indigenous games as a strategy supports the teaching of geometric patterns in the intermediate phase

1.3. Theoretical framework

To accomplish the main aim of the research to investigate the of indigenous games in teaching geometric patterns in the intermediate phase, the researcher employed a

bricolage lens to identify the existing teaching strategies for the teaching of geometric patterns and how educators are implementing indigenous games that are connected to mathematical ideas. Mahlomaholo (2013) indicated that a bricolage theoretical framework as many voices that aim to solve mathematical problems this approach does not restrict a researcher to one theory, but is a collaboration of theories that aim at achieving one objective. It also provides a detailed account of concrete thinking that enables the researcher to utilise a hands-on activity-driven rather than a procedural way of teaching and learning. The bricolage theoretical framework is a bridge of incorporating various games, is learner centred in nature and does not promote an authoritative voice. The approach is based on creativity, collaboration, knowledge, respect and a vision (Wise and Woodhouse, 2017In addition, bricolage consists of principles that assist the researcher in conducting the study (Houtbeckers, 2013). Creativity, collaboration, knowledge, respect, and a vision are the foundations of the theoretical work.The benefit of these principles is that they allow the researcher to create a social value, participation by role players (target group), set leverage for the researcher to acquire new resources, improves the status quo of the study and does not restrict the researcher to any constraints. Creating something suitable for the study means aligning the topic with the suitable audience, which in this case is awareness of teachers using indigenous games in teaching geometric patterns in the intermediate phase, especially in rural schools.

1.4. Problem statement

According to recent literature failure rate in mathematics in the country is related to different factors, such as teaching methods and the inability of teachers to be creative in using indigenous games in teaching mathematics (Ali and Tangkur, 2023). According to the DBE (2011:5), teachers should “value indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution”. This means that teachers should tap into South Africa’s wealthy diversity of cultures and integrate indigenous games as part of the education system in teaching and learning mathematics.

1.5. Research questions

1.5.1. Main research question

Taking the study problem into account, the main research question was:

> *How does the use of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?*

1.5.2. Sub-research questions

To answer the above main research question, the following sub-research questions were posed:

1. What methods are currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase?
2. How does the application of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?

1.6. Aim and objectives of the study

1.6.1. Aim of the study

The principal aim of this study was to investigate the use of indigenous games in teaching geometric patterns in the intermediate phase.

1.6.2. Research objectives

The study intended to attain the following objectives:

1. To identify the methods currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase.
2. To establish how the application of indigenous games as a strategy supports the teaching of geometric patterns in the intermediate phase.

1.7. Research methodology

The framework for this study was pragmatism. Pragmatists contend that knowledge claims come about as a result of actions, conditions and results, rather than from pre-

existing notions (Timonen, Foley and Conlon, 2018). In order to emphasise *what* works, they prefer to concentrate on the research problem rather than the methods. Pragmatists view all approaches as potential means of tackling and understanding a problem that has to be studied (Kaushik and Walsh, 2019). The ability to utilise both quantitative and qualitative methods to solve problems is a benefit of being a researcher. A sequential explanatory design was used in the research, in which one piece of data builds on the findings of the other. This study is divided into two sections: a quantitative section where data were gathered by utilising test responses from the respondents, and a qualitative section that served as an interpretive section where interviews were conducted with selected teachers. For this inquiry, the quantitative data were gathered and examined first before the qualitative data were gathered and examined (Dawadi, Shrestha and Giri, 2021). The outcome of the quantitative phase was used to guide the interpretative phase of the study.

1.8. Data collection, instruments and data analysis

A sequential explanatory approach was used for collection and analysis of data which separated the study into two.. The quantitative phase the researcher collected data by means of questionnaires. Followed by the qualitative research, using semi-structured one-on-one interviews with the selected respondents in order to investigate how the application of indigenous games as a strategy supports the teaching of geometric patterns in the intermediate phase. Thereafter, the researcher analysed the data collected questionnaire responses through the outcome of the quantitative phase, using semi-structured interviews that were transcribed and analysed to build on the findings of the quantitative phase.

1.9. Significance of the study

It is anticipated that this research will benefit many role players, including teachers, learners, researchers, district officials and the DBE in general.

The study will assist teachers to successfully use indigenous games as a strategy to assist them in teaching geometric patterns at all levels. This will help teachers with their strategies and teaching methods that will enhance the achievement of learner in mathematics. This study will address elements that affects the high failure rate in the intermediate phase in the Motheo District of education, especially in remote rural

areas. This may result in improved teaching and learning that may reduce the failure rate in schools, thus benefiting the learners. Incopoerating of indigenous games in the classroom will make teaching and learning effective. Learners will lightly enjoy the lessons mainly because play is incorporated which makes concepts easy for learners to remember.

1.10. Delimitation of the study

The research study was conducted at five selected schools situated in the Free State province of South Africa under the Motheo District of Education.

1.11. Definition of key terms

- **Chalk talk** – an informal lecture with pertinent points, explanatory diagrams, etc, shown on a blackboard" (Merriam-Webster Dictionary, n.d.).
- **Chalk and talk** – "a formal method of teaching, in which the focal points are the blackboard and the teacher's voice, as contrasted with more informal child-centred activities" (Collins English Dictionary, n.d.).
- **Geometric patterns** – The discipline of mathematics dealing with the characteristics and connections of points, lines, surfaces, solids, and higher dimensional equivalents (MaCain, 2017).
- **Games** – A game is just organised play that engages players' senses and grabs their attention(Bollmer and Suddarth, 2022).
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- **Indigenous games** – Recreation-related pursuits that have their roots in a certain cultural group, community or people (Lavallée, 2013).
- **Mathematics** – The abstract science of number, quantity and space(Brunsdon and Comber, 2021.
- **Play** – Engaging in an activity for enjoyment (Wu,Hamilton, Kim and Ratne,2021)

1.12. Chapter structure

The dissertation includes five chapters, outlined below.

Chapter 1 discuss the study's background; theoretical framework; problem statement; research questions; aim and objectives; research methodology; data collection, instruments, data analysis; significance; delimitations of the study and definition of key terms.

Chapter 2 provides a review of the literature, and the work done by other researchers on indigenous games as a teaching strategy to improve mathematics.

Chapter 3 discusses the methodological of the study are discussed in this section construct of the research. The chapter provides the research design employed, explains the population sample, research instruments, and reliability, validity and ethical considerations.

Chapter 4 consist of data from the questionnaire, interviews and observation. The data is presented in tables, figures as well as transcripts.

Chapter 5 entails summary of the chapters and the findings and recommendations

Chapter 2
Literature Review

2.1. Introduction

The study sought to investigate how does the use of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase and whether educators are using indigenous games in teaching geometric patterns in the intermediate phase. The CAPS policy document in South African schools was introduced by the DBE (2011:4-5) to guide teachers in their teaching and to ensure that they equip learners with a variety of knowledge and skills.

Recent research has tended to show that most teachers are not aware that they possess a cultural identity (Biesta, 2015). Ethnicity, race, socio-economic and sexual orientation are all considered as elements of cultural identity. The cultural disposition refers to the understanding of self through the lenses of a teachers beliefs, values and understanding of cultural norms. Student teachers begin their teaching career programmes with substantial values in place (Burn and Mutton, 2015). It should be emphasised that the study refers to moral values when mentioning values. Educators use their underlying value system, which includes personal distinctions between right and wrong, in order to frame their knowledge of teaching (Roberts, 2016). Subsequently, educators are faced with hundreds of decisions that should be made on a daily basis and these decisions should be aligned with the purposes of education, as well as ensuring that learners are educated. Educators' dispositions serve as a value-laden guide that frames their thinking and actions. Effective educators know they possess a value system and can reflect on how that system affects their responses to various teaching situations for the benefit of learners.

2.2. Theoretical framework

A theoretical framework provides a solid foundation that supports and guides the researcher. Imendai (2014) described a theoretical framework as a group of concepts or theories taken from a single theory to explain an occurrence of an event, or to shed some light on a specific phenomenon, or address a specific research problem under

study. The researcher conducted a bricolage theoretical framework to achieve the aim and objectives of the study. The bricolage theoretical framework was introduced by Lévi-Strauss (1962), who defined bricolage as the capacity to employ something that is accessible and merge it with other resources in order to create something meaningful. Mahlomaholo (2013) defined the bricolage theoretical framework as multiple voices that aim at establishing solutions. This approach does not restrict a researcher to one theory, but is a collaboration of theories that aim at achieving the objectives. A bricolage theory promotes physical activities to establish something of value to human dignity (Chevalier and Buckles, 2019). This implies that the theory is understood via practical exercises that correlates mathematical concepts to a real-life situation; for instance, using indigenous games such as and *dibeke* as teaching tools. It becomes exciting as it creates a propitious learning environment and enables multiple methods of learning together with teaching mathematics in the intermediate phase. Theoretical framework is a foundational review of existing theories that serve as a roadmap for developing. Which provides a detailed way of concrete thinking that enables the researcher to utilise a more physical activity-driven rather than a procedural way of teaching and learning.

In addition bricolage theoretical framework becomes a bridge of introducing various games that are more human-orientated in nature and does not promote an autocratic voice. This approach is grounded on creativity, collaboration, knowledge, respect and a vision (Wise and Woodhouse, 2017). The first method is bricolage, which is the creative process of merging components, sometimes with no respect for their original context or purpose and other times with strict adherence. Combining play and mathematical ideas in this instance. The second strategy involves combining geometric patterns and indigenous games. This suggests that mathematical ideas and game rules are combined to produce something valuable. The prior knowledge that learners have from indigenous games is linked to mathematical ideas, sustaining good ties between the two.

The theory's primary argument is to collaboratively generate information from human activity. Information is derived from experiences between people and their climate, according to McMahon (1997), and it is stored in cultures. As a result, the theory emphasises the role of culture and mathematical concepts to comprehend what happens in society and builds knowledge based on the comprehension. For instance,

everyday life can be used to encourage teachers to become innovative, creative and to use indigenous games in their lessons. This will strengthen teaching and learning of mathematical lessons in the Intermediate Phase, which will enable the learners to discover mathematical solutions on their own, using their own understanding and knowledge of the world through experiences encountered, and reflecting on those experiences (Buus, 2015). Our experiences shape how we understand the world and our cognitive lenses have a significant impact on the types of experiences we have (Confrey, 1990). This practice provides a more detailed account of concrete thinking that enables critical thinking and promotes critical thinking (Flavel, 1987).

Both the learning context and the social context that are in the learning process are essential for constructivism. Constructivism is founded on the notion that people actively create or construct their own knowledge and that your experiences as a learner shape your perception of the world. Thus, from constructivism, it is important to note the learner's background and community in the learning process as this background tends to form the understanding and reality of the learner. In essence, learners build on their prior knowledge with new information by using it as a foundation. Which relates to bricolage theoretical framework which takes a raw thing and makes it something of value. For instance, the prior knowledge of learners which in this case is indigenous games is incorporated in teaching of geometric patterns. According to this viewpoint, the teacher's function in a teaching and learning environment should be to facilitate, encourage and lead rather than spoon-feeding the learner.

Some people believe that a teacher should simply pass on knowledge and facts to learners expecting them to understand. It is possible that simply supplying learners with knowledge or notes will not result in successful learning. Von Glaserfeld (1992) argued that if a learner only repeats what has already been said by the teacher or the textbook this is regarded as not effective learning. As a result this type of teaching does not produce logical or creative thinking (Von Glaserfeld, 1992). For the constructivists, on the other hand, learning entails far more than memorising facts, as shown by the argument that in order for learners to really comprehend, they should be involved in active activities and be guided to solve problems to be able to apply information. Learners may convey information with its meaning in their own minds and discover things for themselves while they are engaged in tasks. According to Westerberg (2022), the theory promotes learner-based instruction in which the

instructor acts as a facilitator rather than being the main focus in class. In the classroom, the teacher's job is to direct and assist learners in discovering and constructing their own sense in their social context. In addition, bricolage consists of principles that assist researchers in conducting their study (Houtbeckers, 2013). The benefit of these principles is that they allow the researcher to create a social value, participation by role players (target group), set leverage for the researcher to acquire new resources, improves the status quo of the study and does not restrict the researcher to any constraints.

Creating something suitable for the study means aligning the topic with the suitable audience, which in this case means awareness of teachers using indigenous games in teaching geometric patterns in the intermediate phase. The Constitution of the Republic of South Africa (hereafter Constitution, 1996), advocates for freedom of expression in learning and this disposition of learning assembles the use of materials in hand, to create something meaningful in learning. One of the fundamental claims of this bricolage theoretical framework is to embrace heterogeneous activities and tools, which implies that teachers are free to use various teaching methods and diverse teaching aids that will stimulate the thinking capacity of learners. Data are gathered and analyzed by the theoretical framework. , resulting in connections and developing new codes of new meaning (Barker, 2004).

The researcher believes that the incorporation of indigenous games would do more justice to this study; hence, the decision to use a bricolage theoretical framework in order to meet the objectives set by the study. The bricolage framework guided the literature review to demonstrate how other countries in the Southern African hemisphere have designed strategies to improve mathematics teaching and learning by utilising indigenous games to teach geometric patterns in the intermediate phase.

2.3. Strategies teachers use in teaching mathematics

The mathematics teaching process should demonstrate subject content knowledge and pedagogical content knowledge (Shulman, 1986) and it is the teacher's pedagogical content knowledge that comes into play with the use of relevant and effective teaching strategies. According to Brookfield (2015), teaching interventions that educators employ in their classroom to promote the performance of learners are

referred to as teaching strategies. In other words, learning must have occurred as a function, or a correlation of the instructional operations performed by the teacher. Pedagogy begins when the learner responds to the teacher's presentations and continues when the teacher in turn, responds. What the learner learns under pedagogical operations is what the teacher sets out to teach. Teaching is a dynamic interaction among four components: the learner, the teacher, the curriculum, and the learned repertoire (Dandala, 2013:8). The least divisible components of instruction promotes teacher and learner interaction and predicts new stimulus control for learners, which it is the fundamental unit of pedagogy. Which means that the interaction educators and learners should be embrace in teaching and learning in order to make teaching effective. This permits learners to be innovative and creative/ According to Cellucci (2015), teaching is a complex act, and effective teaching involves a multitude of variables. Some of the variables to be considered, involve the learners' unique learning styles, the teacher's teaching styles, the physical classroom environment, community and school administration priorities as well as pressures.

The teaching strategies of educators are mainly grounded on self-knowledge, subject knowledge, curriculum development and instructions (Lo, Lie and Hew, 2018). This is to say that knowledge acquired by educators influence the teaching methods that educators apply in their classroom. Koh, Chai and Tay (2014) stated that there are three aspects that influence teachers, namely teaching knowledge content, knowledge practice, and effectiveness of their teaching and learning, also referred to by Shulman (1986) as subject content knowledge and pedagogical content knowledge. These aspects produce strategies and methods which teachers apply in their teaching. For instance, training in higher education institutions determines the type of teachers to be produced and how teaching should be conducted in schools.

Some of the teaching strategies or methods used by teachers in teaching mathematics include the chalk and talk method (also called the *chalk talk* method), the discovery approach, the lecturing method, the flipped classroom and the game-based approach.

2.3.1. Chalk and talk method

First and foremost, the commonly used method of teaching mathematics is the chalk and talk method (Phoong, Phoong, and Phoong, 2020). Which is a monologue style

of teaching. While the speaker is writing on the board with chalk, the teaching focuses mainly on the blackboard and the teacher's voice. This method is useful for lecturing and dialogue.

The chalk and talk teaching method is regarded as an effective way of teaching (Francis, Mau and Archer, 2017). This is concurred by the study conducted by So (2012) in *Refined 'chalk-and-talk' of lecture content: Teaching signals and systems at the Griffith School of Engineering*. The findings indicated that learners preferred the chalk and talk method mainly because it has improved their motivation to attend classes and facilitated their learning in a course where they could see the process. This highlights that practical subjects such as mathematics require educators to present their lessons step by step to learners to solve problems and promote better understanding of operations. The advancement of technology has made it possible for educators to use whiteboards or pads that are projected on the screen. The benefit of using the chalk and talk method of teaching allows learners to take notes from the board, which develops their drawing and writing skills. This approach permits the educator to pace learners while writing, as well as to stop in between the lesson in order to explain concepts.

However, this method tends to promote passive learners rather than active learners in the classroom, with teachers being dominant, speaking in front of learners without requiring the interaction of learners. However, countries such as United States, United Kingdom, New Zealand and Australia have moved away from the chalk and talk method (Frydenberg, Deans and Liang,2022). To a more interactive learner-focused approach that promotes collaboration of mathematics and games that allows learners the freedom of learning, with the teacher facilitating the process.

2.3.2. Discovery approach

According to Mphuthi (2015), to make learning more meaningful, geometry can be taught informally using techniques such as cutting, folding and practical ways. The discovery technique, which is defined as a process that happens in problem-solving situations when the learners draw on their own experience and past knowledge, is tied to this informal method (Takahashi,2021). It is a technique of learning whereby

students engage with their surroundings by investigating and handling items while debating issues and conflicts.

The discovery technique is recognised as one of the most effective teaching methods (Lemov, 2021).Since it encourages learners to use their past knowledge and engage in their interests rather than memorise schedules and perform mental calculations. A study conducted in the United Kingdom, titled *What makes great teaching*, indicated that learning in classrooms needs to adapt to a level of instruction, which includes using strategies such as effective interaction, using assessments and delivering material to learners in accordance with their personal learning preferences and asking them to explain the rationale behind a certain activity in a lesson (cited by Msimanga, 2017).

2.3.3. Lecturing method

The idealism-based philosophy of teaching relates to the explanation of the subject to the students (Ren, Wang, Jin and Li ,2021). According to Wankat and Oreovicz (2015), the teacher explains the subject matter to the learners utilising gestures, simple devices, voice changes, position changes and facial expressions. This means that the teacher provides the information and learners only receive without contributing; however, the teacher asks questions to keep the learners attentive. Lecturing methods, however, does have positive objectives, especially for the learning outcome. Lessons are simple to understand. Educators can precisely impart knowledge to learners during classes. In order to avoid confusion, this method enables teachers to be the only sources of information, giving them a great deal of control over what is taught. Lessons using this method are effective. A prepared lecture can be delivered promptly and in advance to fit into the teacher's schedule. Previously recorded lectures can be used again and again. Several educators pre-record their lectures and even play back lectures from other people. The disadvantage of this method is that lecturing is based on the concept that learners are not individuals, and because they all have different learning preferences, learners could not process the information the same way. Nevertheless, this lecture method has a reputation for providing teachers with a direct way to define concepts and interact with learners, the method is a simple way to cover the pacesetter and instruct how learning should take place (Alemi et al., 2012).

2.3.4. Flipped classroom

The flipped classroom is defined as presenting instructional content, frequently online, outside of the classroom as a teaching approach and type of blended learning that flips the conventional learning context by Zainuddin and Halili (2016). This implies that it brings tasks, possibly including some that were previously viewed as homework, into the classroom. With the help of a teacher, a learner can engage with concepts in the classroom while also watching online lectures, participating in online discussions, and conducting research.

In a flipped classroom, learners are in charge of their own learning and research has shown that this approach is successful. According to Riley (2020), the method is gaining popularity, particularly in mathematics classrooms, where it has been reported that it provides for greater learner interest and participation, as well as increased learner–teacher interaction.

2.3.5. Game-based approach

The game-based learning method is defined as a method that involves innovative and creative applications that are based on educational computer games. This method of learning, according to Wu (2013), supports, learning, teaching enhancement, assessment and evaluation of learners.

The game-based learning approach is an innovative learning approach derived from using educational computer games. There are different kinds of game software applications that are for educational purposes such as learning support, teaching enhancement, assessment and evaluation of learners. Wu (2013) stated that the Fourth Industrial Revolution emphasised the need to use technology in classrooms for teaching and learning of certain concepts. The principles of teaching with technology in the Fourth Industrial Revolution are regarded as an important medium for the delivery of the curriculum, especially in developing countries such as South Africa. The game-based approach is supported by the Association for Mathematics Education of South Africa (AMESA), which prioritise to find efficient methods to enhance teaching mathematics in schools (Govender and Junqueira, 2018). Various studies were conducted to stimulate learners' interest towards mathematics (Yeh, Cheng, Chen, Liao and Chan, 2019). Surprisingly, all these studies confirmed that information and

communication technology (ICT) can be trusted to improve learners' performance and interests in the subject. Chigona (2018) indicated that technological advancements have improved the manner in which teaching is conducted in various learning institutions. The above statement is supported by Tachie (2019), who revealed that teachers can teach mathematics more effectively by using technology. According to Joshi and Rahman (2017), ICT integration into the mathematics classroom is beneficial for content delivery. ICT programs motivate learners in various ways and also help them to become independent. Therefore, the utilisation of internet tools and audio-visual instruments are effective in teaching and learning. Joshi and Rahman (2017) further stated that ICT programs make it easy for learners to present their work by using graph tools such as Geogebra, which develops learners' drawing skills, as well as interpreting and analysing mathematical concepts. This method of teaching assists learners with life skills through the use of technology.

In addition to ICT tools, there are also indigenous knowledge systems which may be utilised in mathematics lessons. ICT teaching and learning in rural areas is still an issue in this modern times. This matter was made vivid by the recent Covid-19 pandemic that impacted the entire world, regardless of socio-economic status, community, gender, or nationality. Many schools shifted to online schooling; however, this created a remarkable gap for those who come from underprivileged groups. The educational system has been seriously disrupted by the screaming halt of Covid-19. Millions of people have been impacted by school closures, university closures, and other educational institutions (United Nations Educational, Scientific and Cultural Organization, 2020). This created havoc on the lives of learners from disadvantaged and vulnerable backgrounds, particularly those with special needs and those from low-income families, which deprived learners of physical learning opportunities (Bonal and González, 2020).

2.4. Games and mathematics education

The function of indigenous knowledge systems in schools in South Africa is vital, and the DBE (2011:5) "acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution, 1996, and those would be endorsed in the curriculum". Vygotsky (1986) stated that culture and history become essential aspects when trying to understand and sustain development

and learning. This suggests that one cannot understand the literature on teachers' mathematics knowledge in South Africa without taking cognisance of the country's political and cultural history. The incorporation of games in mathematics promotes the language of mathematics skills and abilities in cognitive development, and advances problem-solving strategies (Spooner, Saunders, Root and Brosh, 2017). Teachers transfer knowledge through the application of the pedagogy of play in the classroom.

2.4.1. The use of games in the teaching and learning of mathematics

Rice (2018) claimed that learning experiences allow learners to improve their use of physical prowess, communication skills, teamwork, and cognitive capacities. Additionally, every game supports African ideals. Gates (2020) matched learners' mathematical knowledge to the knowledge they had picked up from social contexts. This might become less of an issue, for example, if activities are included in math classes. Involving siblings and friends, playing games, and learning from parents, grandparents, and other community members are a few of these. Malloy (1997) provided both the social and historical contexts in his explanation of how the indigenous system knowledge is relevant to learners' environmental activities. More often than not, this takes place outside of the classroom.

Although play and games are generally similar, there are some situations where play becomes different from a game, since in play, the participants' objectives may not be to determine a winner, but merely to pass the time. According to Caroux, Isbister, Le Bigot and Vibert (2015), play is described as an enjoyable action or amusement that takes place while complying with the regulations of the game. Mathematical games can help learners to develop mathematical skills. The word *game* is usually connected with recreation, competition, sportsmanship, winning, losing, enjoyment, and many other similar and related notions. Games can be incorporated into mathematics lessons to make the lessons interesting for learners (Hasana and Alifiani, 2019). This means that educators can use games to enhance mathematical lessons. This incorporation will motivate learners in the class. In playing games, participants have to follow the rules of the games. For example, each player aims to win the game, while adhering to the rules and also having the same interpretation of the rules as the opponent. This is consistent with solving mathematical problems, as certain rules have to be followed to solve a mathematical problem.

In all games, a player strategises the next move, while keeping all the rules in mind. The player ponders over what the opponent's next move will be, the bases of the move and whether the rules are being followed. Visualisation is usually part of the game when going to make the next move. These games are akin to solving mathematical problems to arrive at a solution according to proven rules. In some games, participants can form teams of two or more members to compete against another team, also comprised of two or more members. Hew, Huang, Chu and Chiu (2016) suggested that using games in class can stimulate a learner's intelligence and participation.

Using indigenous games, the lack of finances may be partly alleviated in schools, because indigenous games can often be created simply without spending money. In the South African background, some of these matters have been discussed by Nkopodi and Mosimege (2009), Mosimege and Ismael (2004) and Vithal (2003). The fundamental principle is that natural objects used by different cultures are not familiar to all cultures. If a game is used but is only known by one culture, then the other learners who are unfamiliar with the game should be first introduced to how the game is played. This creates a platform for diversity in cultural values and indigenous knowledge systems to be embraced within various ethnic groups. Learners who are not familiar with a game from one culture may start to learn from their peers how a specific game can be played. Diversity in cultures promotes the spirit of Ubuntu in our society, which allows learners not to sense any form of intimidation by other people's skills or qualities.

According to Boluk and LeMieux (2017), the term *game* is inclusive of all varieties of activities, such as children's street games, puzzle games, board games, dice games, card games, word games, and other international competitive games. Boluk and LeMieux (2017) further defined *game* as an activity that has clearly defined goals that a player engage in following the agreed rules. In other definitions of games, such as those of Grace (2019), Heath (2017) and Williams (2017), there are specific criteria that define a specific game. These criteria are aligned with the definition of Boluk and LeMieux (2017). Podsakoff, MacKenzie and Podsakoff (2016) expressed that games that are part of human activities, are easier to recognise than define. The game is identified with its context. It is a second category defined by the authors above as it highlights the importance of context. Games have a clearly defined context, generally both in time and space. The setting of the game is defined not so much by the rules,

but by the culture in which it is influenced, and in which the game itself will have a number of well-recognised connotations. This context tends to be overlooked when games are played, especially in a formal educational setup. It is generally assumed that games can be used in a variety of circumstances without considering the cultural influence under which such games were initiated or the social circumstances in which they were played.

The purpose of using games in mathematics lessons is to learn the language and vocabulary of mathematics, develop analytical skills, develop the skills of mental mathematics, and develop problem-solving skills and the ability to generate mathematical concepts at different levels. Games also contribute to stimulating data analysis skills in mathematics (Jackson, Cobb, Wilson, Webster, Dunlap and Appelgate, 2015). Studies that showed the use of games in solving problems have been documented (Katsila and Matsoukas, 2018). One important relation between games and solving problems is a central aspect of learning mathematics. Using of games also leads to discovery of patterns in decision-making, logical reasoning and analytical skills (Liao, Yuan, Wang, Li, Zing and Beyah, 2016). Few mathematical concepts that can be identified through the use of chess game is line of symmetry, addition, subtraction and shapes. The chess instruction has been adopted in school curriculums in several countries, such as Italy, Germany, Spain, Turkey, the United Kingdom and the United States, with the European Parliament showing interest and a positive feedback about the playing of chess in schools as an educational tool (Trinchero and Sala, 2016). Research has established that chess develops cognitive abilities (Gardner, 2012).

Nonetheless, games teach a number of mathematical problem-solving skills, including forming and evaluating hypotheses, devising methods, and organising data. Introducing games will help learners to gain good mental interaction, concentration, memory, and the capacity to understand and apply mathematical analytic thinking. It also creates an environment in which learners can discuss their views with their classmates. In addition, Bishop (1991) believed that education can only be truly effective if it is based on learners' cultures. Games are part of learners' everyday lives. It is an important part of any culture's environmental efforts. They practice mathematical concepts, ideas, and information implicitly through the varied games they play in each culture. Mathematics, according to Dienes (1960), is a goldmine for

an endless supply of games. Any mathematical structure can be used to create a game with constraints that are identical to those in the structure. Mathematics has rules and structure, which are comparable to those found in games. To make mathematics more appealing to youngsters, Dienes (1960) used games, singing and dancing and as a result, the mathematics class improved in their performance.

The above-mentioned is supported by Westera (2019), who indicated that applications of games serve a more significant purpose than simply serving as enjoyable pastimes, which is typically the case when games are used. Any game that individuals play generates language, vocabulary, mathematical prowess, and a range of mathematical tasks (Hwa, 2018). Introducing games in the classroom will help to improve performance. Games and mathematics, as two sides of a coin, are thought to have a significant relationship. There are parallels between mathematics and games. The game follows the same mathematical rules, structures, and patterns.

2.4.2. Indigenous games and the teaching of geometric patterns

Simple mathematical concepts can be taught using indigenous games, making mathematics learning more interesting and culturally appropriate. Mosimege (2016) highlighted the importance of indigenous games in regaining African pride in mathematics lessons. The use of indigenous games during the lessons of mathematics in the classroom provides learners with an opportunity to utilise their background and experiences gathered outside the school facility. Current studies appear to support the notion that learners are highly motivated to play and develop essential concepts in mathematics and other important domains by using indigenous games and background to decolonise the school curriculum (Moloi, 2015). According to Nxumalo and Mncube (2019), the use of indigenous knowledge promote problem-solving skills in rural learning ecologies. Aside from indigenous games, researchers have considered the role and use of indigenous materials and practices in the lessons of school mathematics. Here are a few examples of these studies.

In research conducted in Semarang, Indonesia, by Nizaruddin, Omar, Mhd-Ali and Makmor-Bakry (2017), entitled learning mathematics with traditional games, such as *Jirak*, which have an impact on mathematics disposition and student achievement.

Their findings indicated that the achievements of learners using games were better than the achievements of learners who explored conventional learning.

Van der Walt and Potgieter (2018) pointed out that the musical instrument *boom whackers* can be used as a strategy for teaching mathematics to improve teachers' metacognition application. The mathematics classroom should expose a learner to the relationship between real-life situations and mathematical concepts such as visual and theoretical logic. It is important in learning geometry, as reflected in the current school curriculum (Coates, 2017). For instance, D'Ambrosio and Rosa (2008) used paper and string to illustrate geometric patterns, as well as using traditional huts to break down the shapes, illustrating that it contains shapes such as a cone and a circle.

Pelay (2011) indicated that through the process of games, learners can acquire intellectual skills such as attentiveness and improved intellectual pros. It is generally agreed that these acquired skills will eventually improve the results in mathematics. In the literature on knowledge, there seems to be general agreement that the transfer of knowledge occurs when a set of skills learnt in a domain can be generalised to other domains. Goldman (2018) stressed the importance of knowledge consisting of procedures and concepts, which implies that learning is either guided by rules or formed under categories such as fractions, ratio and angles. Moreover, Shulman (1986) explained that curriculum knowledge is a conjunction of horizontal and vertical curricula. He indicated that knowledge of a subject for providing lessons requires more than facts and concepts. In mathematics, concepts such as area, ratio, proportions, geometric figures and numerical patterns, similarity assist in developing the following skills such as logic, reasoning, construction,

accuracy in calculations, interpretation and identifications (Shulman, 1986).

Figure 2.1 Pada (indigenous game)

Pada originates from Zimbabwe. It means balancing using one foot to push a stone from one drawn rectangular box to the other. It can be utilised in the teaching of mathematical concepts such as counting and balancing. While playing *pada*, as indicated in figure 2.1 player gain points by balancing with one foot without using the other foot. Learners push the stone across the squares drawn on the ground. In order to balance on one foot, one has to strategically position oneself. They also learn to calculate while counting in the process because they have to think of the scores and from which box it will start. This indigenous game can be used in the lessons of the concepts of balancing and counting.

Owusu-Mensah and Baffour (2015) conducted a study on *Demystifying the myth of mathematics learning at the foundation phase: The role of Akan indigenous games (Challenges and opportunities for indigenous knowledge systems (IKS) in the education system)*. They indicated that the indigenous game known in Nigeria as *oware* is also commonly known in the Limpopo province in South Africa. This game is regarded to be very effective for lessons in mathematics.

The rules of *oware*, which “is played on a two-rank Mancala board” (Masters, 2023) are as follows:

> Mancala games as shown in figure 2.2, can basically be played in one fundamental motion, which involves “sowing” and “capturing” playing pieces using a board with rows of holes.

> As a result, Mancala board games are often known as “count and capture” games.
>
> On a board with two, three, or four parallel rows of cuplike depressions or holes, they are frequently played by two members or, on other occasions, by two teams.

The set number of identical counters are used to play the game. The objective is to take control of the majority of seeds and eliminate or immobilise the opposing player(s) (Walker, 1990). Numerous changes to the positions of the piece on the board result from each play in a game of *mancala*. These adjustments become possible if multiple sowings and catches are done.

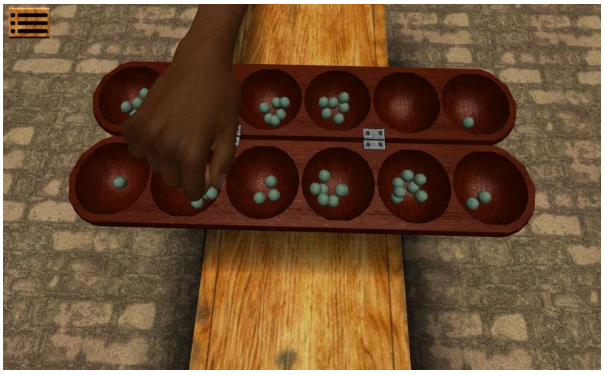


Figure 2.2 Mancala (indigenous game)

In the African context, the most popular games are board games, which vary among various countries. According to Ondenyi (2020), there are over 200 different variations of the *count-and-catch* game, all with fairly different rules which are played throughout Africa. Two rows of pits are used in North and West Africa, three rows are common in Ethiopia and in East Africa and Southern Africa, they use three rows. Four rows are used in the rest of Africa. This concurred with the studies by Moloi (2013) and Nkopodi and Mosimege (2009), which suggested the use of *morabaraba*, a board game played by two people, with 24 tokens (12 for each player). Moloi (2013:127) explained that “the aim of the game is to create rows of three cows (tokens), being vertical, diagonal or horizontal”. In playing this game, the following mathematical concepts such as area, ratio, proportions, geometric figures, numerical patterns that could be incorporated and developed.

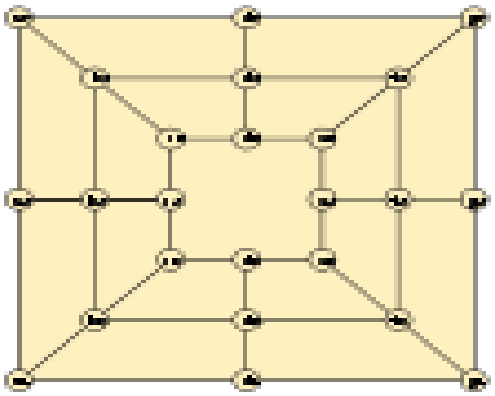


Figure 2.3 Morabaraba (indigenous board game)

Using an indigenous game like *diketo* as a teaching aid assists in the teaching of addition and subtraction (Mosimege, 2004). A new code of learning and teaching using *diketo as shown in figure 2.4* as a teaching tool becomes exciting as it makes learning conducive, which enables different methods of mathematics lessons in the classroom.

Figure 2.4 Diketo (indigenous game)

Mosimege and Ismael (2004) conducted a study on indigenous games called *malepa* as shown in figure 2.5, (string figure gate) in South Africa. Their findings revealed that there is correspondence between mathematical concepts and *malepa*. According to Mosimege and Ismael (2004), *malepa* involves mathematical concepts such as geometric shapes, figures, patterns and relations. The game allows learners to create various geometric figures such as quadrilaterals and triangles, which depends on how

the string is extended, can also be divided into rectangles and squares. They further indicated that the game allows learners to concepts expressed through various linear and graphical representations of quadratic equations. For instance, quadrilaterals and triangles: $y = 2x + 2$; quadrilaterals and intersecting points: $y = 3x + 1$; quadrilaterals and the number of spaces (determined by the combination of triangles and quadrilaterals): $y = 3x + 2$. Moreover, some gates have rotational symmetry, while others have reflectional symmetry.

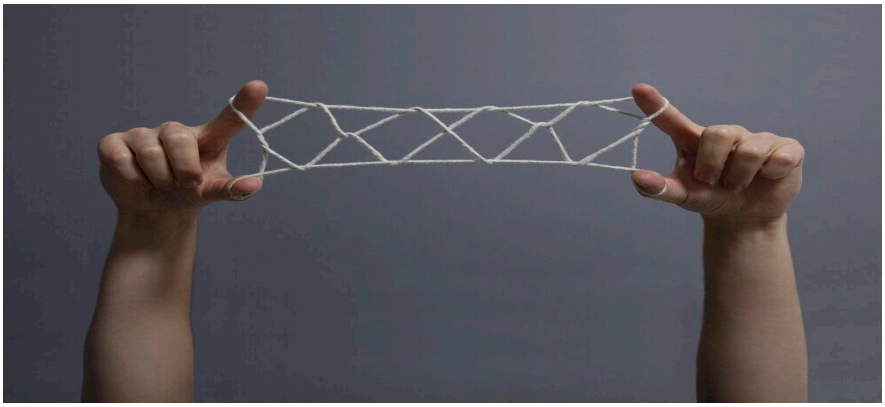


Figure 2.5 Malepa (indigenous game)

Moloi (2015) argued that learners can learn multiple functions from playing indigenous games such as *kgati as shown in figure 2.6*, which can also be referred also to a skipping rope. Learners can be divided into two teams; however, only two people from each team are permitted to hold the skipping rope. Moloi further indicated that through the game, learners can identify geometric shapes with the aim of interpreting, converting and integrating them into mathematics word problems. The movement of *kgati* refers to the way the rope changes shape when it moves, for example, when it swings down for the first time and touches the ground to form a loop that faces upwards, and when it swings up for the first time and weaves in the air to form another loop facing downwards.

The other mathematical concept that can be learnt through this game is about discussions and analysis of the observations. Critical discourse analysis is used to analyse what was observed, and to identify power balances (discursive practice) and social inclusion (social practice), especially where some learners are given a platform to demonstrate the moves of *kgati*, while teachers, other learners and the rest of team members observe the moves of *kgati*.

Figure 2.6 Kgati (indigenous game)

2.5. Conclusion

This chapter highlighted the methods generally used by educators in teaching of mathematics and in support of teaching geometric patterns in the intermediate phase, as well as the incorporation of indigenous games as educational tools to support the lessons of geometric patterns in the intermediate phase. The next chapter addresses the research design and methodology of the study.

Chapter 3
Research Design and Methodology

3.1. Introduction

This study used an explanatory sequential approach which employed quantitative and qualitative techniques. This section highlights the research paradigm, research methodology, research design, population and sample as well as instruments for data collection and analysis. The issues of validity, reliability and ethical considerations are also covered in this chapter.

3.2. Research paradigm

According to Creswell and Plano Clark (2017) and Johnson and Turner (2003), mixed methods research is centred on the idea that using a variety of data and methodologies to analyse and solve complex problems is regarded as the most efficient approach. That is the function of pragmatic approach it resolves the challenges of the research. Pragmatism is appropriate for a mixed methods (Kaushik and Walsh, 2019). This perspective is undoubtedly intriguing to mixed methods researchers, who combine quantitative and qualitative procedures to address issues. Researchers are free to employ any procedures, systems, and approaches for the study (Hopper, Gulli, Howard, Kano, Krupenye, Ryan and Paukner, 2021). Therefore, the researcher used a range of approaches and strategies to investigate the research questions of study. This was appropriate for the study mainly because it is grounded bricolage theoretical framework. Researcher utilized several indigenous games as tool to teaching geometric patterns

3.3. Research methodology

According to Pandey and Pandey (2021), research methodology determines how a study needs to be conducted. It is inclusive of concepts and techniques that support a research method that is presented in order to solve the problem of a study. In addition, May and Perry (2022) indicated that methodology should recognise and clarify various studies and select the most suitable research methodology to investigate a study and

utilising appropriate measuring tools for the research. This study consisted of two research methodologies:

3.4. Quantitative approach

Quantitative research uses statistical or numerical data, which are then statistically analysed to formally test theories by formulating hypotheses (Watson, 2015). The study has been conducted using a survey design. This was done by distributing questionnaires to seek the opinion of teachers regarding the use of indigenous games as a strategy for teaching mathematics, with specific focus on geometric patterns, as well as to seek the methods that are presently used by teachers in teaching geometric patterns (Teddlie and Tashakkori, 2010).

3.5. Qualitative approach

The study used a sequential explanatory design , where the approach was defined as an intensive, systematic investigation about a particular community or group that permits a researcher to examine data in-depth (Atkins, Francis, Islam, O'Connor, Patey, Ivers, Foy, Duncan, Colquhoun Grimshaw and Lawton, 2017). This method is supported by Edwards (2016), who highlighted that the setting of how data is collected may differ according to the researcher. This section is based on textual material that will be derived from a talk or conversation (Krippendorff, 2018). Conversations in qualitative research are usually carried out in audio–visual, photo–voice, interview recordings and observation.

3.6. Research design

Han, Zu and Chen (2018) defined the term *designed study* as a research project that provides structure for data collection. Furthermore, they mentioned that a well-designed study should aim at producing accurate results. In addition, Fellows and Liu (2021) defined a research design as a coherent strategy linking research topics to the implementation of research methodologies. The objective of a research design is to establish a method for collecting scientific data that will be utilised to answer the research questions (Broad, Ortiz and Meades, 2019). In essence, a research design determines the functionality of data in order to address the research questions of the

study (Frost, 2021). In addition, Merriam and Tisdell (2015) indicated that a research design should produce reliable and trustworthy conclusions.

3.7. Sequential explanatory design

The sequential explanatory design was employed. A sequential explanatory research builds on the findings of a prior data set. Therefore, this study consist of two stage: The first stage utilised quantitative approach whereby the researcher distributed questionnaires to seek the opinion of teachers on the use of indigenous games as a tool for teaching mathematics, with specific focus on geometric patterns, as well as to seek the methods that are presently using in teaching geometric patterns (Teddlie and Tashakkori, 2010). The qualitative data were used to gain more depth and clarify the findings of the quantitative phase in the second phase of the study (Pardede, 2019).The results of this mixed methods study were interdependent, which means that they were applied to further develop, clarify, and elaborate upon the conclusions of the initial quantitative stage (Dupin and Borglin, 2020). The researcher was able to answer the two sub-research questions that focused on the teaching methods currently used by educators when teaching geometric patterns, as well as investigating how does the application of indigenous games as a strategy support the teaching of geometric patterns in the Intermediate Phase.

3.8. Population and sample

Drisko and Maschi (2015) defined a research population as a process of selecting subjects to represent the entire population. Wang, Hu, Xia, Wen and Ding (2012) indicated that sampling is the selection from a large population by applying certain criteria. The questionnaires of the study were distributed to fifty mathematics educators from various schools; however, only five teachers were selected for interviews based on cluster techniques. The selection of the five teachers was based on the grades that were underperforming in the school. The observation was conducted in five classrooms in various schools in order to get more information regarding the use of indigenous games as a strategy to support the instruction of geometric patterns to address the objectives of the research. The duration of the observations for two periods The researcher searched for the most effective method of instruction to inspire and encourage learners who are challenged with mathematics.

3.9. Instruments for data collection

Johnson, Christensen and Kagermann (2008:89) defined data collection as a process of preparing and collecting the data. The researcher utilised three tools for collection of the data: questionnaires for the survey part, individual interviews and observation that were conducted in the classroom.

3.9.1. Research instruments

Three instrument tools were used for data collection: a questionnaire that was distributed to participates through email, semi-structured interviews and observations.

3.9.2. Questionnaire

A questionnaire is a type of research tool that consists of a series of questions to collect data from respondents. The principal requirement of questionnaire format is that questions are sequenced in a logical order, allowing a smooth transition from one topic to the next (Sarantakos, 2005). This would ensure that participants understood the purpose of the research and they would carefully answer questions towards the end of the survey (McGuirk and O'Neill, 2005). Structured questionnaires were used to gather data. Items in the questionnaire were close-ended and related to the opinion of the teachers whether they were aware of indigenous games, and whether they have been using it in their teaching and learning of mathematics as stipulated in the CAPS document. The factors for selection were restricted to the objectives of the study.The researcher structured the questionnaire by first discovering methods that are currently used by educators in teaching of geometric patterns in the Intermediate Phase. The second phase of the questionnaire was mainly focused on awareness of educators pertaining application of indigenous in teaching and learning .

The researcher conducted the questionnaire (Annexure 1) via email by using a link that was sent to the educators via WhatsApp. This was meant strictly for educators who were teaching mathematics in the intermediate phase. As the participants opened the link, it requested them to fill in the consent form before proceeding with the survey. The duration of the questionnaire was approximately 15 minutes to 30 minutes. Once the participants have completed the procedure, the researcher received a notification to indicate that the participants have answered the questionnaire.

3.9.3. Interviews

Interviews were conducted among the educators before the observation. This helped the researcher to check whether what they mentioned during the interviews was reflected in their teaching activities. Semi-structured, open-ended interviews were conducted by the researcher (Annexure 2). The aim of the interview was to investigate methods currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase and how the application of indigenous games as a strategy supports the teaching of geometric patterns in the intermediate phase.. The interviews were scheduled beyond the teachers' scheduled class periods and took place where it was appropriate and convenient for them. The participants were comfortable with the interview being conducted after school. Therefore, the researcher set appointments with the educators and the interviews were conducted in person. Before the interviews, consent papers were distributed to the teachers. The interviews duration was approximately 30 minutes to an hour.

Common language with the teachers was employed during the interviews in order to collect rich data from them. The typical language refers to English. Interviews alone were insufficient since the findings would be constrained by the educators' capacity to communicate their thoughts in-person. Therefore, it was necessary to verify their teaching strategy in the class through observations. According to Nardi (2018), observational approaches can be used to validate the data gathered through interview and survey methodologies.

3.9.4. Observation procedure

Information from a primary source is actively obtained through observation. In the course of scientific observation, humans and phenomena are observed in their most natural environment, rather than utilising arranged settings such as laboratories and group discussions. In essence, this permits the researcher to observe the everyday lives of participants and it give the researcher insight on how participants make decisions and respond to circumstances that they are encountered daily (Saville, 2016). The selection of educators elected for observation was the five educators' that were selected for interviews. Observations were based on how educators present their lesson when teaching geometric patterns in the intermediate phase. The researcher mainly focused on the teaching methods that were conducted by educators during the

lesson as well as interaction in the class (Annexure 3). The fundamental elements for this study were based on lesson plans, teaching pedagogies as well as the activities that were conducted in the classroom. The lesson plan determined if educators were aware of the use of indigenous games as a strategy of teaching and learning in the intermediate phase, which gave the researcher the prospective of the teaching methods that are currently used when teaching geometric patterns in the intermediate phase. Furthermore, the lesson plan also indicated whether educators were creative in their lesson preparation and adhered to the interest of learners when conducting a lesson plan.

The first stage of the observation was based on how teaching and learning in mathematics took place. The second stage of the lesson was mainly focused on the interaction between educator and learners.

The last stage of the lesson was guided by a worksheet (Annexure 3) to show the incorporation of indigenous games and how mathematics is converted and interpreted into geometric and numeric patterns to make sense of the learning of mathematics word problems for learners in elementary grades.

3.10. Data analysis

Data analysis is defined as a process that unlocks hidden data in raw information and transforming it to something meaningful (Fairclough (2013). The researcher collects and analyses data through a bricolage, resulting in connections and developing new meaning (Barker, 2004). The theory was founded on the idea that education should interact with and extend knowledge, and that educational approaches should allow for experimentation, thought and reflection.

The data emerging from the questionnaire were quantitative in nature and were analysed by using the IBM SPSS Statistics, and content analysis was used for the qualitative data (Teele, Nkoane and Mahlomaholo, 2020). Content analysis is regard as a research method which consist of textual, visual, or aural material are systematically coded and categorised (Coe and Scacco, 2017).This approach is regarded as an effective way of presenting qualitative findings (Chevalier and Buckles, 2019).

Since both quantitative and qualitative data were involved, the analysis of the data was carried out in stages. During the first stage the researcher distributed the questionnaire in order to determine if the educators were knowledgeable about the use of indigenous games in teaching geometric patterns. The second stage utilised semi-structured interviews. This was done to analyse the explanations that shaped the educators' perceptions of indigenous games as a teaching strategy in teaching geometric patterns.

The third stage was the observations, and their analysis were examined. The rankings were created at this point using the information from the observation sheets according to the teaching strategies that were applied in the classroom when teaching geometric patterns. At this juncture, the researcher observed how educators utilised indigenous games as a strategy of teaching geometric patterns. As a bricolage theoretical framework, was employed during the quantitative and qualitative analysis stage to recognise, understand, and analyse whether the educators were aware of the use of indigenous games in teaching geometric patterns in the intermediate phase. This idea was used throughout the questionnaires, interviews and observation to investigate the knowledge that the educators had about indigenous games and if they were applying those techniques in their teaching pedagogy.

3.10.1. Quantitative analysis

The researcher distributed a questionnaire and then examined the participants' responses. After reviewing the responses, the researcher rated them according to how frequently they occurred. The researcher used a coding system to conveniently collect the results of the educators. The coding method made it possible to display data on tables and pie charts, which gave findings a clear representation.

3.10.2. Qualitative analysis

This second phase involved a thorough qualitative analysis with a focus on the data obtained from the interviews with the educators. The literature study from Chapter 2 was reviewed to analyse and identify methods that are currently used by educators when teaching geometric patterns and the incorporation of indigenous games in the mathematics classroom. The recordings were viewed in order to get insight of educators about the use of indigenous games in teaching geometric patterns in the

intermediate phase. The first stage of the analysis was listening to the recorded interview and modifying the transcript. The interview transcripts were then organised. The transcribed interviews were compared or contrasted several times in order to get as near to the data source as possible. The lesson observation of educators was the second stage of data analysis after the interviews in order to analyse the teaching strategies applied in their classrooms when teaching geometric patterns.

3.11. Validity

Validity is defined as a yardstick that determines how valid the data is through the use of the research instrument (Yazan, 2015). Validity consists of both internal and external validity (Krawczyk, Topolewski and Pallot, 2017). Internal validity establishes a causal correction relation between the dependent and independent variable. For instance, in this study, the assumption was that there is a relationship between indigenous games and mathematics concepts.

3.12. Reliability

Reliability refers to the instrument's ability to measure the repetition of the research findings and produce results (Bush, 2022). According to Chowdhury, Yadaiah, Prakash, Ramakrishna, Dixit, Gupta, and Buddhi (2022) reliability means the degree to which a measurement technique can be depended upon to secure consistent results upon repeated application, and this is in line with Cooper's definition, it is the consistency of measurement (Panuccio, Galeoto, Marquez, Tofani, Nobilia, Culicchia, and Berardi, 2021)

3.13. Ethical considerations

The University of the Free State granted the researcher with the ethical clearance. Thereafter, the researcher requested permission to conduct the study at the selected schools from the Free State Department of Education, which was granted.

The participants were requested to sign an informed consent form to document their consent to voluntary participate in the study. They were informed of their role and responsibility as well as their right to withdraw at any point should they wish to do so,

without any pressure. The researcher ensured that confidentiality and anonymity of participants were ensured to protect the participants' identities. The names of the schools and the participants were not disclosed during the survey questionnaire, interviews and observation.

3.14. Conclusion

This section discussed the study's paradigm, methodology of the study, population and sample, instruments for data collection, data analysis, reliability, and ethical considerations.

Chapter 4
Presentation of Research Findings

4.1. Introduction

The study investigated the use of indigenous games in teaching geometric patterns in mathematics in the intermediate phase. This chapter presents the data gathered through the explanatory sequential mixed method. The responses presented here were collected from the teachers' questionnaire and the individual interviews with the five educators selected from various schools. The first section of the chapter presents the demographical data of the respondents. Demographical data is of a great value in a study mainly because it provides the researcher enhancement of understanding of specific background traits of a target audience, such as age, race, ethnicity, income, employment status, and marital status. This is of a great importance to This is followed by the data obtained in the interviews, followed by the data from the observation. The findings from the study are presented within the context of the sub-research questions posed in Chapter 1, which guided the study, namely the methods currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase, and how the application of indigenous games as a strategy supports the teaching of geometric patterns in the intermediate phase. The research methodology and design were described, discussed and presented in the previous chapter, which also included a thorough explanation of the sources of data and the data-generating methodologies that were employed to generate significant data to address the study topics. The presentation of the data results is the primary focus of Chapter 4, which is divided into two portions. The results of the information recorded from the teachers are presented in the first section, where the general demographics are presented first.

4.2. Presentation of findings of data collected from educators

The open-ended questionnaire, semi-structured interviews, and lesson observations were employed in this research to gather information from the teachers. The results of the open-ended questionnaire and semi-structured interviews are reported in the first of two sections that make up the rest of the presentation of the data gathered from the

teachers. The results of the data in this first portion are arranged according to the themes and their subthemes. The data produced from the lesson observations are instead presented in the second portion. In this section, the findings are arranged in accordance with the characteristics of classroom instruction and learning, which were the focus of the lesson observations.

4.2.1. Presentation of findings of data from educators

The study findings from the educators' responses to the open-ended questionnaire, semi-structured interviews, and lesson observations are presented in this part. The section begins by providing background information on the participants before providing demographic information on the teachers who took part in the study. The open-ended questionnaire used as the first data-generating instrument in this study, included a first section that collected demographic data about the teachers.

4.2.1.1. Biographical data

The biographical data of the respondents are presented in Table 4.1.

Table 4.1 Biographical data of respondents

Educators (N=50)			
Biographical variables	**Description of variables**	**Frequency**	**Percentage**
Gender	Male	23	46
	Female	27	54
Age	20–30 years	16	32
	31–40 years	12	24
	41–50 years	17	34
	51–60 years	5	10
Years in teaching	More than 9 years	24	48
	7–9 years	12	24
	4–6 years	7	14
	Less than 4 years	7	14
Grades currently taught	Grade 4	6	12
	Grade 5	5	10
	Grade 6	6	12
	Grade 7	7	14
	Grades 4 and 5	7	14

Educators (N=50)			
Biographical variables	**Description of variables**	**Frequency**	**Percentage**
	Grades 4 and 6	4	8
	Grades 4 and 7	6	12
	Grades 5 and 6	4	8
	Grades 5 and 7	2	4
	Grades 6 and 7	5	10
Type of school	Public school	50	100
	Private school	–	–
Race	Black	39	78
	White	3	6
	Indian	–	–
	Coloured	8	16
Qualification	Advanced Certificate in Teaching (ACT)	1	2
	Education Diploma	6	12
	Postgraduate Certificate in Education (PGCE)	3	6
	Bachelor of Education (BEd)	25	50
	Masters	1	2
	Doctoral degree	–	–

4.2.1.2. Presentation of findings from questionnaire and interviews

A questionnaire was used prior to the interviews and lesson observation to acquire a general view of the methods when geometric patterns in the intermediate phase are being taught.

Also, five educators underwent a 45–60 minute interview. All of the interviews were audiotaped, and verbatim transcripts were created. Because these interviews allowed for probing, which encouraged the educators to elaborate on their comments, they helped in capturing a greater knowledge of their perspectives and experiences. The results are presented in their raw form, utilising direct quotations from the participants in order to give extensive and comprehensive descriptions of the educators' points of view.

The researcher made a verbatim transcript of the educator questionnaires, interviews and class observation audiotapes. In order to become comfortable with the resulting

data, the transcripts, teacher questionnaires, and handwritten field notes were reviewed multiple times.

The codes in a tabular format served to illustrate the connections between the participants and the data. The

4.2.2. Responses from closed questionnaire items

4.2.2.1. Preference of teaching method

Question: *Indicate your preference of your teaching method when teaching geometric patterns.*

The preferred method of teaching as shown in Figure 4.1 Stipulate that the majority of the teachers preferred the chalk and talk method when teaching geometric patterns.

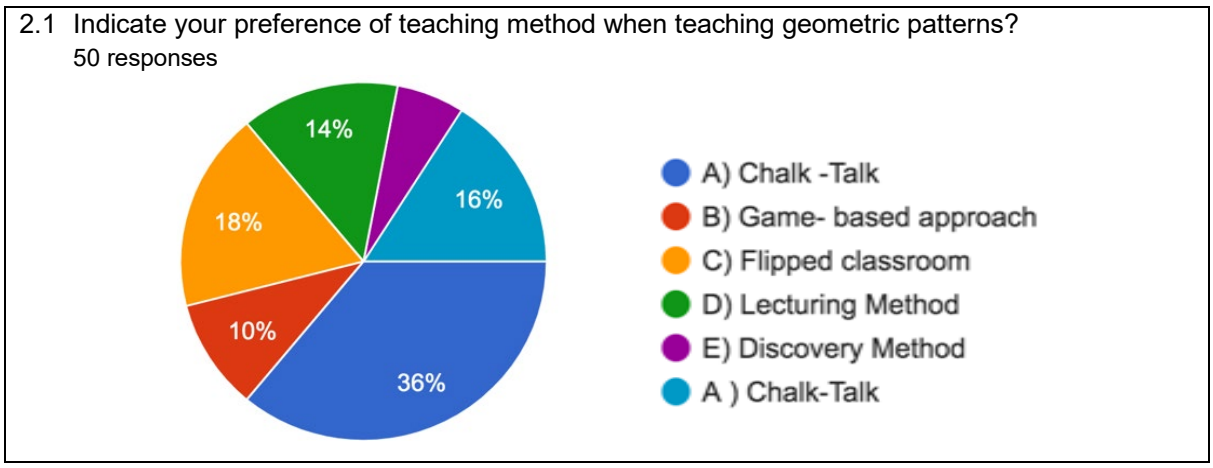


Figure 4.1 Preference of teaching method when teaching geometric patterns

4.2.2.2. Inspiration of the teaching method mentioned above

Thirty-six educators indicated that their teaching method was inspired by their primary school teacher. Therefore, they adapted to the teaching method when teaching geometric patterns in the intermediate phase. The following excerpts from educators' explanations support the above statement.

- **Teacher 1**: *This was inspired by one of my teachers at primary background.*
- **Teacher 30**: *This method was inspired by one of the lecturers at university*.

- **Teacher 10**: *This was inspired by one of the lecturers as it is effective in a sense that learners are given knowledge*.

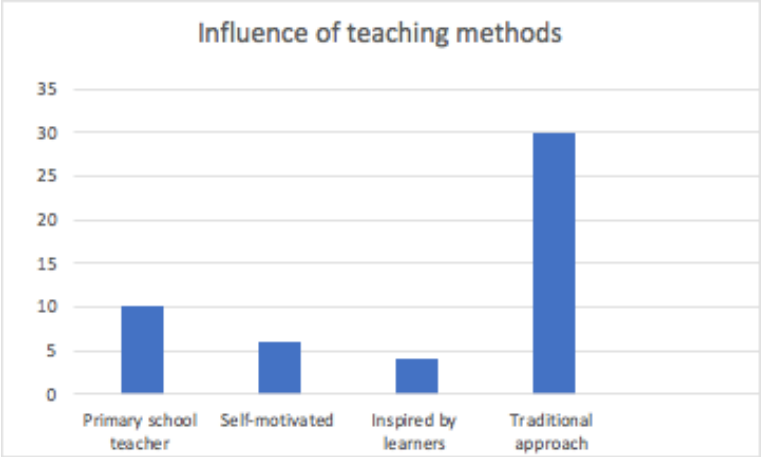


Figure 4.2 Influence of the teaching method

On the questionnaire responses, some of the teachers expressed that their teaching method was inspired by their lecturers at university level. The table below showcase the findings.

4.2.2.3. Common challenges faced when teaching geometric patterns

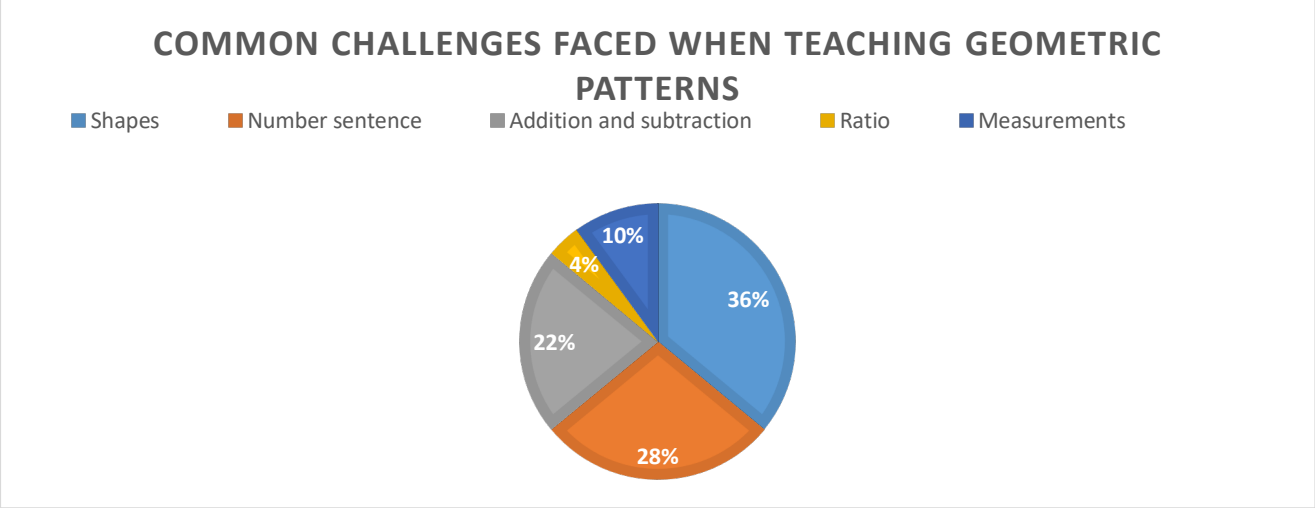


Figure 4.3 Common challenges faced when teaching geometric patterns

Figure 4.3 shows that 36% of the educators indicated that they were struggling with *shapes*. The above chart indicate that majority of learners struggle with shapes. Therefore, the incorporation of indigenous will be of a great value to improve the performance of learners in geometric patterns.

4.2.2.4. Measures used to overcome the challenges encountered when teaching geometric patterns

From Figure 4.4 it is evident that the majority of educators conducted extra classes to assist their learners.

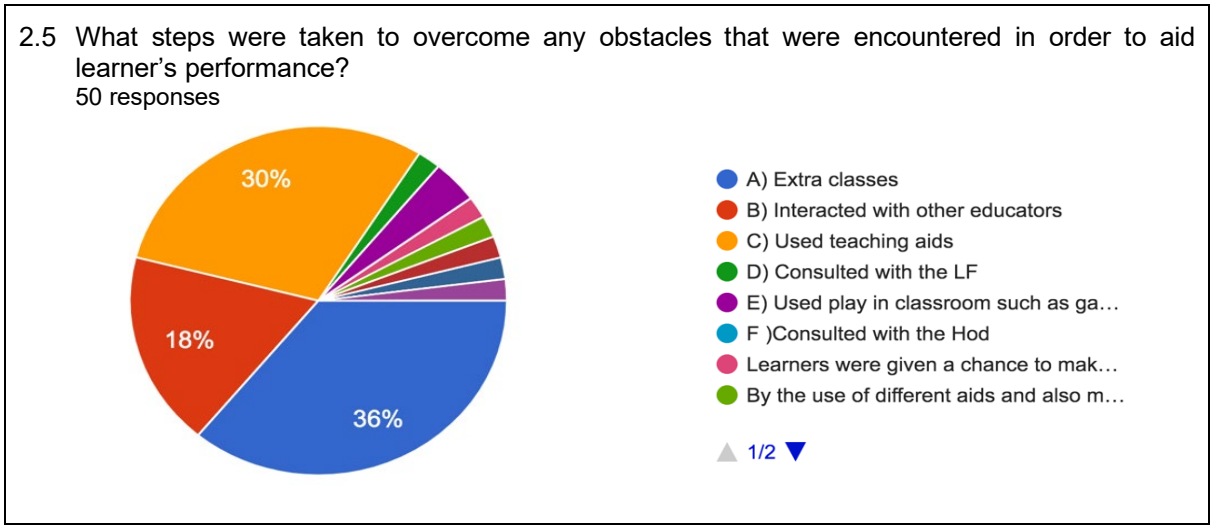


Figure 4.4 Measures used to overcome challenges when teaching geometric patterns

4.2.2.5. Link between real-life situations and mathematical concepts

The educators agreed that there is a link between mathematical concepts and real-life situations. The educators indicated that mathematical concepts relate in *additions* and *subtractions*.

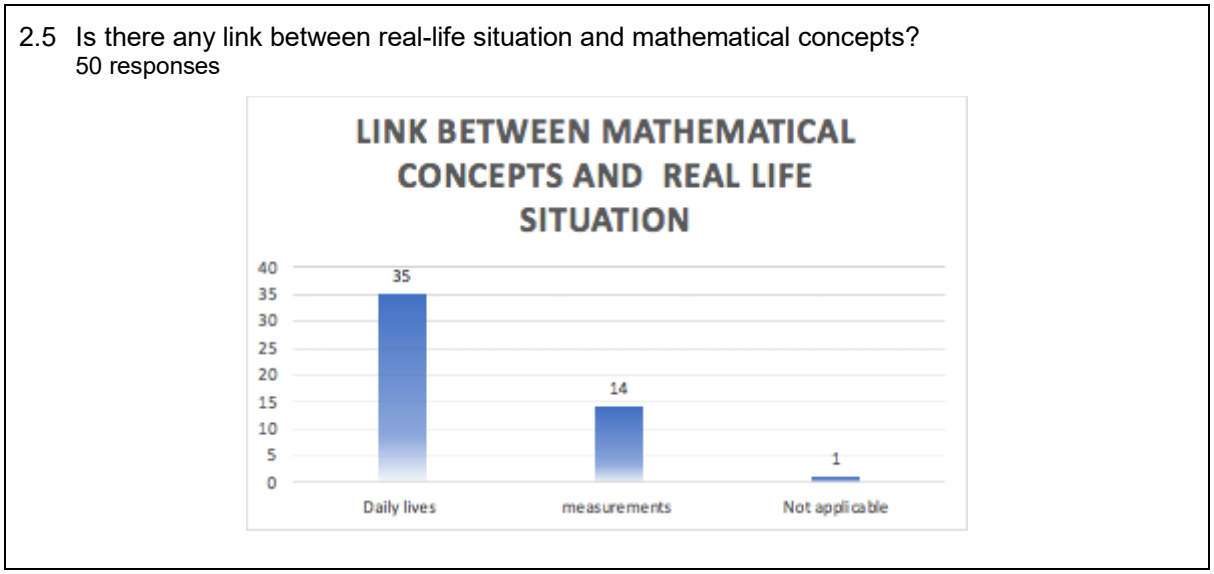


Figure 4.5 Link between real-life situations and mathematical concepts

4.2.3. Mathematical concepts connected to the use of indigenous games

Educators indicated that through the use of games, *addition* was identified as a mathematical concept. This is shown in Figure 4.6.

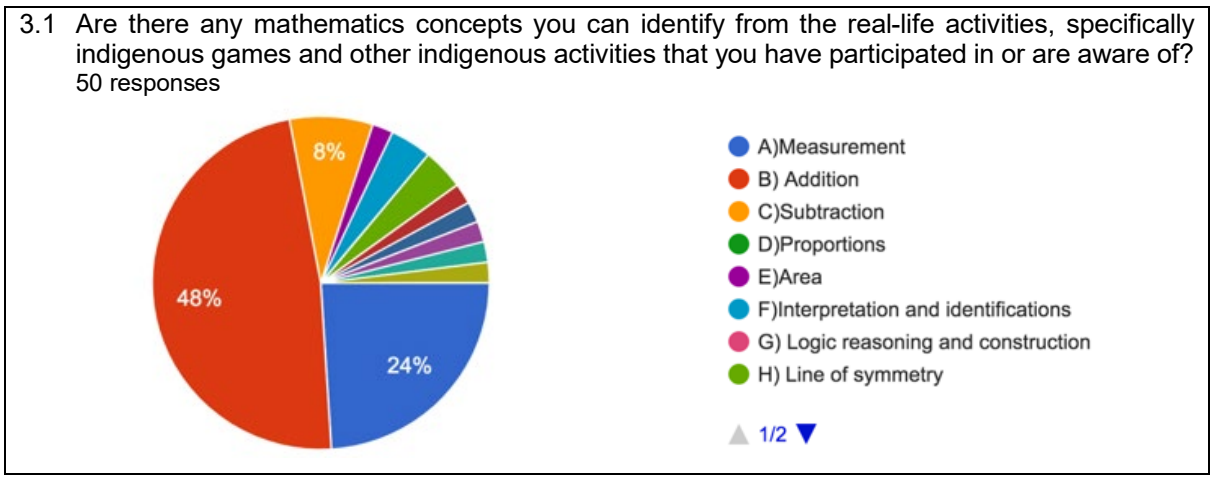


Figure 4.6 Mathematical concepts and the use of indigenous games

4.2.3.1. Game-based learning

Various countries are implementing game-based learning. The question was asked whether the curriculum in South Africa should be adapted to include this approach.

The majority of educators (45) indicated that game-based learning may be effective to improve academic performance of learners. This is supported by the following excerpts:

- **Teacher 1**: *Yes. Game-based introduces creativity into traditional classroom. It also encourage learners to interact in class.*
- **Teacher 40**: *Yes, to develop our content and making teaching fun*.
- **Teacher 30**: *Yes, South Africa should be adapted to this method to make teaching fun for learners and teachers.*
- **Teacher 14**: *Primary school learners learn effectively through play; hence Free State Education MEC Tate Makgoe introduced Edu Walls or Education walls in primary schools, e.g. visit Tsholohelo Primary School or Kgato Primary School in Rocklands.*
- **Teacher 20**: *Yes, curriculum that we are presently using is failing us.*
- **Teacher 17**: *Yes, it is high time we develop skills that can help the school system.*

4.2.3.2. Use of indigenous games applied in mathematics lessons

Figure 4.7 Shows that educators rarely applied the use of indigenous games in teaching geometric patterns.

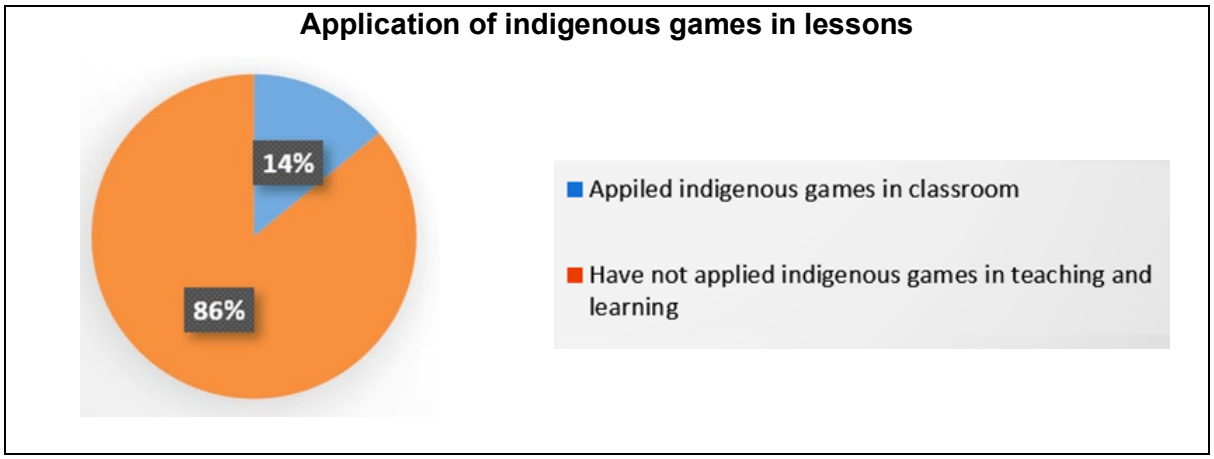


Figure 4.7 Use of indigenous games in teaching geometric patterns

4.3. Responses from the five educators' interviews

A total of five teachers participant in the invited.

4.3.1. Participants' responses to open-ended interview items

Question 1: How long have you been teaching in the intermediate phase?

Based on the question above, it is evident that the educators have been in the field for quite some time and have a number of years of experience teaching mathematics. The excerpts below support the statement above:

- **Teacher A:** *I have been in the system for 25 years. I first started teaching foundation phase for 15 years then I started teaching intermediate phase for 10 years.*
- **Teacher B:** *I started teaching intermediate phase for 9 years*.
- **Teacher C:** *I've been teaching mathematics for 7 years*.
- **Teacher D:** *For 20 years*.
- **Teacher E:** *I have been teaching for 10 years in the field*.

Question 2: What were your major subjects at the higher education institution?

The educators majored with mathematics at the higher education institution. The following excerpts support the statement:

- **Teacher A**: *Mathematics and Language.*
- **Teacher B**: *Language*.
- **Teacher C**: *Mathematics, Technology and machinal technology*.
- **Teacher D**: *Mathematics and languages; geography I did primary subjects*.
- **Teacher E**: *Mathematics*.

Question 3: Which grades are you currently teaching in the phase?

The majority of the educators are teaching grade 5 in the intermediate phase. The excerpts below show their answers:

- **Teacher A**: *Grades 4 and 5.*
- **Teacher B**: *I am currently teaching Grades 5 and 4.*
- **Teacher C**: *Grades 4 to 7.*
- **Teacher D**: Grades 5 and 7.
- **Teacher E**: Grades 5 and 6.

Question 4: How long have you been teaching mathematics in each grade?

According to their answers, it is evident that the educators have been teaching in the grades for more than three years. The excerpts below proves the statement:

- **Teacher A**: *Grade 5 it has been 5 years and Grade 4 has been 10 years.*
- **Teacher B**: *For 6 years both the grades*.
- **Teacher C**: *The junior phase has been 3 years and the senior phase 4 years*.
- **Teacher D**: *For 4 years.*
- **Teacher E**: *I have been teaching both the grades for 3 years*.

Question 5: What are the major challenges you have faced in your classroom pertaining to the teaching of geometric patterns in the intermediate phase.

All the participants responded positively to this question by stating what they classified as barriers to learning of geometric patterns based on their experiences. The educators indicated that the core issue in geometric patterns was *shapes*. The

educators attested to the fact that learners cannot differentiate the shapes and its properties. The excerpts below confirm the educators' views:

- **Educator A:** *Learners struggle to differentiate shapes and their properties. Secondly, instructional language is a problem mainly because most of the learners cannot apply nor read the language. In most cases the teacher must read the questions and explain to show how to do the work.*
- **Educator B:** *Shapes, most of my learners cannot differentia shapes*
- **Educator C:** *Basically one of the challenges that I have encountered in the class, I have realised that most of our learners are not familiar with the shapes they are familiar with the properties of the shapes.*
- **Educator D**: *The problem that learners have they cannot calculate area. They lack knowledge of geometric patterns in mathematics, they don't understand what it is and also shapes – they cannot differentiate the shapes, so I constantly have to repeat the name of the shapes.*
- **Educator E:** *Learners are struggling with shapes; they tend not to be able to differentiate the shapes.*

Question 6: Is there any form of support that you are getting to solve the matter?

The teachers stated that they usually embarked on different activities to assist learners who have difficulties in mathematics overcome those challenges. For example, extra classes were used as a form of support for learners who encountered problems in the mathematics classroom. The excerpts below from Educator B support the above mentioned statement :

- **Educator A:** *I usually write the definitions for learners on the board; thereafter I explain the terms. I usually use teaching aids in classroom. In particular when presenting patterns*
- **Educator B**: *I conducted extra classes for learners that are struggling.*
- **Educator C**: *No.*
- **Educator D**: *Yes, they are doing workshops. The previous term there was a workshop of mathematics of setting a quality assessment paper and the subject advisors are still coming even though they are not specifically looking at the geometric patterns, but they are checking things that work in general*.
- **Educator E**: *No.*

Question 7: I actually want you to reflect back to your childhood experience and share your memories on the games you used to play; these games may be indigenous games or any form of games that you remember. Feel free to mention more than one game.

The educators were still fond of the indigenous games they used to play in their childhood. The excerpts below supports the above mentioned :

- **Educator A**: *Diketo.*
- **Educator B**: *Chess.*
- **Educator C**: *Dibeke.*
- **Educator D**: *Diketo*, *dibeke and high jump.*
- **Educator E**: *Chess.*

Question 8: Which mathematics concepts have you learnt or identified in the different indigenous games? Indicate each indigenous game and the related mathematics concepts.

The educators were not so informed about the application of indigenous games in teaching geometric patterns in the mathematics classroom. The excerpts below support this statement:

- **Educator A**: *Counting*.
- **Educator B**: *Counting.*
- **Educator C**: *Dibeke. I can say I learnt counting, the measurements as well, whereby one can count the distance.*
- **Educator D**: *Diketo has addition.*
- **Educator E**: *Learners can concentrate when playing the game.*

Question 9: Lesson plans give direction in how learning should be conducted. Which teaching strategies do you prefer when teaching patterns ?

The teaching strategies applied by educators in teaching geometric patterns characterise the traditional approach of teaching, whereby educators do not use

practical activities to develop the understanding of learners. The excerpts below further support this statement:

- **Educator A:** *My lesson plans are grounded on the textbook.*
- **Educator B:** *I constantly reflect on the text book to conduct my class.*
- **Educator C:** *Because we are in multigrade our ATP [advanced teaching programme] annual teaching plan is a combination of phases from Grade 4 to 6, so teaching of geometric patterns I normally draw patterns that they are familiar with, for example our uniform has a lot of patterns such as diamonds, cross, etc. When I introduce a subject of shapes, I draw the shapes on board; the learners identify the shapes. Our learners find it difficult of completing a table of input and output.*
- **Educator D**: *I let learners to discover things on their own. I usually draw shapes on the board then I ask them to mention the names of shapes, or I ask questions.*
- **Educator E:** *I write on the board, then learners observe.*

Question 10: The conventional approach refers to the chalk and talk method, it involves direct instruction by the educator to transfer knowledge to learners. This form of teaching has been the centre of teaching and learning for many years. Should this form of learning continue to be practiced in rural or farm schools?

Teaching methods adapted by educators in their classroom. Utilises conventional teaching and learning. The excerpts below further support this statement:

- **Educator A:** *Yes, I preferably use Chalk and talk method of teaching.*
- **Educator B:** *I constantly reflect on the text book to conduct my class then write on the board.*
- **Educator C:** *Yes, according to the different learning styles as an educator you need to apply teaching styles some learners who learn by hearing.*
- **Educator D:** *The method is effective so that learners can see spelling on the board so that they can understand where we are presently; there are not enough teaching aids.*
- **Educator E:** *Yes, it is effective for teaching and learning*.

Question 11: In your view, how can indigenous games be used to help the learners understand geometric patterns?

Five of the educators stated that they learnt mathematical concepts in their childhood through games, but could not link geometric patterns and number sentences to their statements. However, Educator C could link geometry to indigenous games. The following excerpts explain the educators' views:

- **Educator A**: *Yes, various games involved counting.*
- **Educator B:** *Yes, soccer. Counting the number of goals*.
- **Educator C:** *When we talk about indigenous its board, we have diketo, kgathi and morabaraba. Marabaraba helps kids to learn about movements, counting, differentiate the type of movements. And also morabaraba itself, the appearance of the drawing board has some patterns. It is simple to understand to learn this game and understand the patterns.*
- **Educator D:** *When they play, the more they learn, and teacher just guide learners or also use match sticks to draw shapes.*
- **Educator E:** *I am not certain.*

4.4. Observation procedures

The researcher took the following into consideration during classroom observation:

Educators lesson plan does not include indigenous games as a teaching strategy. The objective of the lesson is not communicated to learners by the educators, instead content is written on the board. This is a clear indication that teaching strategies used by educators in teaching of geometric patterns promotes the traditional method of teaching. Educators who participated in the study utilised the chalkboard as a teaching tool to present their lessons. The participants of the study confirmed that learners are not given a platform to make sense of the information or problem presented, instead the educators give learners an explanation. In essence, learners' prior knowledge is not consulted by educators in the classroom. Table 4.2 substantiates the above statements.

Table 4.2 Observation sheet

Indicator	Educator A	Educator B	Educator C	Educator D	Educator E
Introduction	Lesson presented did not address relationship between geometric patterns and indigenous games	Introduction was mainly focused on geometric patterns; there was no correlation between indigenous games and geometric patterns	The educator did not refer to the use of indigenous games; however, used a real-life situation to teach shapes	Lesson presented did not include indigenous games	Lesson presented did not address relationship between geometric patterns and indigenous games
Objective	Objective of the lesson is communicated clearly by the educator to learners	The objective was clearly communicated	Educator instructed learners to identify shapes in the classroom	The objective was communicated to learners	The objective was communicated to learners
Interaction	No interaction between educator and learners	Educator picked two learners to make corrections on the board. Further corrected the mistake of learners	Learners identified shapes	Educator requested learners to read out the names of shapes from the board	Educator did not interact with learners
Prior knowledge of learners	Educator did not consult on the prior knowledge of learners	Learners knowledge was not addressed in the lesson	Educator did not ask learners about their history or knowledge	Educator did not reflect to the experiences of learners in their lesson	Prior knowledge of learners was not addressed
Teaching strategies and Interaction between educator and learners	There was no flow of communication in the classroom	Teacher did not engage in indigenous games. Learners were not given the platform to share ideas	Educator requested learners to draw those shapes on the board	Teacher put shapes on the board and learners were expected to identify the properties of the shapes as well as naming them.	The educator wrote on the board, then observed the work of learners
Teaching resources that are used in classroom	Textbook and chalkboard	Chalkboard	Chalkboard	Chalkboard and textbook	Chalkboard
Learning variety of learners	The educator applied one strategy to teach her lessons; did not apply the needs of learners	Educator applied one teaching strategy	Educator addressed the various needs of learners	Educator did not attend to the various learning styles	Educator did not meet the needs of various learners

4.5. Summary of the findings from the observations

Observations were conducted by the researcher to investigate the teaching methods that are currently used by educators in teaching of geometric patterns and how the application of indigenous games as a strategy support the teaching of geometric patterns in the Intermediate Phase. Figure 4.2 indicates that educators introduction does include indigenous games and geometric patterns relation. The objectives of the lesson are no communicated to inform learners what is expected from them. As a results there no effective interaction between educators and learners during teaching and learning. This was similar in all classes for the purpose of maintaining the interest of learners and their understanding of particular concepts or topics. In addition educators do not consult the prior knowledge of learners in their presentation and commonly use chalkboard and textbook in their classrooms. Educators' are innovative to create a conducive teaching that cater the different learning styles of learners.

4.6. Conclusion

The chapter highlighted on the data collection and analysis of the study. The next chapter presents the findings and conclusion of the research. The research findings indicate that educators lack familiarity with the pedagogical application of indigenous games for teaching geometric patterns in the intermediate phase. Instead of building on the learners' prior knowledge, the traditional way of teaching still relies on classroom processes and imparts knowledge to students with the expectation that they would passively absorb it. This is especially true in mathematics classrooms. However, it appears that traditional education does not consider the varied requirements and challenges faced by learners in the twenty-first century, failing to provide them with the knowledge and critical thinking skills they need.

Chapter 5
Discussion of Findings

5.1. Introduction

The study investigated the use of indigenous games in the teaching of geometric patterns in the intermediate phase. The chapter commences by reviewing the previous chapters and presenting reflections on it. The findings of this study are discussed in this chapter and display the manner in which they have responded to the research questions.

Following that, some implications of the study's findings and recommendations is discussed. The study was guided by the main research question and the two sub-research questions:

5.1.1. Main research question:

How does the use of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?

5.1.2. Sub-research questions:

1. What methods are currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase?
2. How does the application of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?

These questions were generated from the following research objectives:

1. To identify the methods currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase.
2. To establish how the application of indigenous games as a strategy supports the teaching of geometric patterns in the intermediate phase.

The study's findings, which provided evidence of educators in the classroom, were discussed in Chapter 4. The results came from the questionnaire and interviews and observations.

5.2. Discussion of findings

The findings were acquired using three methods that were presented in three sections: Findings from the educators' questionnaire, the interview responses of five educators, followed by the results from the observations.

5.2.1. Sub-research question 1

This section presents the response to the first sub-research question addressed by the study:

> *What methods are currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase?*

Teaching of geometric patterns can be conducted using various teaching methods. First, the chalk and talk method focuses on the blackboard and the lecture voice prohibit informal activities in the classroom. Second, the lecture method is based on philosophy. Third, the learner-centred method which is commonly known as flipped classroom permit learners to watch online lessons and also grant learners the platform to create their own learning, with the educator supervising their learning. However, before the observation, the educators mentioned that they applied all the teaching strategies in their lessons, this was proven not to being the case when the observations were conducted. The study revealed that the chalk and talk method, which is commonly known as a traditional method, is still being practiced in the teaching of geometric patterns. To some extent, this method restricts learners enjoyment of mathematics.

The performance of learners in mathematics appeared to be significant influenced by the inadequate content knowledge that educators possess (Luo and Zou, 2022). The study made it evident that educators were not trained to apply various teaching methods for geometric patterns. According to Louck-Horsley, Stiles, Mundry, Love and Hewson (2009), one of the contributing factors to the poor achievement of mathematics in the country is affected by poor teaching practices and lack of teacher

content knowledge. One participant emphasised that the curriculum is centred on content rather than ensuring that learners understand the content being conducted in the classroom. Another participant stated that the curriculum was based on adaptation of foreign ideology. This statement is supported by Deerskin (2017, cited by Tachie and Galawe, 2021), who indicated that the doctrines of education in South Africa is grounded on the foreign approaches. The educators in this study revealed that learners share the common challenge that they do not perform well in the topic of geometric patterns. The participants of this study indicated that learners' performance is affected by a lack of understanding. Learners' cannot concentration for a long time in a classroom which becomes a hiddenness to their own learning. Application of chalk and talk make learners not to be interested in the classroom. Without the use of instructional aids such as charts or slides, educators struggle to stimulate the creativity of learners. As a result, this type of teaching and learning limits learners to express themselves as well as make learners not interested in the lesson presented. This study discovered that the preferred method of educators was one of the contributing factors to the performance of learners, mainly because it does not address the language of the learner.

The *chalk and speak* method fails to capture the attention of many learners in learning since it does not use any teaching tools. Learners should be given more freedom to express themselves and learn freely at their own speed as part of a more practical education. The hands-on approach of an elementary school can keep kids engaged. The indispensability of mathematics to human development cannot be denied, however there is a delusion that has been believed over the years that have made some people to view mathematics as a difficult subject to comprehend. This negative perception has led many learners to dislike the subject.

The teaching methods that educators practice in their classroom should enhance learners understanding of mathematical concepts and skills. Studies that were conducted on mathematical teaching and learning are predominantly focused on curriculum implementation, educational programmes of educators, instructional methods, educators' competencies and the knowledge possessed by educators instead on educators' strategies of teaching and their pedagogical skills (Leonard, 2018).

The research revealed that educators hardly ever apply different teaching techniques as a strategy when teaching geometric patterns in the intermediate phase. The majority of educators stated that they provided extra classes for the learners or provided learners with a lot of activities. The teaching strategies applied by educators promote the chalk and talk teaching approach, educators do not use hands on activities to develop the understanding of learners. The educators stated that they usually embarked on different activities to in order to assist learners overcome barriers. For example, educators volunteered themselves to conduct afternoon classes to help learners with barriers they have encountered in the mathematics classroom. The following excerpt from Teacher B supports the above statement:

- **Educator B**: *I utilise afternoon classes for learners who did not understand the work.*

Furthermore, the educators indicated that they get a form of support from the Education Department. This is supported by the following statement by Teacher D:

- **Educator D**: *Yes, they are doing workshops; the previous term there was a workshop of mathematics, of setting a quality assessment paper. The subject advisors are still coming, even though there are no specific looking at the geometric patterns, but they are checking that things work general.*

5.2.2. Sub-research question 2

How does the application of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?

Educators were familiar with indigenous games; however, they are not familiar with how they should apply them in teaching of geometric patterns. Prior to the classroom observation, educators claimed that they included knowledge of learners into their lesson delivery. According to the National Research Council (2000), educators need to ensure that the prior knowledge of learners is taken into consideration for effective learning.

The study investigated whether educators are using indigenous games in teaching geometric patterns in the intermediate phase. The CAPS policy document was introduced in South African by the DBE (2011:4-5) in order to guide teachers in their teaching and to ensure that they equip learners with a variety of knowledge and skills.

As a result, mathematics educators should take into account all learners, irrespective of their colour, gender, race and culture in order to achieve effective teaching and learning.

The study was conducted using a theoretical lens of a bricolage theoretical framework. As covered in Chapter 2, this theory encourages hands on activities that connects mathematics to everyday life situations in order to bring out something of value to the human dignity (Chevalier and Buckles, 2019). As a result, this theory encourages collaboration of real- situation in mathematics classroom so that learning environment is conducive for learners and enable multiple methods of teaching in the intermediate Phase.

For example, one of the educators interviewed mentioned that he presented a lesson using a chess game. He further explained that the game enabled learners to identify mathematical concepts. Nevertheless, the study stipulate that educators still apply the chalk and talk method in their classrooms. This is, however, not supported by Smith (2000), who indicated that effective teaching should facilitate the process of learning instead of transferring knowledge from the educator to the learner. Educators should motivate practical and interdependent approaches. This form of teaching and learning promotes critical thinkers and innovative learners The researcher discovered that educators were more concerned about the curriculum coverage instead of the development and understanding of learners(Dutta, 2020).

The findings revealed that Educator A, B, D and E had insufficient knowledge about the use of indigenous games as strategy for teaching and learning. These four educators were not supportive of the application of indigenous games in teaching and learning. The educators could not relate to the games they have mentioned to incorporate them with geometric patterns in the intermediate phase. The educators agreed that mathematics can be a practice related to real-life situations, but no in-depth opinions were given. The four participants stated that they learnt mathematical concepts in their childhood through games but could not link geometric patterns to their statement. However, participant C could link geometry to indigenous games. The following excerpts explain the educators' views:

- **Educator A**: *Yes, various games involved counting.*

- **Educator B**: *Yes, soccer, counting the number of goals*.
- **Educator C**: *When we talk about indigenous its broad, we have diketo, kgathi and morabaraba. Marabaraba help kids to learn about movements, counting, differentiate the type of movements. And also morabaraba itself, the appearance of the drawing board has some patterns. It is simple to understand to learn this game and understand the patterns.*
- **Educator D**: *When they play more, they learn, and teacher just guide learners or also use matches sticks to draw shapes.*
- **Educator E**: *I am not certain*.

5.2.3. Main research question for the study

This section answers to the primary research question:

> *How does the use of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?*

The purpose of this study is to investigate the use of indigenous games in teaching geometric patterns in the intermediate phase

For the purpose of answering this primary research question, all the answers to the sub-research questions were combined. This study produced a bricolage framework that may be applied in mathematics classes to improve how teaching is conducted when teaching geometric patterns.

5.3. Limitations to the study

Despite this study's significant findings, its shortcomings are also acknowledged. The study data collection was mainly focused on methods the educators are currently using when teaching mathematics in general as well as the application of indigenous games as a strategy to support the instruction of geometric patterns in the intermediate phase. If researcher included learners as participants, the study would have gained more perception into the experience of both learners and educators pertaining to the application of indigenous games in teaching and learning of mathematics. In addition, the researcher should have conducted an observation for educators after were trained on the application of indigenous in teaching of geometric patterns this could have create more data for this study

5.4. Conclusion

The study investigated the use of indigenous games in teaching geometric patterns in the intermediate phase. The section provides an outline of the study that was conducted by addressing the sub-research questions :

The first phase assisted the researcher in finding answers to sub-question 1:

> *What methods are currently used by teachers in teaching mathematics in general and in support of geometric patterns in the intermediate phase?*

According to the data, it was evident that the teaching methods of the educators were affected by various factors. It emerged from this study that the teaching techniques that educators apply in their classroom are inspired by their experiences. The most common contributor of preferred teaching methods emerged from their experience in their primary career, the university where they studied, as well as the previous curriculum which is the outcomes-based education(Namoun and Alshanqiti, 2020). This is supported by a study conducted by Gilakjani and Sabouri (2017), which revealed that educators enter the field of teaching with predetermined beliefs about teaching that will better their classroom practices. As a result, educators think it is fit to transfer these techniques into their mathematics classroom. Which makes it evident that educators do not make informed decisions when selecting their teaching methods, not to mention the learning style of learners that are not considered in the development of their lessons.

The data of the study revealed that the educators apply common teaching strategies when teaching geometric patterns, which is commonly known as the traditional method. As a result, teaching and learning depends on the educator to transfer knowledge to learners instead of learners engaging in the lesson. According to Sueb, Hashim, Hashim and Izam (2020), these teaching techniques rely on the educator to instruct learners, while referring to the textbooks for learners' classwork and homework learning tasks, and the use of closed-ended questions that required quick responses were some of the practices. The use of chalk and talk in the classroom procedures indicated that educators have difficulty implementing indigenous games in teaching mathematics. Educators are not trained to incorporate indigenous game

+s as a teaching tool. The educators had very little knowledge of using indigenous games when teaching geometric patterns in the intermediate phase. This is concurred by a study conducted by Bhudia (2021). The findings revealed that the methods applied by educators in the mathematics classroom contributed highly to the low achievement of learners. Bhudia further encouraged the inclusion of indigenous games as a teaching method in the school mathematics classroom.

Zulu (2020) explained that the chalk and talk strategy relies mainly on the chalkboard as well as the teacher's voice as a focal points of formal teaching technique known as chalk and talk. He further indicated that there has been criticism of this formal and somewhat unimaginative approach to teaching, with many people arguing that if educators want to inspire and engage their learners, they should not rely solely on this method. Another criticism of this teaching approach is that it frequently leaves many children behind, especially those who have not had any pre-school education. As a result, the researcher argued that the most essential component is teacher preparation. Learners require teaching strategies that inspire them and give them the freedom to study while they are in school in order to receive a good education; this is where chalk and talk teaching falls short.

The second phase of this study sought to answer sub-research question 2:

> *How does the application of indigenous games as a strategy support the teaching of geometric patterns in the intermediate phase?*

The findings of this study revealed that educators are not familiar with the use of indigenous games as pedagogy of teaching geometric patterns in the intermediate phase. The traditional method of teaching is still embracing classroom procedures, where knowledge is delivered to learners who are expected to passively absorb it, which is still predominant in mathematics classes, instead of referring to the prior knowledge of learners. Traditional education, on the other hand, does not seem to take into account the learners' diverse needs and challenges in the twenty-first century, failing to provide them with the necessary knowledge and thinking abilities.

The use of indigenous games in the classroom brings a different perspective to teaching and learning. This justifies the need for the creation of a structure that could assist educators in fostering indigenous games in teaching and learning. A bricolage

theoretical framework encourages practical attempts to create something valuable to human dignity (Chevalier and Buckles, 2019). This suggests that educators are not limited to the use of chalk-talk, but they can utilise indigenous games such as *diketo* and *kagti* as teaching aids to teach mathematic concepts. A study that was conducted by Moloi, Mosia, Matabane and Sibaya (2021) revealed that mathematical concepts can be identified through the use of *kgati* such as circles and semi-circles, from the movement of the game learners were able to interpret and convert into geometric and numeric patterns. Therefore, incorporation of indigenous games in classrooms can enable learners to utilise mathematical principles to solve problems as well as foster the notion that learning is enjoyable.

The DBE (2011:5) “acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution and those would be endorsed in the curriculum” and emphasised the importance of the indigenous knowledge system in South African schools. According to Vygotsky (1986), culture and history become crucial elements when attempting to comprehend and maintain development and learning. This shows that knowledge of South Africa’s political and cultural past is necessary in order to comprehend the literature on educators’ knowledge.

The use of games in mathematics instruction helps learners develop their problem-solving skills and language, as well as their mathematical language and vocabulary (Poole, Clarke-Midura, Sun and Lam, 2019). Educators use play-based learning as a method for imparting knowledge to their learners. According to Rice (2018), learning experiences help develop learners’ cognitive ability, communication skills, teamwork, and physical prowess. Each game also emphasises these African values. Mosimege (2016) emphasised the use of traditional games in recovering African identity in mathematics education. Indigenous games have much potential to assist mathematics educators in various contexts to consider and modify their classroom procedures to better enhance the development of learners to apply real-life situations in the mathematics classroom.

The study’s conclusions show that the participating teachers had inadequate knowledge of the application of indigenous games as a teaching strategy. The key findings of the study as summarised in this section were covered in detail in Chapter 4.

The conclusions further show that the participating teachers had inadequate knowledge of the significance of the use of indigenous games in teaching geometric patterns. Unfortunately, the educators' understanding of the critical elements of problem-solving skills development and the effective use of the problem-solving instructional approach in mathematics classrooms was insufficient. As a result, the educators employed teacher-centred classroom practices that are content-focused, which make it evident that the educators did not refer to the prior knowledge of learners when teaching geometric patterns.

5.5. Recommendations

The recommendations are aligned with the findings of the study that was conducted:

For the curriculum developers in the Free State education system: To reintroduce the application of indigenous games in the curriculum policies of mathematics in the intermediate phase (Lee and Perret, 2022). Mathematics educators should be trained to incorporate the application of indigenous games in their lessons to make lessons enjoyable for learners and align indigenous games to relevant topics, and reflect on the prior knowledge of learners in order to make lessons effective.

Educators should be trained to implement indigenous games in teaching and learning. This teaching strategies would encourage learners to enjoy geometric patterns mainly because play would be applied in classroom. It is also suggested that educators indigenous games develop their lesson plans based on games relative to the content that will be taught in classrooms.

This will assist learners to collaborate mathematical concepts to their everyday life situation in order to enable educators to use indigenous games as a strategy of teaching geometric patterns in the intermediate phase and to develop short-term professional programmes for in-service courses, workshops, seminars, and training programmes that expose educators to the use of indigenous games as a strategy to teach mathematics in the intermediate phase. It is also recommended that application of indigenous games in teaching of geometric patterns enable learners to link mathematics concepts to real situations. This form of teaching and learning would develop innovative and critical thinkers to solve mathematical problems. The above-mentioned statement is supported by Majeed, Jawad and AlRikabi (2021) who

revealed that games develop the strategic thinking of learners. Further recommendations should be undertaken by both educators and learners in order for the researcher to acquire more insight to the study.

References

Adolphus, T. 2011. Problems of teaching and learning of geometry in secondary schools in Rivers State, Nigeria. *International Journal of Emerging Sciences*, 1(2):143-152.

Ahiaku, P.K.A. 2017. Factors influencing learners' performance in geography in the National Senior Certificate Examination in selected public high schools within uThungulu District. (Doctoral thesis, University of Zululand).

Alemi, M., Sarab, M.R.A. and Lari, Z. 2012. Successful learning of academic word list via MALL: Mobile Assisted Language Learning. *International Education Studies*, 5(6):99-109.

Ali, C.A. and Tangkur, M., 2023. The Mathematics Teacher at the Crossroads Between Indigenous Cultural and Exotic Games in Teaching Mathematics

Arends, F., Winnaar, L. and Mosimege, M. 2017. Teacher classroom practices and mathematics performance in South African schools: A reflection on TIMSS 2011. *South African Journal of Education*, 37(3),

Atkins, L., Francis, J., Islam, R., O'Connor, D., Patey, A., Ivers, N., Foy, R., Duncan, E.M., Colquhoun, H., Grimshaw, J.M., Lawton, R. and Michie, S. 2017. A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. *Implementation Science*, 12(1), article 77.

Barker, C. 2004. The Sage dictionary of cultural studies.California:Sage Publications

Bereczki, E.O. and Karpati, A. 2018. Teachers' beliefs about creativity and its nurture: A systematic review of the recent research literature. *Educational Research Review*, 23:25-56.

Bhuda, M.T. 2021. The Ndebele indigenous games pertinent to primary school mathematics learning: Why indigenous games are a vital tool for mathematics teaching and learning. University of Mpumalanga, South Africa. https://openscholar.ump.ac.za/handle/20.500.12714/529

Biesta, G. 2015. Freeing teaching from learning: Opening up existential possibilities in educational relationships. *Studies in Philosophy and Education*, 34(3):229-243.

Bishop, A.J. 1991*. Mathematical enculturation: A cultural perspective on mathematics education*. Mathematics Education Library series, Vol. 6. Springer Science & Business Media.

Blaise, J.G. 2018. The effects of high-stakes accountability measures on students with limited English proficiency. *Urban Education*, 53(9):1154-1181.

Bollmer, G. and Suddarth, A., 2022. Embodied parallelism and immersion in virtual reality gaming. *Convergence*, *28*(2), pp.579-594

Boluk, S. and LeMieux, P. 2017. *Metagaming: Playing, competing, spectating, cheating, trading, making, and breaking videogames* (Vol. 53). United State University of Minnesota Press.

Bonal, X. and González, S. 2020. The impact of lockdown on the learning gap: family and school divisions in times of crisis. *International Review of Education*, 66(5):635-655.

Brahier, D.J. 2020. *Teaching secondary and middle school mathematics*. Place: Routledge.

Broad, G., Ortiz, J. and Meades, S. 2019. Public libraries: Measuring their value. *Public Library Quarterly*, 38(3):309-319.

Brookfield, S.D. 2015. The skillful teacher: On technique, trust, and responsiveness in the classroom. John Wiley

Brunsdon, C. and Comber, A., 2021. Opening practice: supporting reproducibility and critical spatial data science. Journal of Geographical Systems, 23(4), pp.477-496.

Bruner, E. 1996. Tourism in the Balinese borderzone. Displacement, diaspora, and geographies of identity. In Lavie, S. and Swedenburg, T. Eds., *Displacement, disaspora, and geographies of identity* (pp. 157-179). New York: Duke University Press.

Bush, T., 2012. Authenticity in research: Reliability, validity and triangulation. Research methods in educational leadership and management, 6(19), pp.75-89.

Buus, L. 2015. The learning potentials and challenges when integrating Web 2.0 in a problem-based learning approach. (Doctoral thesis, Aalborg University, Denmark).

Burn, K. and Mutton, T. 2015. A review of 'research-informed clinical practice' in initial teacher education. *Oxford Review of Education*, 41(2):217-233.

Burton, L. 2003. Introduction. In Burton, L. (Ed.). *Which way social justice in mathematics education?* (pp. xv-xxiii). Westport, CT: Praeger Publishers.

Caroux, L., Isbister, K., Le Bigot, L. and Vibert, N. 2015. Player–video game interaction: A systematic review of current concepts. *Computers in Human Behavior*, 48:366-381.

Cellucci, C. 2015. Mathematical beauty, understanding, and discovery. *Foundations of Science*, 20(4):339-355.

Charamba, E. 2021. Role disparity: The effect of gender in science education. *Gender and Behaviour*, 19(2):17931-17938.

Chevalier, J.M. and Buckles, D.J. 2019. *Participatory action research: Theory and methods for engaged inquiry*. New York: Routledge.

Chigona, A. 2018. Digital fluency: Necessary competence for teaching and learning in connected classrooms. *The African Journal of Information Systems*, 10(4), article 7.

Chowdhury, S., Yadaiah, N., Prakash, C., Ramakrishna, S., Dixit, S., Gupta, L.R. and Buddhi, D., 2022. Laser powder bed fusion: A state-of-the-art review of the technology, materials, properties & defects, and numerical modelling. Journal of Materials Research and Technology, 20, pp.2109-2172.

Coates, M.C. 2017. Integrating factors of grit in school culture: Case studies of two freshman academies (Doctoral thesis, Oklahoma State University).

Coe, K. and Scacco, J.M. 2017. Quantitative content analysis. In *The International Encyclopedia of Communication Research Methods*, pp. 346-356. Missing information

Collins English Dictionary. (n.d.). "Chalk and Talk". https://www.collinsdictionary.com/dictionary/english/chalk-and-talk#:~:text=chalk%20and%20talk%20in%20British,Collins%20English%20Dictionary Accessed 26 May 2023.

Confrey, J., 1990. Chapter 8: What constructivism implies for teaching. Journal for Research in Mathematics Education. Monograph, 4, pp.107-210. Missing information

Creswell, J.W. and Plano Clark, V.L. 2017. *Designing and conducting mixed methods research*. Place: Sage Publications.

Cullen, J.L. 2013. Children's ability to cope with failure: Implications of a metacognitive approach for the classroom. Chapter 7: *Instructional Practices* (pp. 267-300). Elsevier.

D'Ambrosio, U. and Rosa, M. 2008. A dialogue with Ubiratan D'Ambrosio: A Brazilian conversation about ethnomathematics/Um dialogo com Ubiratan D'Ambrosio: uma conversa brasileira sobre etnomatematica. *Revista Latinoamericana de Etnomatemática*, 1(2):88-111.

Dandala, S.S. 2013. Factors contributing to senior secondary school learners' poor performance in science subjects in the Mount Frere Education District of the Eastern Cape Province, South Africa (Doctoral thesis, Walter Sisulu University).

Dawadi, S., Shrestha, S. and Giri, R.A. 2021. Mixed-methods research: A discussion on its types, challenges, and criticisms. *Journal of Practical Studies in Education*, 2(2):25-36.

Derry, G.N. 1999. *What science is and how it works*. Princeton University Press.

Dienes, G.J. 1960. Introduction—defects in silicas. *Journal of Physics and Chemistry of Solids*, 13(3-4):272-278.

Dole, S. 2014. Curriculum intent, teacher professional development and student learning in numeracy. In Yeping, L. and Lappan, G. Eds., *Mathematics curriculum in school education* (pp. 473-492). Springer, Dordrecht.

Drisko, J.W. and Maschi, T. 2015. *Content analysis. Pocket Guide to Social Work Research Methods*. Oxford University Press.

Dupin, C.M. and Borglin, G. 2020. Usability and application of a data integration technique (following the thread) for multi-and mixed methods research: A systematic review. *International Journal of Nursing Studies*, 108, article 103608.

Edwards, P.M. 2016. The value of long-term stream invertebrate data collected by citizen scientists. *PloS One*, 11(4), article e0153713.

Fairclough, N. 2013. *Critical discourse analysis: The critical study of language*. Routledge.

Fellows, R.F. and Liu, A.M. 2021. *Research methods for construction*. John Wiley.

Flavel, J.H. 1987. Speculations about the nature and development of metacognition. In Weinert, F.E. & Kluwe, R. (Eds.), *Metacognition, motivation, and understanding* (pp. 21-29). Hillside, NJ: Lawrence Erlbaum.

Francis, B., Mau, A. and Archer, L. 2017. The construction of British Chinese educational success: exploring the shifting discourses in educational debate, and their effects. *Journal of Ethnic and Migration Studies,* 43(14):2331-2345.

Frost, N., 2021. *Qualitative research methods in psychology: Combining core approaches*, 2nd edition. McGraw-Hill Education (UK).

Frydenberg, E., Deans, J. and Liang, R., 2022. Building empathy in children through community connections: a guide for early years educators. Taylor & Francis.

Gates, M.R.G. 2020. Mathematics teacher educators' visions for mathematical inquiry in equitable mathematics spaces (Doctoral thesis, Boston College, Chestnut Hill, MA).

Gardner, M. 2012. Hexaflexagons. *The College Mathematics Journal*, 43(1):2-5.

Gay, G. 2018. *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.

Geist, E. 2015. Math anxiety and the "math gap": How attitudes toward mathematics disadvantages students as early as preschool. *Education*, 135(3):328-336.

Gilakjani, A.P. and Sabouri, N.B. 2017. Teachers' beliefs in English language teaching and learning: A review of the literature. *English Language Teaching*, 10(4):78-86.

Goldman, A.I. 2018. *Philosophical applications of cognitive science*. Routledge.

Grace, L.D. 2019. *Doing things with games: Social impact through play*. CRC Press.

Han, H., Xu, H. and Chen, H. 2018. Social commerce: A systematic review and data synthesis. *Electronic Commerce Research and Applications*, 30:38-50.

Hasana, S.N. and Alifiani, A. 2019. Multimedia development using visual basic for application (VBA) to improve students' learning motivation in studying mathematics of economics. *Indonesian Journal of Mathematics Education*, 2(1):34-42.

Heath, M.B. 2017. *Nineteenth-century fictions of childhood and the politics of play*. Routledge.

Hew, K.F., Huang, B., Chu, K.W.S. and Chiu, D.K. 2016. Engaging Asian students through game mechanics: Findings from two experiment studies. Computers & Education, 92:221-236.

Hopper, L.M., Gulli, R.A., Howard, L.H., Kano, F., Krupenye, C., Ryan, A.M. and Paukner, A. 2021. The application of noninvasive, restraint-free eye-tracking methods for use with nonhuman primates. Behavior Research Methods, 53, pp.1003-1030.

Houtbeckers, E. 2013. Bricolage in the everyday life of Hub Helsinki. The First Finish Social Enterprise Research Network Conference at Helsinki: *FinSERN*, 1:139-147.

Hwa, S.P. 2018. Pedagogical change in mathematics learning: Harnessing the power of digital game-based learning. *Journal of Educational Technology & Society*, 21(4):259-276.

IBM Corp. 2021. *IBM SPSS Statistics for Windows*, Version 28.0. Armonk, NY: IBM Corp.

Imendai, S. 2014. Is there a conceptual difference between theoretical and conceptual frameworks? *Journal of Social Sciences*, 38(2):185-195.

Jackson, K., Cobb, P., Wilson, J., Webster, M., Dunlap, C. and Appelgate, M. 2015. Investigating the development of mathematics leaders' capacity to support teachers' learning on a large scale. *ZDM: The International Journal on Mathematics Education*, 47(1):93-104.

Jardine, D.W. 2017. *Back to the basics of teaching and learning: Thinking the world together*. Routledge.

Johnson, B. and Turner, L.A. 2003. Data collection strategies in mixed methods research. In Tashakkori, A.M. and Teddlie, C.B., Eds., *Handbook of mixed methods in social and behavioral research* (pp. 297-319). Thousand Oaks: Sage Publications.

Johnson, M.W., Christensen, C.M. and Kagermann, H. 2008. Reinventing your business model. *Harvard Business Review*, 86(12):57-68.

Joshi, Y. and Rahman, Z. 2017. Investigating the determinants of consumers' sustainable purchase behaviour. *Sustainable Production and Consumption*, 10:110-120.

Katsila, T. and Matsoukas, M.-T. 2018. How far have we come with contextual data integration in drug discovery? *Expert Opinion on Drug Discovery*, 13(9):791-794.

Kaushik, V. and Walsh, C.A. 2019. Pragmatism as a research paradigm and its implications for social work research. *Social Sciences*, 8(9), article 255.

Koh, J.H.L., Chai, C.S. and Tay, L.Y. 2014. TPACK-in-Action: Unpacking the contextual influences of teachers' construction of technological pedagogical content knowledge (TPACK). *Computers & Education*, 78:20-29.

Krawczyk, P., Topolewski, M. and Pallot, M. 2017. Towards a reliable and valid mixed methods instrument in user experience studies. In 2017 *International Conference on Engineering, Technology and Innovation (ICE/ITMC)* (pp. 1455-1464).

Krippendorff, K. 2018. *Content analysis: An introduction to its methodology*. Sage Publications.

Lavallée,D.A 2013, 2013. Painter: A Simple NeWS Program 19. The Sun Technology Papers, p.237.

Lee, I. and Perret, B. 2022. Preparing high school teachers to integrate ai methods into STEM classrooms. In *Proceedings of the AAAI Conference on Artificial Intelligence*, 36(11):12783-12791.

Lemov, D., 2021. Teach like a champion 3.0: 63 Techniques that Put Students on the Path to College. John Wiley & Sons.

Leonard, J. 2018. *Culturally specific pedagogy in the mathematics classroom: Strategies for teachers and students*. Routledge.

Lévi-Strauss, C. 1962. *The savage mind*. London: Weidenfeld and Nicholson.

Liao, X., Yuan, K., Wang, X., Li, Z., Xing, L. and Beyah, R. 2016. Acing the IOC game: Toward automatic discovery and analysis of open-source cyber threat intelligence. In *Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security* (pp. 755-766).

Lo, C.K., Lie, C.W. and Hew, K.F. 2018. Applying “first principles of instruction” as a design theory of the flipped classroom: Findings from a collective study of four secondary school subjects. *Computers & Education*, 118:150-165.

Loucks-Horsley, S., Stiles, K.E., Mundry, S., Love, N. and Hewson, P.W. 2009. *Designing professional development for teachers of science and mathematics*. Corwin Press.

Luo, S. and Zou, D., 2022. A systematic review of research on technological, pedagogical, and content knowledge (TPACK) for online teaching in the humanities. Journal of Research on Technology in Education, pp.1-1

Mahlomaholo, S. 2013. On bricolage and the creation of sustainable postgraduate learning environments. TD: *The Journal for Transdisciplinary Research in Southern Africa*, 9(3):379-392.

Majeed, B.H., Jawad, L.F. and AlRikabi, H. 2021. Tactical thinking and its relationship with solving mathematical problems among mathematics department students. *International Journal of Emerging Technologies in Learning*, 16(9):247-262.

Masters, J. 2023. *Masters traditional games*. https://www.mastersofgames.com (Accessed 26 May 2023).

Mata, M. de L., Monteiro, V. and Peixoto, F. 2012. Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research*, vol. 2012, article ID 876028.

May, T. and Perry, B. 2022. Social research: Issues, methods and process. McGraw-Hill Education (UK).

McKinney, C. and Tyler, R. 2019. Disinventing and reconstituting language for learning in school science. *Language and Education*, 33(2):141-158.

Merriam, S.B. and Tisdell, E.J. 2015. *Qualitative research: A guide to design and implementation*. John Wiley.

Merriam-Webster Dictionary. (n.d.). "Chalk talk." Merriam-Webster.com Dictionary. https://www.merriam-webster.com/dictionary/chalk%20talk Accessed 26 May 2023.

Moloi, T.J. 2013. An analysis of challenges in the teaching of problem solving in Grade 10 mathematics. *The Journal for Transdisciplinary Research in Southern Africa*, 9(3):480-492.

Moloi, T.J. 2015. Using indigenous games to teach problem-solving in mathematics in rural learning ecologies. *Journal of Higher Education in Africa/Revue de l'enseignement supèrieur en Afrique*, 13(1-2):21-32.

Moloi, T.J., Mosia, M.S., Matabane, M.E. and Sibaya, K.T. 2021. The use of indigenous games to enhance the learning of word problems in grade 4 mathematics: A case of Kgati. *International Journal of Learning, Teaching and Educational Research*, 20(1):240-259.

Mosimege, M.D. 1997, January. The use of games in mathematics classrooms. In *Proceedings of the 5th Annual Meeting of the Southern African Association for Research in Mathematics*.

Mosimege, M.D. 2016. Reclaiming our African pride through the integration of ethnomathematical studies in mathematics teaching and learning. *22nd Annual National Congress of the Association for Mathematics Education of South Africa*. Tshwane University of Technology, Mbombela Campus, Mpumalanga, South Africa.

Mosimege, M. 2020. The use of indigenous games in the teaching and learning of Mathematics. *Revemop*, 2:e202009-e202009.

Mosimege, M. and Ismael, A. 2004. Ethnomathematical studies on indigenous games: examples from Southern Africa. *Ethnomathematics and Mathematics Education*, 119-137.

Moss, R.D. 2022. A phenomenological examination of the organizational culture of a recidivism prevention program (Doctoral thesis, Capella University, Minnesota).

Mphuthi, G. 2015. *Euclidean geometry workshop: Abstraction of constructions*. Association for Mathematics Education of South Africa, vol. 2:11.

Msimanga, M.R. 2017. Teach and assess: A strategy for effective teaching and learning in Economic and Management Sciences (Doctoral thesis, University of the Free State).

Namoun, A. and Alshanqiti, A., 2020. Predicting student performance using data mining and learning analytics techniques: A systematic literature review. Applied Sciences, 11(1), p.237.

National Professional Teacher' Organisation of South Africa. 2014. Making schooling more effective. NAPTOSA, 8(1).

National Research Council, 2000. *Inquiry and the national science education standards: A guide for teaching and learning*. National Academies Press.

Nkopodi, N. and Mosimege, M. 2009. Incorporating the indigenous game of *morabaraba* in the learning of mathematics. *South African Journal of Education*, 29(3):377-392.

Nizaruddin, M.A., Omar, M.S., Mhd-Ali, A. and Makmor-Bakry, M. 2017. A qualitative study exploring issues related to medication management in residential aged care facilities. *Patient Preference and Adherence*, 11:1869-1877.

Ondenyi, E. 2020. *Imarisha: Reinforcement learning toolkit for African board games* (No. 2807). EasyChair.

Owusu-Mensah, J. and Baffour, K.P.Q. 2015. Demystifying the myth of mathematics learning at the foundation phase: The role of Akan indigenous games (Challenges and opportunities for indigenous knowledge systems in the education system). *International Journal of Educational Sciences*, 8(2):313-318.

Pandey, P. and Pandey, M.M. 2021. Research methodology tools and techniques. Bridge Center.

Panuccio, F., Galeoto, G., Marquez, M.A., Tofani, M., Nobilia, M., Culicchia, G. and Berardi, A., 2021. Internal consistency and validity of the Italian version of the Jebsen–Taylor hand function test (JTHFT-IT) in people with tetraplegia. *Spinal Cord*, *59*(3), pp.266-273.

Pardede, P. 2019. Mixed methods research designs in EFL. In *Proceeding English Education Department Collegiate Forum (EED CF) 2015-2018*. Indonesia, Jakarta: UKI Press, pp. 230-243.

Pelay, N. 2011. Jeu et apprentissages mathématiques: élaboration du concept de contrat didactique et ludique en contexte d'animation scientifique (Doctoral thesis. Université Claude Bernard – Lyon I, Français).

Phoong, S.Y., Phoong, S.W. and Phoong, K.H., 2020. The effectiveness of frog virtual learning environment in teaching and learning mathematics. Universal Journal of Educational Research, 8(3B), pp.16-23.Podsakoff, P.M., MacKenzie, S.B. and Podsakoff, N.P. 2016. Recommendations for creating better concept definitions in the organizational, behavioral, and social sciences. *Organizational Research Methods*, 19(2):159-203.

Poole, F., Clarke-Midura, J., Sun, C. and Lam, K. 2019. Exploring the pedagogical affordances of a collaborative board game in a dual language immersion classroom. *Foreign Language Annals*, 52(4):753-775.

Ren, X., Wang, X., Jin, X. and Li, M., 2021. The impact of personal moral philosophies on the safe practice of students in chemistry and related majors. *Science & Education*, *30*, pp.67-80

Rice, G. 2018. *The tumult and the shouting: My life in sport*. Pickle Partners Publishing.

Sanusi, I.T., Oyelere, S.S. and Omidiora, J.O., 2022. Exploring teachers' preconceptions of teaching machine learning in high school: A preliminary insight from Africa. Computers and Education Open, 3, p.100072.

Shulman, L.S. 1986. Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2):4-14.

Sibaya, K.T. 2019. Designing a context-based strategy for teaching and learning of mathematics word problems (Doctoral thesis, University of the Free State).

Smith, J. 2000. *A critical survey of empirical methods for evaluating active labor market policies* (No. 2000-6). Research Report.

Spaull, N. 2013. *South Africa's education crisis: The quality of education in South Africa 1994-2011*. The Centre for Development and Enterprise.

Spooner, F., Saunders, A., Root, J. and Brosh, C. 2017. Promoting access to common core mathematics for students with severe disabilities through mathematical problem solving. *Research and Practice for Persons with Severe Disabilities*, 42(3):171-186.

So, S. 2012. Refined 'Chalk-and-Talk' of lecture content: Teaching signals and systems at the Griffith school of engineering. In *23rd Annual Conference of the Australasian Association for Engineering Education 2012.* Melbourne, Australia.

South Africa. *Constitution of the Republic of South Africa, 1996*. Cape Town: Government Gazette.

South Africa. Department of Basic Education. 2011. *Curriculum and Assessment Policy Statement (Intermediate Phase).* http://www.thutong.doe.gov.za

Sueb, R., Hashim, H., Hashim, K.S. and Izam, M.M. 2020. Excellent teachers' strategies in managing students' misbehaviour in the classroom. *Asian Journal of University Education*, 16(1):46-55.\

Tachie, S.A., 2019. Meta-cognitive skills and strategies application: How this helps learners in mathematics problem-solving. Eurasia Journal of Mathematics, Science and Technology Education, 15(5), p.em1702.

Tachie, S.A. and Chireshe, R. 2013. High failure rate in mathematics examinations in rural senior secondary schools in Mthatha District, Eastern Cape: Learners' attributions. *Studies of Tribes and Tribals*, 11(1):67-73.

Tachie, S.A. and Galawe, B.F. 2021. The value of incorporating indigenous games in the teaching of number sentences and geometric patterns*. International Journal for Cross-Disciplinary Subjects in Education*, 12(1), 4350-4361.

Tajudin, N.A.M. and Chinnappan, M. 2016. The link between higher order thinking skills, representation and concepts in enhancing TIMSS tasks. *International Journal of Instruction*, 9(2):199-214.

Takahashi, A., 2021. Teaching mathematics through problem-solving: A pedagogical approach from Japan. Routledge.

Tan, O.S. 2021. *Problem-based learning innovation: Using problems to power learning in the 21st century*. Gale Cengage Learning.

Teddlie, C. and Tashakkori, A. 2010. Overview of contemporary issues in mixed methods research. In Tashakkori, A. and Teddlie, C. (Eds.), *SAGE Handbook of mixed methods in social and behavioral research*, 2nd edition. pp. 1-41.

Teele, T., Nkoane, M.M. and Mahlomaholo, M.G. 2020. Corollaries of pedagogic praxis on technological skills transfer for emerging farmers. *Gender & Behaviour*, 18(1):14750-14761.

Timonen, V., Foley, G. and Conlon, C. 2018. Challenges when using grounded theory: A pragmatic introduction to doing GT research. *International Journal of Qualitative Methods*, 17(1), article 1609406918758086.

Trinchero, R. and Sala, G. 2016. Chess training and mathematical problem-solving: The role of teaching heuristics in transfer of learning. *Eurasia Journal of Mathematics, Science and Technology Education*, 12(3):655-668.

United Nations Educational, Scientific and Cultural Organization. 2020. *Basic texts of the 2003 convention for the safeguarding of the intangible cultural heritage*.

Van der Walt, M. & Potgieter, E. 2018. Tshimologo: A new dawn for self-directed learning and mathematics education. In *9th Annual Unisa Iste Conference on Mathematics, Science and Technology Education* (p. 140).

Vithal, R. 2003. *In search of a pedagogy of conflict and dialogue for mathematics education*. Springer Science & Business Media.

Von Glaserfeld, E. 1992. Constructivism reconstructed: A reply to suchting. *Science & Education*, 1:379-384.

Vygotsky, L.S., 1986. Thought and language-Revised edition. Cambridge, MA: Massachusetts Institute of Technology.

Walker, R. 1990. Nitrates, nitrites and N-nitrosocompounds: A review of the occurrence in food and diet and the toxicological implications. *Food Additives & Contaminants*, 7(6):717-76

Wang, X., Hu, M., Xia, Y., Wen, X. and Ding, K. 2012. Pyrosequencing analysis of bacterial diversity in 14 wastewater treatment systems in China. *Applied and environmental microbiology*, 78(19):7042-7047.

Wankat, P.C. and Oreovicz, F.S. eds. 2015. *Teaching engineering*. Purdue University Press.

Watson, C. 2015. A sociologist walks into a bar (and other academic challenges): Towards a methodology of humour. *Sociology*, 49(3):407-421.

Westera, W. 2019. Why and how serious games can become far more effective: Accommodating productive learning experiences, learner motivation and the monitoring of learning gains. *Journal of Educational Technology & Society*, 22(1):59-69.

Westerberg, M., 2022. Prostate cancer incidence, treatment and mortality: Empirical longitudinal register-based studies and methods for handling missing data (Doctoral dissertation, Department of Mathematics).

Williams, A. 2017. *History of digital games: Developments in art, design and interaction*. CRC Press.

Wise, D.T. and Woodhouse, D.J. 2017. A cubical flat torus theorem and the bounded packing property. *Israel Journal of Mathematics*, 217(1):263-281.

Wu, Y., Hamilton, R.W., Kim, N.Y.J. and Ratner, R.K., 2021. Navigating shared consumption experiences: Clarity about a partner's interests increases enjoyment. Journal of Marketing Research, 58(3), pp.439-455.

Yazan, B. 2015. Three approaches to case study methods in education: Yin, Merriam, and Stake. *The Qualitative Report*, 20(2):134-152.

Yeh, C.Y., Cheng, H.N., Chen, Z.H., Liao, C.C. and Chan, T.W. 2019. Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning*, 14(1):1-19.

Zainuddin, Z. and Halili, S.H., 2016. Flipped classroom research and trends from different fields of study. *International Review of Research in Open and Distributed Learning*, 17(3):313-340

Annexure 1
Questionnaire

Research Question 1

These were questions that were conducted for the questionnaire survey.

1.1 Indicate your preference of your teaching method when teaching geometric patterns?

A) Chalk and Talk

B) Game based approach

C) Flipped classroom

D) Lecturing Method

E) Discovery Method

1.2 Teaching methods are affected by various knowledge aspects that develop the teaching approach. What inspired your teaching approach/ method? Explain why you chose that teaching preference indicated on 1.1?

1.3 In the Intermediate Phase, how does the teaching approach mentioned above support the teaching and learning of geometric patterns.

1.4 What were some of the difficulties you encountered when teaching geometric patterns?

1.5 What steps were taken to overcome any obstacles that were encountered in order to aid learners' performance

Research Question 2

2.1 Is there any link between real life situation and mathematical concepts? Please elaborate on your answer.

2.2 Are there any mathematics concepts you can identify from the real-life activities, specifically indigenous games and other indigenous activities that you have participated in or aware of?

2.3 How can you use indigenous games and related concepts in problem-solving in mathematics classrooms?

2.4 Learners in the Intermediate Phase tend to lose concentration during the lesson more especially when the content which is taught is not applicable to them. What may be the contributing course to this problem?

2.5 Traditional teaching is concerned with the teacher being the controller of the learning environment. Power and responsibility are held by the teacher, and they play the role of instructor (in the form of lectures) and decision maker (in regard to curriculum content and specific outcomes). This method has dominant over the past years in mathematics classroom. In your own opinion do think this approach meet the needs of learners in the farm schools state your reasons?

2.6 Various countries have shifted from traditional approach to games based learning. Should the curriculum in South Africa be adapted to this approach? Why or why not?

2.7 Have you used any of the mentioned indigenous games in you're mathematics lessons? If yes explain how the indigenous game was used to explain or illustrate the various mathematics concepts

Annexure 2

Interviews with Teachers

For example the following questions were asked during the interviews:

Teachers' Interview Questions:

1. How long have you been teaching mathematics in the Intermediate phase?
2. What were your major subjects at the higher education institution?
3. Which grades are you currently teaching in the phase?
4. How long have you been teaching mathematics in each grade?
5. What are the major challenges you have faced in your classroom pertaining to the teaching of geometric patterns in the Intermediate Phase?
6. Is there any form of support that you are getting to solve this matter?
7. I actually want you to reflect back to your childhood experience and share your memories on the games you used to play; these games may be indigenous games or any form of games that you remember. Feel free to mention more than one game.
8. Which mathematics concepts have you learnt or identified in the different indigenous games? Indicate each indigenous game and the related mathematics concepts.
9. Lesson plans give direction in how learning should be conducted. Which teaching strategies do you use when teaching geometric patterns?
10. The conventional approach refers to the chalk and talk method, it involves direct instruction by the educator to transfer knowledge to learners. This form of teaching has been the centre of teaching and learning for many years. Should this form of learning continue to be practiced in rural or farm schools?
11. In your view, how can indigenous games be used to help the learners understand geometric patterns?

Annexure 3

Observation Sheet (Teachers)

The act of observing a teacher's performance in their classroom or learning environment is known as classroom observation. Classroom observations are a quantitative method of observing and recording instructor behaviour and mastery in action.

Grade observed: _____

Date of observation: _____

Observer: _____

Code of the teacher: _____

Indicator	Focus area	Comments
Introduction	Does the Introduction refer to the relationship between geometric patterns and indigenous games?	
Objective of the lesson	Is the aim of the lesson clearly indicated to learners? Are the expectations clearly indicated to learners during the presentation? Do the Objectives of the Lesson include reference to the use and integration of indigenous games?	

Indicator	Focus area	Comments
Interaction	Teachers understand that young children vary considerably in the pattern and pace of their growth, thinking, language, and social capacities due to individual differences and cultural persuasions.	
Prior Knowledge of learners	Does the teacher address culture, historical, values, and attributes in their lesson?	
Teaching strategies and Interaction between educator and learners	Does the educator engage learners about the use of indigenous games, places, and things that are meaningful to them; and provide opportunities for learners to share their ideas with the class? Is the lesson learner centred, does the activity allow learners to come up with problems and solve those problems	
Teaching resources that are used in classroom	Which teaching tools does the educator use to conduct their lesson? Is the use of indigenous games used as tool to instruct mathematical concepts	
Learning variety of learners	Does the educator use a variety of teaching approaches to accommodate the different learning styles, temperaments, and personalities of learners and diversities	

Annexure 4

Ethical Clearance

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

17-Apr-2022

Dear Miss Bessie Galawe

Application Approved Research Project Title:

The use of indigenous games in the teaching of geometric patterns in mathematics in theIntermediate Phase

Ethical Clearance number:

UFS-HSD2021/1130/22

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested tosubmit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis

Chairperson: General/Human Research Ethics Committee

205 Nelson MandelaDrive
Park West Bloemfontein 9301South Afr

Dr Adri du Plessis
Digitally signed by Dr Adri duPlessis
Date: 2022.04.19 12:34:32 +02'00'

Annexure 5

Request for Permission to Conduct Research

Dear Department of Education

I am doing research and would like to request permission to conduct our research at Willows primary School ;Phutaneng Primary School; Waterbone Primary School AND Dinaweng primary School.

DATE: October 2021 - 30 November 2021

TITLE OF THE RESEARCH PROJECT

The use of indigenous games in the teaching of geometric patterns in mathematics in the Intermediate Phase

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

Busiswe Faith Galawe 2012178584 0710010413

FACULTY AND DEPARTMENT:

Faculty of Education
The School of Mathematics, Natural Sciences, and Technology Education

STUDYLEADER(S) NAME AND CONTACT NUMBER:

Prof Mosimege
082 3879013

WHAT IS THE AIM / PURPOSE OF THE STUDY?

The purpose of the study is to promote the use of indigenous games in teaching of geometric patterns in the Intermediate Phase.

WHO IS DOING THE RESEARCH?

My name is Busisiwe Faith Galawe and I am a masters (in mathematics education) student. My research interest relates to the use of indigenous games in the mathematics classroom. The focus of the study is to find out whether teachers have any knowledge of indigenous games, and if they do, whether they use them in the teaching of geometric patterns in the Intermediate Phase.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

No. This study is yet to receive approval from the Research Ethics Committee of UFS

Approval number: No approval number. This study is yet to receive approval from the Research Ethics Committee of UFS

WHY ARE YOUR INSTITUTION/ORGANISATION/COMPANY INVITED TO TAKE PART IN THIS RESEARCH PROJECT?

The participants (teachers) will be selected based on their willingness to take part in the study; the nature of the classrooms in which they teach (i.e. geometric patterns); and the knowledge they possess regarding indigenous games. In addition, these teachers are selected because they are exposed to learners that struggle with geometric patterns in teaching of mathematics. And they are willing to explore the use of indigenous games as a strategy to teach geometric patterns in the Intermediate Phase. It is therefore expected that these participants will be able to respond to the research questions of this study based on their experience and expertise.

WHAT IS THE NATURE OF PARTICIPATION IN THIS STUDY?

Interview will be conducted first before the researcher visits the classroom. This technique will encourage participants to contribute their views freely. An open-ended initial question will be posed to help participants feel less compelled or constrained to think in a particular way (Tlali, 2013). This is to assist the researcher to find out more about the teaching methods that educator utilize in their classroom, as well as the indigenous knowledge that educators possesses. Lastly, to find out whether educators apply indigenous games in their teaching.

The interviews will be 15 – 45 minutes long, and after the session the observation will be conducted to observe whether teachers uses indigenous games as a teaching strategy to teach geometric patterns in the Intermediate Phase. The duration of observation sessions will depend on the duration of the class lesson. The researcher will use a pre-used observation form to guide the lesson observation.

In this study, fifty Intermediate Phase teachers will be purposively selected from various schools to complete the questionnaires. Questionnaire will take between 15 -45 minutes. The researcher will conducte the questionnaire survey via google form to get the respondents of participants. This will require the researcher to get email address of participants in order to resume time.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The present study will assist educators to use indigenous games in order to teach geometric patterns. This will be done with appreciate strategies, teaching methods to improve the performance of learners. The study will identify factors that are contributing to the high failure rate in mathematics and develop skills that will improve the performance of learners in Mathematics in the Intermediate phase in the Motheo District of Education, especially in remote areas. This may result in better teaching and learning, which may reduce the failure rate in schools, thus benefiting the learners.

WHAT IS THE POTENTIAL RISKS TAKING PART IN THIS STUDY?

Economic harm and Loss of work time are the reasonably foreseeable risks of harm or side effects to the potential participants. The measures that will be taken to mitigate the risks include the focus group discussion happening on weekends and after school hours to ensure that teachers are protected from potential economic harm.

WILL THE INFORMATION BE KEPT CONFIDENTIAL?

The confidentiality of information of the participant will be maintained, e.g. your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a fictitious name or a pseudonym, and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. Your answers may be reviewed by people responsible for making sure that research is done properly, including the members of the Research Ethics Committee. The participants' anonymous data may be used for other purposes, e.g. research report, journal articles, conference presentation and privacy will be protected in any publication of the information. While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information confidentially. I shall, however, encourage all participants to do so. For this reason, I advise you not to disclose personally sensitive information in the focus group.

HOW WILL THE INFORMATION BE STORED AND ULTIMATELY DESTROYED?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet in my room for future research or academic purposes; electronic information will be stored on a password protected personal laptop. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. It is imperative that information will be destroyed.

WILL THERE BE PAYMENT OR ANY INCENTIVES FOR PARTICPATING IN THIS STUDY?

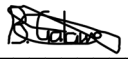
There will be no costs that will be incurred by the participants. Also, teachers can quit the study if they do not want to take part in the study due to this cost.

HOW WILL THE INSTITUTION / ORGANISATION / COMPANY BE INFORMED OF THE FINDINGS / RESULTS OF THE STUDY?

If you would like to be informed of the final research findings, please contact Busisiwe Faith Galawe on 0710010413 or faithgalawe@gmail.com. Should you require any further information or want to contact the researcher about any aspect of this study, please contact the person named above. Should you have concerns about the way in which the research has been conducted, you may contact the supervisor using the following details; email: mosimegeMD@ufs.ac.za. The findings will be discussed online or sent to the participants via email.

Yours sincerely

Busisiwe Galawe



Annexure 6

Letter of Permission

Enquiries: M.Z. Thango
Ref: Research Permission: B.F. Galawe
Tel. 051 404 8808
Email:

Department of Education
FREE STATE PROVINCE

4 Griesel street
Fichardt Park
Bloemfontein
9301

Dear Ms. B.F. Galawe

PERMISSION TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION: MOTHEO DISTRICT

This letter serves to inform you that you have been granted permission to conduct research in the Free State Department of Education within the Motheo Education District. The details in relation to your research project with the University of the Free State are as follows:

Topic: The use of indigenous games in the teaching of geometric patterns in Mathematics in the Intermediate Phase.

1. **List of schools involved:** Dinaweng Primary School, Phutaneng Primary School, Waterbone Primary School, Williamstrip School and Willows Primary School.
2. **Target Population:** Fifty five educators teaching Mathematics in grade 4-7 at the selected schools.
3. **Period of research:** From the date of signature of this letter until 30 September 2022. Please note that the department does not allow any research to be conducted during the fourth term (quarter) of the academic year. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension. The researcher is expected to request permission from the school principals to conduct research at schools.
4. The approval is subject to the following conditions:
   4.1 The collection of data should not interfere with the normal tuition time or teaching process.
   4.2 A bound copy of the research document should be submitted to the Free State Department of Education, Room 101, 1st Floor, Thuto House, St. Andrew Street, Bloemfontein or can be emailed to the above-mentioned email address.
   4.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.
   4.4 The ethics documents must be adhered to in the discourse of your study in our department.
5. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours Sincerely,

Mr. MZAMO W. JACOBS
DIRECTOR: QUALITY ASSURANCE, M&E AND STRATEGIC PLANNING

DATE: 24/02/2022

Annexure 7

Consent Form to the Principal

Principal's consent form to the Principal

Re: Application for permission to conduct research In partial fulfilment of my Master's degree in Mathematics Education, I have to conduct and submit a research thesis on the topic, *The use of indigenous games in the teaching of geometric patterns in mathematics in the Intermediate Phase*. In view of this, I humbly request your office to grant me permission to collect data at your school. The study will utilize eductors who are teaching mathematics from grade 4 to 7. In addition, I will conduct an interview with one educator and also observe his/her classroom.

It will be a great honour if I am provided with the opportunity to conduct the study at your school.

I hope my request is in order.

_____

Yours in education

B.F Galawe (2012178584) STRICTLY CONFIDENTIAL I

_____ (name and surname), the Principal of

_____ school in Motheo District hereby grant permission to B.F Galawe student number 2012178584 to carry out a study at my school.

Signature _____

Date: _____

Annexure 8

Proof of editing

Certificate of Editing

DORATHEA (DORA) DU PLESSIS

Technical & Language Editing

PO Box 38917
Langenhovenpark, Bloemfontein 9330

082 635 0214
technicalediting.dora@gmail.com

30 May 2023

CONFIRMATION OF TECHNICAL AND LANGUAGE EDITING

I hereby confirm that I have done the technical and language editing for the following

master's dissertation:Student: Busisiwe Faith Galawe

Student number:	2012178584
Title:	The use of indigenous games in the teaching of geometric patterns in mathematics in theIntermediate Phase
Degree:	Master of Education: Specialisation in Subject Education in Mathematics
University:	School of Mathematics, Natural Sciences and Technology Education, Faculty of Education,University of the Free State

Language editing included consistency and accuracy in grammar, punctuation, spelling and sentence structure.I tried to retain the student's own writing style, while making sure that the student's intended meaning was notaltered during the editing process. All amendments were marked with the Microsoft Word Track Changes feature. I also left comments for issues that the student needed to check or revise. The student, therefore, hadthe option to accept or reject the suggestions and changes to the document.

Technical editing included the layout done on a MS Word template that I created specifically for this document.I checked all acronyms and abbreviations for consistent use in the text. I also checked the list of references to make sure that dates and author names used in the text matched those in the list of references. The student was informed of sources in the reference list that were not cited or were cited but not included in the list.

I have more than 40 years of experience in typing, technical and language editing for postgraduate students from universities all over South Africa and also abroad. I gained my experience during the

years I was typing student dissertations and theses and while working at different departments at the UFS from 1978 to 1981 andagain from 1998 to 2014. I also assisted in compiling a document on technical layout and referencing methodsand have presented guest lectures on referencing methods and technical layout issues to postgraduate studentsat the UFS. In the past couple of years, I have also done language editing for a number of journal articles as wellas seven books for publication.

Disclaimer: The ultimate responsibility for accepting or rejecting the amendments and recommendations madeby means of track changes rests with the student. The editor cannot be held responsible for any changes madeto the document in terms of the format and style and subsequent amendments or additions to the text.

Yours sincerely

Dorathea (Dora) du
Plessis Technical &
Language Editor