

**DESIGNING A CONTEXT-BASED STRATEGY FOR
TEACHING AND LEARNING OF MATHEMATICS WORD
PROBLEMS**

by

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FDE, BEd Hons, MEd (UJ)

**Thesis submitted in fulfilment of the requirements for the degree
Philosophiae Doctor in Education
(PhD Curriculum Studies: Mathematics Education)**

**FACULTY OF EDUCATION
AT THE
UNIVERSITY OF THE FREE STATE
BLOEMFONTEIN**

JUNE 2019

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DECLARATION

I declare that the thesis,

**DESIGNING A CONTEXT-BASED STRATEGY FOR TEACHING AND LEARNING
OF MATHEMATICS WORD PROBLEMS**

hereby submitted for the qualification of Doctor of Philosophy at the University of the Free State is my own independent work and that I have not previously submitted the same work for qualification at/in another university/faculty.

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KT Sibaya

June 2019

ACKNOWLEDGEMENTS

My sincere appreciation is extended to:

My Almighty God, who gave me an opportunity to learn, and who protected me throughout the thesis journey.

My family:

- My Wife: with your sleepless nights supporting me;
- My Children: Tumi: with your countless catering services; and
- Moss and Lebo: for proofreading my daily attempts.

Church:

- Pastor Sizwe: As a pastor and motivator you were always there for me.
- Me Nchape: You were a real mother to me.
- Lastly, to all members of the church; thank you for your prayers.

My thesis committee:

- Dr Moloji and Dr Mosia, who assisted me to shape my study and persistently provided me with guidance, feedback and support. You also believed in me from the beginning and taught me how to participate in academic discourses. Your countless hours of educational discussions made me believe in you to be my pillars. Yes, indeed, you deserve the best.

Cell Doctors:

- Prof Hlalele: You really know how to build and motivate a person! Do you still remember “A Brown Envelope”?
- Dr Tsotetsi: Your mentorship deeply shaped me as a researcher. In my career, you are my role model.
- Dr Dube, thank you for your words of encouragements, PUSH! BABA! PUSH.

My fellow Master’s and PhD students:

- For the genuine support you have provided to me throughout the thesis journey.
- Mr Dlamini (Chapter 4), for the follow-ups I have made with you,

- Mr Baas (preacher), who pushed my ideas and gave me words of encouragement in moments of doubt.
- Mrs Mlambo (This research!!!), Mr Mofokeng (This research???), Mr Mzo (Ah! tomorrow is still a day!!!),
- Mr & Mrs Nyembe, you were always there for me, guys. *Ha uweng Banna!*

SuLE and SURLEC family:

- Dr Nkoane, I aspire to be the impactful teacher, mentor and researcher you are.
- Dr Tladi, for developing my thinking;
- Dr Nhlapo, for shaping my study. Thank you all for your undivided support, sharing and debating.

DEDICATION

This thesis is dedicated to my beautiful wife, Mankuni, my son, Moses, my daughters, Lebo and Tumi and lastly to my mother, Mamorena who has passed on. Without your support, this journey would never have been possible.

SUMMARY

This study aims to design a context-based strategy for the teaching and learning of mathematical WP for Afromontane learners. In the context of this study, Afromontane learners form part of the social construct of people that live and subsist in mountainous places, drawing from the wealth of their cultural and indigenous knowledge. This wealth of knowledge, which has sustained the Afromontane or Indigenous people, is often marginalised in the teaching and learning of mathematics, particularly WP. For these apparent reasons, I found it necessary to design a context-based strategy that would enhance teaching and learning of mathematical WP for Afromontane learners. In order to attain this goal, firstly, I opted to utilise Community Cultural Wealth as a lens through which I looked into the challenges experienced by these learners in their attempts to use these indigenous skills. Secondly, I employed Participatory Action Research (PAR) as the research methodology with a view that would also assist to generate data from the research site with the aid of the research participants. Critical Discourse Analysis (CDA) is a technique employed to analyse and interpret data generated from the research field, taking into consideration the three levels of analysing and interpreting data, namely: textual analysis, discursive practices and social structures.

Key findings of the study include:

Inadequate skills to teach mathematical WP within the context of the learners as a remaining challenge that forces some teachers to opt for using traditional way of teaching (rote teaching and algorithmic approach)

- Teachers still lack skills to integrate indigenous games with mathematical WP
- Abstract teaching and learning of mathematical WP still remain a challenge
- The creation of a learning environment in the classroom setting during tuition time still remains a challenge

Based on the findings of the study, the following is recommended:

- Collaborative teaching and learning mathematical WP with the Hands-on strategy

- The use of indigenous games as a tool to bridge a gap between traditional and western practices
- Teaching and learning mathematical WP through manipulatives
- Connection of the conceptual world with the real world

Keywords: Afromontane learners; context-based strategy; word problems

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ABBREVIATIONS/ACRONYMS

AMESA	Association for Mathematics Education of South Africa
ARU	Afromontane Research Unit
BES	Black Education System
CAPS	Curriculum and Assessment Policy Statement
CAR	Collaborative Action Research
CBPAR	Community-Based Participatory Action Research
CCW	Community Cultural Wealth
CER	Critical Emancipatory Research
CPA	Concrete Pictorial Abstract
CPF	Community Policing Forum
DBE	Department of Basic Education
DRC	Democratic Republic of Congo
FNESC	First Nations Education Steering Committee
HOD	Head of Department
IEA	International Association for the Evaluation of Educational Achievement
IJONTE	<i>International Journal on New Trends in Education</i>
IKS	Indigenous Knowledge Systems
LOLT	Language of Learning and Teaching
MES	Mathematics Education and Society
NAEP	National Assessment of Educational Progress
NAEYC	National Association for the Education of Young Children
NCTM	National Council of Teachers of Mathematics
NCS	National Curriculum Statement
PAR	Participatory Action Research
PALAR	Participatory Action Learning and Action Research
PBA	Pan Balance Approach
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Students Assessment
SA	Subject Advisor
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality
SADC	Southern African Development Community
SAIDE	South African Institute for Distance Education
SAPS	South African Police Services

SANC	South African Numeracy Chair
SATU	South African Teachers' Union
SEDA	Small Enterprises Development Agency
SASA	South African Schools Acts
SBST	School-Based Support Team
SG	School Governance
SMT	School Management Team
SCALE	Stanford Center for Assessment Learning and Equity
TAT	Threats Assessment Team
TIMSS	Trends in International Mathematics and science Study
UMALUSI	Council for Quality Assurance in General and Further Education and Training
UNESCO	United Nations Educational, Scientific and Cultural Organization
WKS	Western Knowledge Systems
WP	Word problems

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CHAPTER 1: THE ORIENTATION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION

This study aims to design a context-based strategy to enhance the teaching and learning of mathematical word problems (WP) for Afromontane learners. This chapter gives an outline of the study, commencing with a brief background to contextualise the problem statement. It further provides a brief outline of the theoretical framework, methodology, an overview of the literature review, generation of data, analysis of data, the value of the study, the ethical considerations, and the layout of chapters.

1.2 BACKGROUND TO THE STUDY

The concept *Afromontane learners* geographically refers to learners who are located in rural and mountainous areas (Da Silva 2015:viii). Thus, in the context of this study, Afromontane learners form part of the social construct of learners that live and subsist in these mountainous rural places and use their indigenous knowledge and cultural wealth to sustain their livelihood. The relevance of considering Afromontane ways of living in teaching and learning is propagated by the Afromontane Research Unit (ARU). ARU argues in the *Ke eo taba QwaQwa Campus Newsletter* (ARU 2015:4) that Afromontane learners have indigenous skills and knowledge that which need to be integrated into the teaching and learning of mathematical WP.

Karen, McDonald, Mhairi and Weston (2001:18-20), whilst in agreement, take this debate further and contend that one way to improve these learners' learning is by integrating their wealth of indigenous knowledge and skills into their teaching and learning environments.

Integration of Afromontane ways of living into curriculum is neither innovative nor a new idea, for instance, the Curriculum and Assessment Policy Statement (CAPS) defines mathematics as:

Human activity that involves observing, representing and investigating patterns and quantitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to develop mental processes that enhance

logical and critical thinking, accuracy and problem solving that will contribute in decision-making. (DBE 2011:8)

From the definition, I have observed that the use of social phenomena justifies the need for the integration of a diverse social context into different ways of knowing for different social context in the teaching and learning of mathematics. Thus, Afromontane learners' social context is important towards enhancing their learning of mathematics. Moloji (2014:486) helps one to understand that one of the reasons for learners' unsatisfactory performance in mathematics, in particular in Afromontane areas, is because their indigenous wealth of knowledge is often marginalised from the classroom.

Sepeng (2015:18,) who claims another reason for their unsatisfactory performance might be one of not teaching them within their context, supports this. In addition to that, Kundema (2016:56-57) further claims that learners are not given a platform to engage themselves freely in the lessons presented by teachers in the classrooms. This is supported by Cope (2016:10), who states that this unsatisfactory performance might be the result of teaching them in an abstract way. It is affirmed by Sibanda (2013:9), in agreement with Nutti (2013:59-71), who also indicates that learners across the world experience similar mathematical WP challenges. In South Africa, for example, learners were unable to convert mathematical WP into mathematical symbols, while Nigerian learners were found to be experiencing some challenges when it comes to learning them in the abstract ways (Okafor & Anaduaka 2013:249). In the global context, learners found to be struggling to identify and correct errors deliberately designed to test their competences of solving mathematical WP (Mati 2002:21).

In addressing these challenges, The Department of Basic Education (2011:293) introduced 'teach and assess' as a strategy that could be employed to enhance teaching and learning of mathematics in South African schools. As a South African mathematics teacher, I observed the strategy being helpful to assist learners in the elementary grades, instead of learning it in a hard, or difficult way. I also learnt that, through extra classes conducted by teachers, they learn mathematics, in particular mathematical WP, better. This is affirmed by Dunley-Owen (2015:2), who acknowledges the efforts made by South African maths teachers who give extra

classes daily, over weekends and during their holidays. Even though the strategy is implemented, learners still struggle; therefore I suggest that there should be a context-based design in a manner that would encourage teachers to teach mathematical WP within the context known to the learners (Molefe & Brodie 2010:5-6).

In a similar way, the Nigerian Education Department adopted the learning of mathematics “From known to unknown” as a strategy that could assist Nigerian learners in learning mathematical WP in a better way, as claimed by Okafor and Anaduaka (2013:249). Merttens (2012:33) brings to our attention Concrete-Pictorial-Abstract (CPA) as the best model recommended by the Singaporean Education Department as strategy to assist learners in learning mathematical WP better and with understanding.

However, for teaching and learning of mathematics to be effective and efficient, teachers should create conducive learning spaces for their learners to learn mathematics freely (Robinson 2010:1-2). Much emphasis is placed on encouraging teachers to create conducive learning environments for their learners to learn mathematics effectively (DBE 2011:296-297). Learning environments should be created in manner that would develop the ability of learners to understand themselves, and to interact with events and resources around and outside their world (Singh 2014:388). Wilson (2015:27), in the Sabbatical Report, claims horses, cows, cars and trains as learning and useful resources that could be used by learners to determine speed and distance.

The conditions of learning mathematics in countries like New Zealand and UK are conducive because they have adopted modern teaching as their best strategy. However, in countries like Cameroon, the Democratic Republic of the Congo, Ethiopia, Nigeria, Rwanda and Uganda, conditions for learning mathematics were challenging, because citizens had a negative attitude towards mathematics. However, educational departments from these countries have been working on the challenges by introducing new approaches that would assist citizens to teach and learn mathematics better and with understanding.

With reference to the conducive conditions identified in the previous paragraph, I found it necessary to consider the threats and risks that might hamper teaching and learning of mathematical WP around the globe. One of the major risks was to learn that South

African and Malaysian teachers experienced challenges when teaching mathematical WP because they had to translate mathematical WP sums into the language understood by learners, and sometimes the translations were not exactly as they were supposed to be (Reynders 2014:29; Namirah & Kusnandi 2017:75-76). As a result, learners find it difficult to convert mathematical WP into mathematical symbols and learn them within their context. Brown (2013:V) found the shortage of teaching materials and qualified teachers in the elementary grades as an alarming challenge, and as a result, learners struggled to learn basic numeracy skills. That challenge contributed to the low education outcomes and negative attitude towards mathematics.

In Singapore, the challenge rests with mathematics curriculum, where many people fear an inclusion of CPA in the elementary grades as a learning model that would encourage their children to learn mathematics through rote-learning and procedural learning (Merttens 2012:33).

Despite the risks and the threats experienced by learners from the countries, as cited above, the Timss 2015 report indicates that mathematics results have improved substantially. In South Africa, the results improved from 41% to 56% in Grade 3, and 30% to 37% in Grade 5 from 2012 to 2014, respectively (DBE 2014:11); in Nigeria, it improved from 25% in 2009 to 39% in 2012 (Namirah & Kusnandi 2017:75-76). Finally, the study conducted by Mullis, Martin, Foy and Arora (2012:23) indicates that Singaporean fourth-graders exceeded the benchmark of 30% set by the Timss Advanced International Benchmarking by 43% – far more than learners from other countries that scored 30% in the 2011 Timss report.

1.3 PROBLEM STATEMENT

It transpires from the global context that learners experience challenges in the teaching and learning of mathematical WP, not affecting only learners from this level of context, but this was also found to be escalating regionally, being high locally (cf. 2.1).

In view to the above, I found these challenges affecting Afromontane learners who form part of the social construct of people that live and subsist in mountainous areas. I learnt that they use their indigenous knowledge and cultural wealth to sustain their livelihood, while ignoring this in the learning process of mathematical WP. Lucero

(2010:127) asserts that the indigenous knowledge and cultural wealth that have sustained them were marginalised in the teaching and learning of mathematics, particularly with regard to mathematical WP. This claim is substantiated by Moloji (2014:486-487), who declares that their indigenous wealth of knowledge was often marginalised from classroom settings. In addition, Wiersum (2012:23-24) announces some mathematical policies and textbooks as destructive, because they were designed to describe mathematical concepts in a wide-range of terms like 'numbers', 'operations', 'relationships', 'patterns', 'functions' and 'algebra', and were not clear as to how teachers could filter the indigenous knowledge and cultural wealth of Afromontane learners. This is further, supported by Nabie (2015:219-221), who claims non-involvement of traditional leaders in the reviewing process of mathematical policies as derisive, because Afromontane learners learn mathematical WP in the hard way. Reynders (2014:21-25) asserts that as long as they do not learn mathematical WP within their context, they would fail to grasp and interpret or convert mathematical WP sentences into symbols. Ukpokodu (2011:46) states that the prevailing situation is even worse, because mathematics teachers also struggle to identify and link the indigenous knowledge or games with mathematical WP. The Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ III) of 2011 raises the issue of insufficient skills to link cultural knowledge with the task-given instructions by teachers as other outstanding factor.

In the effort to bridge the prevailing gap, I assumed that the Mathematics Curriculum Assessment Policy Standard (CAPS) came with a definition to narrow the gap. CAPS defines mathematics as a human activity aiming to build relations in physical and social phenomena (Department of Basic Education 2013:8). This definition creates a platform for Afromontane learners' ways of knowing that mathematics is grounded within their social and physical context. Next, I learnt that the policy is not clear as to how they should link their social and physical beings into mathematical reasoning. Against the above background, I want to argue that there should be a context-based strategy design to enhance teaching and learning of mathematical WP. This strategy could include indigenous games for the mere reason that learners at the elementary grades learn mathematical WP better and with understanding through games (Bose & Seetso 2016:2; Raoano 2016:28).

1.3.1 Research question

The research question for this study is as follows:

How can a contextualised strategy that enhances teaching and learning of mathematical WP be designed for Afromontane learners?

1.3.2 The aim of the study

The aim for this study is as follows:

To design a contextualised strategy that enhances teaching and learning of mathematical WP for Afromontane learners.

1.3.3 The objectives of the study

For the purpose of this study, five objectives were used to break down the preceding aim of the study further as follows:

- to identify the challenges in the teaching and learning of mathematical WP for the Afromontane learners;
- to investigate solutions for challenges experienced in the teaching and learning of mathematical WP for Afromontane learners;
- to analyse the condition conducive to the implementation of a context-based strategy for the purpose of sustainability beyond the duration of the study;
- to investigate the threats and the risks for the implementation of a context-based strategy in teaching and learning of mathematical WP; and
- to identify indicators of success for the implementation of a context-based strategy in teaching and learning of mathematical WP.

1.4 THEORETICAL FRAMEWORK

This study addresses the Community Cultural Wealth theory (CCW) as a framework to view the objectives and experiences of the marginalised Afromontane learners with regard to using their wealth of indigenous skills and knowledge in the teaching and learning of mathematical WP by drawing from their cultural background. Yosso (2005:15) describes CCW as a theory addressing the racial and social imbalances

within people from the same society or group. Thus, looking through the CCW lens, this study focused on unfolding mathematical, linguistic and interpretational challenges experienced by learners in the teaching and learning of mathematical WP and further narrowed the gap between the disadvantaged (Afromontane learners) and privileged learners. It is for these reasons that Xenofontos and Papadopoulos (2008:3) encourage mathematics teachers to work towards linking teaching of mathematical WP with activities that eliminate cultural discrimination amongst learners. Yosso (2005:76) discourages forms of mathematical activities that benefit learners from accumulating better and specific forms of knowledge, skills and abilities than learners do.

The CCW theory is therefore central to the teaching and learning of mathematical WP for Afromontane learners. The Programme for International Students Assessment (2012:141-142) declares an involvement of parents as significant in the study of mathematical WP, because it helps learners to perform better in the subject. In the same way, Ernest (2010:23) regards both the integration of school and home lessons as imperative, because learners can learn to link theories with practices. The DBE (2011:8) acknowledges that by doing so, learners would see the beauty of mathematics, develop love and be curious about the subject.

Lastly, by looking through the same lens, the study focuses on unfolding the various forms of capital, such as aspirational, navigational, social, linguistic, familial and resistant, which attract on the knowledge of learners from homes being taken into the classroom setting (Yosso 2005:77-81; Gay 2013:49-50).

1.5 OVERVIEW OF LITERATURE REVIEW

This section motives and analyses literature review to enhance teaching and learning of mathematical WP to Afromontane learners. Subsection 1.3.3 highlighted five objectives of the study, and in the next subsections the highlights were given indicating as to how each of these objectives contributed in an attempt to attain the aim of the study.

1.5.1 Justification for the need to develop a context-based strategy

The first two sub-challenges of the study (cf. 3.2.1 & cf. 3.2.2) justified the need to design a context-based strategy to enhance teaching and learning of mathematical WP for Afromontane learners. Justification for learning mathematics through indigenous knowledge appears to be obscured in the CAPS document, because the policy is not clear on how learning mathematics through an indigenous knowledge system occurs within the context of learners. This is supported by Maferethane (2012:34-35), who claims the implementation and integration process as being challenging, because even teachers themselves are not familiar with the process. In addition, Graham (2015:170-173) declares insufficient cultural intervention programmes and lack of communication strategies between parents and teachers as major reasons. For these apparent reasons, I found it necessary to design a context-based strategy that would enhance the teaching and learning of mathematical WP for Afromontane learners. In the process of designing a context-based strategy, objectives such as teaching and learning mathematical WP within the context of learners and concretising teaching and learning of mathematical WP concepts will be addressed.

1.5.2 Determining and describing the components of a context-based strategy

Section 3.3.1-3.3.5 determines how one could go about employing five components of a context-based strategy to address the identified challenges. The literature reviews inform us that it sounds meaningful in the teaching and learning of mathematical WP when teachers teach mathematical WP within the context of the learners. Emphasis is placed on the fact that learners who are located in mountainous places have indigenous skills, knowledge to offer in the teaching and learning of mathematical WP, even though these were not recognised in the past, and some are not well documented. From the literature review, it is evident that the fourth-graders do well in mathematical WP when they learn through manipulatives or concrete objects like trees, cows, stones, etc. It is also evident from the literature review that English as a language of learning and teaching (LOLT) is given high priority in the teaching and learning process of mathematical WP, but at some stage teachers use a little bit of a mother tongue to clarify a complex part on mathematical WP and emphasise the key concepts.

In line with the above, Section 4.6 will describe the research design, indicating a route to be taken throughout the research process. The highlights of the events that will take place will be presented in the form of a table (cf. 4.1, Plan of action). Lastly, the stages will be discussed to show how the process will unfold.

1.5.3 Exploring conditions conducive to the successful implementation of a context-based strategy

Sections 3.4.1–3.4.5 will clarify how one could determine conducive conditions in order to ensure that this context-based strategy is implemented properly. The creation of a conducive learning environment for learners to learn mathematical WP on their own appears to be of a great assistance. The acknowledgement of indigenous knowledge systems by the DBE is seen as playing a prominent role in the learning process of mathematics, particularly with regard to mathematical WP, because it opens a platform for learners to learn the phenomenon of interest through the system. The use of manipulatives or concrete objects for learners to learn mathematical WP opens a learning space to learn the phenomenon of interest better and with understanding.

In the line with the above, the opening paragraphs in Sections 5.2.1–5.2.5 will provide the best practices of the challenges identified in these sections. The best practices provide one with the expectations that, when teaching and learning of mathematical WP take place, teachers are advised to prepare lessons in a manner that connect teaching with the environmental settings of their learners. The issue of allowing learners to rely on their own language when they cannot find the relevant thought in the teaching and learning process of mathematical WP, should be seen as an advantage to create conditions conducive to the successful implementation of a context-based strategy.

1.5.4 Threats and risks that may hamper the success of the strategy and solutions

Sections 3.5.1–3.5.5 clarify the threats and risks that might hamper the success of the strategy and solutions. The literature review highlights the most threatening factors, such as observing most of the learners learning mathematical WP in the traditional way, where they come to school on daily basis, dealing with what the teacher is ready to teach, rather than to be given a platform to participate in the lesson. Another

threatening point is that the use of indigenous knowledge systems is acknowledged by the DBE in the teaching and learning process of mathematics, but there is no clear indication how the systems could merge into the teaching and learning of mathematical WP. Moreover, the South African education system allows learners to progress to the next grade, even if they are not ready.

It is amazing to observe that most of the textbooks and mathematical policies are still designed or oriented from a Western context rather than within the African context, to accommodate the indigenous skills of learners who were marginalised in the past.

1.5.5 Demonstrating the indicators of successes of the framework

Sections 5.3.1–5.3.5 illustrate indicators of success for learners who perform extremely well when mathematical WP is taught within their context. The creation of a conducive learning environment plays a significant role to enable them to use indigenous skills and knowledge for the integration of mathematical WP into games. The Concrete Pictorial Abstract (CPA) model is relevant to assist them with learning mathematical WP effectively and efficiently. Finally, the use of code switching plays a prominent role for learners to improve their understanding with regard to the use of complex mathematical concepts, in particular, to assist them with translating mathematical WP into the symbols.

1.6 METHODOLOGY AND DESIGN

This study adopts Participatory Action Research (PAR) as a research method. In PAR, the research participants are regarded as co-workers, not objects. This means that they are given opportunities to assist with shaping and guiding the study and participate in the decision-making process (Clark 2015:9; Rosenthal & Khalil 2010:70; Babbie & Mouton 2001; Cherrington 2015:42). Hertz-Lazarowitz, Zelnike and Azaiza (2010:271) and De Palma (2010:218) declare PAR as a navigator that assists people in striving to have the same vision during the decision-making processes. The research participants for the study are labelled as ‘participants’ for the reason that they are not engaged in questions, but with others in the focus-group discussions (Roller 2017:32; Wagner, Kawulich & Garner 2012:230).

In the light of the above, I found it necessary to contextualise the situation of the study in order to inform my readers about the research setting. The research was geographically conducted in the mountainous area where the indigenous knowledge and cultural wealth sustained the Afromontane learners are marginalised in the teaching and learning of mathematical WP (Kinley 2015:16). PAR is applied within social learning contexts and addresses the issues of powerless people (Rosenthal & Khalil 2010:70).

For the purpose of this study, PAR was utilised as a tool to show how participants could work collaboratively as a team to attain a common goal. The research goal was to design a context-based strategy to enhance teaching and learning of mathematical WP for Afromontane learners. To attain this goal, the research participants selected a parent who acted as a facilitator to facilitate the research proceedings on behalf of the entire group (Amaya & Yeates 2014:8-9). To avoid confusion and the issue of research participants being ineffective or loitering during the research proceedings, the research participants jointly designed a research plan and presented it in the form of a table indicating time, place and number of activities they would engage in (Pendleton 2001:XII). The research participants also work together with the facilitator to identify a research problem, develop a research methodology, collect data, analyse the findings and make recommendations about how the problem should be resolved (Elmusharaf 2015:71; Bless & Higson-Smith 1995:55). Greener (2008:59-65) presents a case that there are several ways in which research processes can be planned or managed.

1.7 GENERATION OF DATA

Mack *et al.* (2005:1) describe data as information generated for a specific research objective. For the purpose of this study, the specific research objective was to find out how the indigenous skills and cultural wealth of the Afromontane learners were marginalised in the teaching and learning of mathematical WP (cf. 1.3). In order to generate the relevant data, the study employed Participatory Action Research (PAR) as a research method in a view to allow free participation of participants in the research process (Juujärvi & Lund 2015:2-3). Cherrington (2015:42) describes free participation as a sense of confidence and the ability to network with other people as well as with one's environment.

However, for a free and fair data collection process, the research participants selected a parent who acted as a facilitator to facilitate the research activities on behalf of the entire team in order to attain the main research objective, namely to design a context-based strategy to enhance teaching and learning of mathematical WP for Afromontane learners. For this reason, data were generated from the focus-group discussions where every person was given room to share and contribute his or her own indigenous knowledge freely and without fear or prejudice in the research study (Chaleunvong 2009:3-4; Mack *et al.* 2005:21). For this reason, the research participants were free to engage in the process of designing a research plan, where they jointly identified a problem, developed a research methodology, collected data, analysed the findings and made recommendations about how the problem should be resolved (Nieuwenhuis 2014:8; Yilmaz 2013). The research participants for this study were people located in the mountainous places and form part of the social construct of people who live and subsist in these mountainous places, drawing from the wealth of their cultural and indigenous knowledge (cf. 1.4).

In order to know that data were generated from the people who live and subsist in the mountainous places and draw from the wealth of their cultural and indigenous knowledge, I learnt that their children could also benefit from learning mathematical WP by employing those skills. I also learnt that during the apartheid regime people fought for their cultural identity and their ability to take part in the education system, but were denied to do so (Twiggy 2015:247-249; Swepston & Rasmussen 1999:4).

However, with the hope that cultural activities would improve the education system and socio-economic situation of South Africans, I conducted my research study amongst people located in mountainous areas, with a view that their indigenous skills and knowledge could assist me in designing a context-based strategy that would enhance teaching and learning of mathematical WP for Afromontane learners (Nkoane 2006:50-54).

1.8 DATA ANALYSIS

According to Hox and Boeije (2005:593), data can be generated for various reasons, and one of the reasons could be to evaluate and address the challenges that were overlooked in the past. After data have been generated, the data then have to be

analysed (Roller 2017:19-20). Analysis of data means to organise and evaluate it after having been generated in order to produce results (Olivier 2017:9; Chaleunvong 2009:3). In addition, Berg (2004:199-201) asserts that data analysis provides researchers with time to reflect on the problem identified, and to check whether it has been addressed as planned or not. From the various studies conducted previously, I learnt that researchers used various approaches to conduct research-based studies and I then analysed this (Vosloo 2014:321; Hox & Boeije 2005:595; Mason 2002:1-3).

For the purpose of this study, the research participants adopted Critical Discursive Analysis (CDA) as an approach. By choosing CDA as an approach, the aim of the research participants was to analyse the words spoken by team members in the research proceedings to determine whether they are interpreted and analysed in line with Van Dijk's ideology and to create a cohesive report for the study (Van Dijk 1993:353). According to Van Dijk, CDA addresses the social problems that constitute society and culture and show a link between text and society. Wodak and Meyer (2009:12) concur with Van Dijk to say that texts taken from the research study could be analysed in order to get deeper meanings. The mass of generated data from the research participants was classified according to themes formulated from the cultural review, in line with the objectives of the study. Each theme was classified according to the research objectives, analyses and interpretation of data generated. The empirical evidence relating to these themes were finally presented.

1.9 THE VALUE OF THE RESEARCH STUDY

According to Georghiou (2015:5), the research becomes productive when participants are given a platform to participate and when they are always kept informed about the research proceedings. Mack *et al.* (2005:22) assert that they would make positive contributions and the study would remain meaningful to them. In addition, Walkington (2005:8; 15) stresses that once they feel comfortable about the research study, they would remain loyal and the study would yield better results. Mason (2002:6-7) claims that a research study should be designed in a manner that benefits its participants. Vosloo (2014:324) agrees to state researchers, participants and other relevant stakeholders in the local communities and learning institutions as the beneficiaries of the research studies. According to (Habib 2015:4), benefiting from the

study means to improve one's own conditions in life, not conducting the study under the impression that the information is needed only to benefit the researcher.

For the purpose of the study, I regarded Afromontane learners, the research participants and community members at large as beneficiaries, because initially the essence of conducting the study was to design a context-based strategy that would benefit learners from the mountainous places. One might ask how they would benefit from this strategy? This strategy introduced *kgati* (rope skipping) as an indigenous game to benefit learners. Learners were to observe the moves made by *kgati*, identify the geometric shapes that were formed, convert the shapes into numeric patterns and later on convert the numeric patterns into mathematical WP. It was noted that learners in the elementary grades learn mathematical WP better with concrete objects that are within their context (Dunley-Owen 2015:6). Wiersum (2012:23), who claims that they learn better with understanding further substantiates this claim. Finally, Molefe & Brodie (2010:4) highlight that these skills would assist tutors and lecturers at colleges and universities in capacitating student teachers to become better teachers when teaching mathematical WP.

1.10 ETHICAL CONSIDERATIONS

The major role of the researcher was to inform the participants about the purpose of the research project, the duration and the key role one had to play in the research proceedings (Øye, Sørensen & Glasdam 2016:456). Equally important, other roles of the researcher were to ensure that every participant is treated fairly and with dignity, that justice prevails, and that everyone is free to withdraw any time he or she wants. Furthermore, no information would be divulged to anybody (Berg 2004:195; Mason 2002:41; Bryman 2012:135-136). In the case of the minors, parental consent forms were given to parents of the learners. The research processes were explained in language that is age appropriate (Dixon 2015:2070; Babbie 2004:67-82). This is exactly what is encouraged by Preece and Manicom (2015:128), who emphasises that during the research processes, researchers have to consider that learners do not learn in the same way as adults and, as a result, one needs to be patient in order to avoid harassing them.

Now, having observed that the learners I intended to work with were minors, I had to prepare consent forms and send them to the parents for evaluation and approval of participation of their children in the research study. The information in the consent forms included the following: My identity as a researcher, the purpose of the research, reasons why their children have been selected, disadvantages and benefits of the study, privacy, anonymity, confidentiality, and the right to participate and withdraw (Dongre & Sankaran 2015:1189-1190; Fouka & Mantzourou 2011:4-6). In the pre-meeting held in the school hall with the research participants, the aforementioned ethical considerations were also highlighted. I also had to ask for clearance from the Ethics Committee of the University of the Free State to conduct the study. Finally, I had to ask for permission from the Free State Provincial Head of the Department of Education to conduct the study and I had to wait for their approval before the research proceedings could start (Houston 2016:15; Peter 2015:2628).

1.11 THE LAYOUT OF CHAPTERS

Chapter 1: This chapter focuses on the introduction, background, problem statement, research question, aim, objectives of the study, an overview of literature review, methodology and design, generation of data, data analysis, the value of the research study and the ethical considerations.

Chapter 2: This chapter outlines the theoretical framework in line with the study.

Chapter 3: The related literature review is presented in line with the study.

Chapter 4. This chapter deals with the research design and methodology used in the study.

Chapter 5: This chapter focuses on the data analysis, as well as the presentation and interpretation of the results, towards designing a context-based strategy for teaching and learning of mathematical WP to Afromontane learners.

Chapter 6: In this chapter the conclusions, summary, findings and recommendations for future research are presented.

CHAPTER TWO: THEORETICAL FRAMEWORK OF ENHANCING TEACHING AND LEARNING OF MATHEMATICAL WP FOR AFROMONTANE LEARNERS

2.1 INTRODUCTION

This study aims to design a context-based strategy to enhance teaching and learning of mathematical WP for Afromontane learners. In this chapter, the researcher begins by introducing Community Cultural Wealth (CCW) as a learning theory. Then, discusses the historical background of CCW as a theory. The emphasis is also laid on the review of different philosophical tenets of CCW and advanced types of formats relating to the use of CCW. The researcher also considers the use of epistemology and ontology as stances to assist in viewing whether the nature of reality and knowledge exists in the study or not. Rhetoric is used to indicate that the language used in the study remains acceptable. Through the use of this rhetoric is able to maintain sound relations between himself and his participants at all times. Finally, the researcher defines the central concepts of the study and reaches a conclusion.

2.2 CCW THEORY AS A THEORETICAL FRAMEWORK FOR THE TEACHING AND LEARNING OF MATHEMATICAL WP FOR AFROMONTANE LEARNERS

This study is guided by an assumption that teaching and learning of mathematical WP are central worldwide (Southern and Eastern Africa Consortium for Monitoring Educational Quality III – SACMEQIII 2010:3; Trends in International Mathematics and Science Study – TIMSS 2015:2). Various studies have shown that learners experience problems in the process of learning mathematical WP. Although strategies have been implemented, the problem still exists (Ng & Rao 2010:183-184; Alro, Ravn & Valero 2010:12-13; Department of Basic Education 2014:18). For these apparent reasons, the researcher decided to conduct a research study based on designing a context-based strategy that would enhance teaching and learning of mathematical WP for Afromontane learners. The Department of Basic Education (2011:5) acknowledges and values the use of indigenous knowledge systems in the teaching and learning of

mathematics, especially mathematical WP, but the challenge remains, because the 'how' part of the implementation process has not yet been addressed.

In view of the above, the researcher used CCW as my lens to find out what happened in previous years and what is currently happening regarding the indigenous knowledge and cultural wealth of the Afromontane learners. The researcher learnt that these funds of knowledge have not yet been incorporated into the teaching and learning of mathematics, especially with regard to mathematical WP. This claim is substantiated by Moloji (2014:585) and Sepeng (2015:25), who declare that their indigenous knowledge and cultural wealth were often marginalised from the classroom settings. Voss (2015:24) declares that mathematics teaching should take place for social justice; that is, daily activities given to learners should not discriminate against them based on their cultural backgrounds.

However, the researcher suggests that there should be a context-based strategy designed to enhance teaching and learning of mathematical WP for Afromontane learners to narrow the prevailing gap. Nasir, Hand and Taylor (2008:197-199) affirm that societal gaps could be narrowed through the efforts made by teachers, parents and other relevant stakeholders. Cutts (2014:online) lists a number of efforts that could possibly make this happen, such as setting goals, preparing one's mindset to maintain a positive relationship with the goal and working towards achieving the goal. Liou, Antrop-Gonzalez and Cooper (2009:75-81) state that everything is possible when people work together.

In line with the above, the researcher also suggest that for the strategy to be efficient in use, it should link with the CCW as a framework of the study, because of the mere fact that CCW encourages learners to learn mathematical concepts through cultural games (Yosso 2005:77-81). This claim is supported by Moloji (2015:22), who states that through learning mathematics through games, learners can realise that mathematical content is within their space; that is, by means of their daily games, their mathematical skills are developed, which are not difficult for them to learn. In addition, Mothata, Lemmer, Mda and Pretorius (2000:110) further recommend the use of CCW theory as imperative in the teaching and learning process of mathematical WP, because it embraces issues related to culture, and redresses the social, economic and

traditional imbalances of the past where learners with a wealth of indigenous skills were marginalised.

2.2.1 The background of Community Cultural Wealth and its implications for teaching and learning mathematical WP to Afromontane learners

This part of the study briefly presents the background of CCW as a theoretical framework. Further, presents Critical Social Theory (CST) as a theory integrated with CCW in the teaching and learning of mathematical WP.

According to Habermas (JeongSuk 2003:9), CST originated from the Frankfurt School in Germany where Habermas lectured philosophy and sociology as a Marxist (he did not believe social reality to be rational) in the early seventies. He also became a director of the same institution during the time when Marxists refused to accept liberalism as an alternative tradition in a society where /people were free to air their views.

The crisis or the unrest arousing between Marxists and Liberalists required him to reconsider the intellectual framework according to which the Frankfurt School operated. The crisis forced him to work towards CST that would embody the enlightenment ideal of freedom and justice. For these reasons, he constructed critical theory as a theory of action, a theory that entailed bourgeois science and culture, with which liberalism was closely associated. The idea of introducing CST as an alternative approach was considered by theorists and researchers like Hoare, Chris and Robinson (n.d:53), Kumar (1995:4), Waters (1994:181), Lash (1990:153-155), Popenoe, Boulton and Cunningham (1996:24-25) and Bailey and Gayle (2003:345-347). It was regarded as of vital importance, because it would have an impact on the issues involved in the use of culture, education and community as a tangled trio that would work collectively towards mediating the epistemic power of everyday life experiences by people of current and ancient times.

From the above historical background, it transpires that CST is a theory constructed with the aim of integrating culture, education and community. From this idea, I could take a stance that CCW theory is incorporated into CST, for the mere fact that both theories address culturally, educationally and community-related issues as declared by Yosso (2005:15), Ernest (2010:23), Nasir *et al.* (2008:188-189) and JeongSuk

(2003:9). The studies conducted by researchers like Nkoane (2006:52-54), Mahlomaholo and Netshandana (2012:487), Sepeng (2015:25), Nasir *et al.* (2008:188-191) and Chilisa (2012:3-4) also show that there is an existing gap between the three issues. For these apparent reasons, I decided on CCW as a lens to assist in bridging the prevailing gap.

However, the studies conducted and related to CCW theory by Nasir *et al.* (2008:13), Lash (2012:12), and Van Oers, Wardekker, Elbers and Van der Veer (2008:12) declared culture and an education system as two different entities used separately in the past administration. As a result of that, scholars have been working hard to produce numerous articles in their attempts to narrow the gap between the two entities, also trying to show integration, but the gap still remains (Sepeng 2015:12; Chikodzi & Nyota 2010:12). However (Yosso 2005:78), in an effort to bridge the gap, presents CCW as a model shown below.

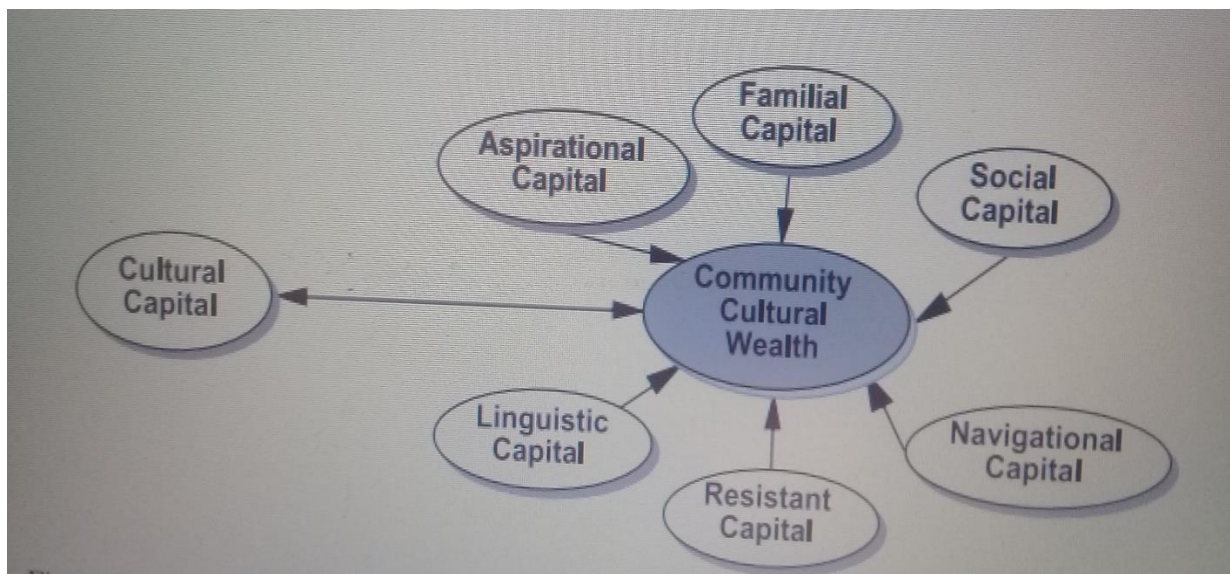


Figure 2.1: A model of Community Cultural Wealth (Adapted from Yosso 2005)

Figure 2.1 shows how the information regarding the use of culture is communicated from the CCW as a mother body at the centre, fenced by the various forms of capital. This figure suggests that certain cultural data are only communicated between CCW and the cultural capital, which lies far apart from other forms of capital. This is affirmed by observing that, at the two edges of a long arrow, one end touches only the mother body while the other end touches only the cultural capital. The edges of the small arrows pointing at the mother body at the centre further suggests that all six forms of capital rely on the mother body to get the information regarding the use of culture. In

the next discussion, the researcher shall further explain how far these interactions implicate culture in the teaching and learning of mathematical WP.

2.2.2 Tenets of community cultural wealth

This section focuses on the tenets of CCW, and the impact they have made on the study. Yosso (2005:77-81) refers to them as ‘forms of capital’ and classify them as aspirational capital, navigational capital, linguistic capital, familial capital, social capital and resistant capital.

2.2.2.1 Aspirational capital

Aspirational capital is defined as the ability to maintain hopes and dreams for the future in spite of challenges (Liou *et al.*, 2009:538 & Ako-Asare 2015:20). In the context of the study, the researcher views mathematical concepts such as mathematical WP, shapes, time and capacity or volume as concepts that could derail the hopes and dreams of learners as far as their future is concerned. It is evident that learners in the elementary grades (Grades R–6) learn mathematical WP better and with understanding through games and from within a cultural context (Dunphy, Dooley & Shiel 2014:17; Malloy & Malloy 1998:249-250; Bishop 1988:180-181). Sepeng (2015:18-20) asserts that by learning within their context implies that they learn better from the things that they could see in their environmental settings. Yamamura, Martinez and Saenz (2010:132) declare that the best way teach them, namely through manipulatives, substantiates this claim. The DBE (2011:8) further claims that by doing this, learners would develop and see the beauty of mathematics. Navarrete, Omarshah and Van Egmond (2015:10) advance that they would not only see the beauty of mathematics, but also hold on to their hopes and dreams. Lai, Auhl and Hastings (n.d:3) and Ako-Asare (2015:22-23) argue that by learning through manipulatives they would also be able to grasp and maintain their learning standards when learning mathematical WP.

Coming to the issue of how the interaction between the aspirational capital and CCW implicates teaching and learning of mathematical WP, the researcher learnt that even young children have certain goals to attain in life. Some of the goals are to see themselves doing well in mathematics to become designers, engineers, builders, etc., in life. Therefore, for them to attain these goals, they have to learn how to become

creative and think critically. This claim is supported by Dunley-Owen (2015:5), who urges mathematics teachers to encourage their learners to reason critically when solving mathematical WP. After they have completed their in-service training courses, they have to go back to their respective societies and serve (Koeyi 2016:4-6).

2.2.2.2 Linguistic capital

The researcher learnt from the concept, aspirational wealth (cf. 2.2.2.1) that learners have to go back to their communities to serve the community with the skills they have acquired from their in-service training. The researcher also learnt that this attainment of goals could possibly happen when they communicate their ambitions through the linguistic skills they have. For these reasons, the researcher argues that learners cannot attain their goals if they cannot communicate their ambitions clearly through language. This account is supported by Ako-Asare (2015:21), who declares linguistic capital as a form of capital reflecting on how learners use their intellectual and social skills attained through communication experiences to attain their goals.

In the context of this study, the researcher views linguistic capital as a wealth by which the ability of learners to solve mathematical WP is developed. Similarly, he also learnt that this linguistic wealth could be used to assist learners to read mathematical WP with understanding and reasoning, and apply skills and knowledge to new learning situations. Dale (2016:23), who describes linguistic capital as a treasure utilised by learners to translate mathematical sentences into mathematical symbols, supports this version. In addition, Suurtamm, Quigley and Lazarus (2015:1) claim that the best way of utilising this wealth efficiently is by improving the teaching and learning of mathematical MP through the relevant vocabulary. At this stage, the researcher views relevant vocabulary as terminologies often used by teachers when teaching mathematical WP. Facer, Kruger and Pretorius (2009:40) list the following terminologies as examples of keywords often used by teachers when teaching mathematical WP.

Increased by – assists learners in thinking about using a plus sign (+) to a given mathematical WP to solve

Decreased by – assists learners in thinking about using a minus sign (-) to a given mathematical WP to solve

Difference of – assists learners in thinking about using a minus (-) to a given mathematical WP to solve

Sum of – assists learners in thinking about using a plus sign (+) to a given mathematical WP to solve

Dunley-Owen (2015:4) advises mathematics teachers to encourage learners to use the listed words above more often, because they are not used in daily communication. Most importantly, Mahofa (2014:14-15) advises teachers to encourage their learners to use English frequently in order to read and interpret the task-given instructions on mathematical WP correctly.

In relation to the above discussions, the researcher views an arrow in Figure 2.1 that moves from linguistic wealth and points at CCW, which discloses that there is interaction between the two constructs. The arrow further suggests that the interaction is about communicating cultural wealth between the constructs. In my view, this communication expresses that even if learners might go out there and learn how to read, reason and apply mathematical WP knowledge appropriately to be used in different learning situations, they might still have to go back to their respective communities and serve the same skills, because they are still regarded as members of the community. This discussion is supported by Dunley-Owen (2015:7) and Rudhumbu (2014:90-91), who claim this turn as a plough-back, because it will assist learners who struggle to solve mathematical WP.

2.2.2.3 Familial capital

Aspirational capital appears to be a vehicle that drives the ambitions of learners to learn mathematical WP with understanding in order to attain their goals (cf. 2.2.2.1). Linguistic capital as a linguistic mechanism assists learners to communicate and interpret the terminologies used when solving mathematical WP (cf. 2.2.2.2). This section provides us with an idea how parents and siblings assist learners with mathematical WP. Learners acquire familial capital by utilises cultural knowledge that they gain through their connection with their immediate and external family members, as well as the community, carrying a sense of community history, memory and cultural instinct. This facilitates their comprehension of mathematical WP (Luna 2012:5-6). According to Liou *et al.* (2009:538-539), the cultural knowledges acquired by learners



from their parents and siblings should assist them to communicate their familial cultural stance when meeting with other learners from various backgrounds. Figure 2.1 above displays that the effectiveness and existence of aspirational wealth, linguistic wealth and familial wealth are drawn from the CCW, which, in turn, are communicated through Cultural Wealth (funds of knowledge).

However, from the familial wealth context, the researcher learnt that the success of learners is highly dependent on the support they get from their parents or from the wishes that parents might have for their children. Sometimes parents might wish their children to become teachers, medical doctors, engineers, builders, etc., only to find that their children are missing a point or not dreaming in the same way as they are. This version is proven by Dunley-Owen (2015:6), who declares that aspirations and parental and teacher pressure can be good, but can lead to unnecessary frustration and problems due to complete lack of insight.

However, in the context of this study, my view is to look at how parents in the past assisted their children to get educated from their cultural backgrounds. I learnt that even though most of the parents were uneducated, they were able to use their natural resources to sustain them and their families. The researcher learnt that their children used their toes, fingers, sticks, beads and sweets for counting, and horses for travelling, etc. He also learnt that even in current years learners from disadvantaged families could still learn mathematical WP through the use of small stones – not abacuses or counting frames – because some learners cannot afford to buy them, in case a Grade 4our learner is asked to solve the following mathematical WP:

Four stones decreased by one

Then, a learner will go around looking for the stones, and doing the following:

- grouping and putting four stones apart: 
- trying to figure out the meaning of 'decreased by', which means that she or he has to subtract (-) or put one stone apart from the four stones grabbed from the ground : 
- thinking of introducing a sign that gives a number sentence a meaning (=)

- ultimately coming to the following conclusion,



However, within the teaching and learning environment where mathematical WP is taught, Jegede (2011:41) encourages teachers to explain difficult mathematical WP words or concepts in the language understood by all learners at primary schools, as well to code-switch to English, wherever possible. Similarly, we find that Bjorn *et al.* (2016:362) also argue a point that basic knowledge of number sentences (WP) should be grounded within the cultural knowledge of a child. In addition, Bishop (1988:181) also urge parents to use their context-based cultural knowledge to assist learners with mathematical WP, at the same time letting them know how good and rich they are because of indigenous knowledge, as well as how they can best assist them to solve mathematical WP.

The effectiveness and the use of indigenous skills as formal teaching and learning aids will be seen working only if they are included and implemented in the school curriculum (Bush 2002:5-6). The explanation by Sepeng (2015:25) emphasises a fact that learning becomes meaningful if it extensively covers and links what is always embedded in cultural practices, making sense to learners at home and doing the same at school.

2.2.2.4 Navigational capital

This is an overview of the work presented from the previous sections, where an aspirational capital appears to be a vehicle that drives the ambitions of learners to learn mathematical WP with understanding in order to attain their goals (cf. 2.2.2.1). Linguistic capital is a linguistic mechanism that assists learners to communicate and interpret the terminologies used when solving mathematical WP (cf. 2.2.2.2). Familial capital as an anchor represent the support they get from their parents and siblings at home in order to learn mathematical WP better (cf. 2.2.2.3). This section provides us with an idea of how learners use their communication skills overcome the hurdles of learning mathematical WP in a hard way.

Liou *et al.* (2009:538) define navigational capital as the ability to overcome hurdles and obstacles appearing in the process of teaching and learning mathematical WP through indigenous games. In the context of this study, overcoming hurdles and obstacles implies that learners have to work hard to pave their way towards learning mathematical WP in the best way. Collins, Sibthorp and Gookin (2016:4-6) assert that they could go through the hurdles through the assistance and support they get from their families. In agreement, Magidi (2015:20-21) note that fourth-graders from disadvantaged families could still learn mathematical WP best from traditional ways of learning, for example, they could do counting through sticks and stones, do drilling of new mathematical concepts every day and writing speed tests to grasp the concepts for a longer period of time. This claim is supported by Jooste, Press, Slamang and Van Deventer (2012:3), who suggest that playing around with words sums like *three more than eight, two more than four, four less than ten, five less than twelve*, etc., as one of the best strategies that could assist them to overcome the hurdles. In addition, The DBE (2011:20; 34) emphasises that they could even learn concepts better and with more understanding when these are regularly asked in the mental maths activities presented during the first ten minutes before the lessons commence every day.

In the light of the above discussion, the researcher maintains that learners from disadvantaged backgrounds could still benefit from learning mathematical WP best through traditional ways of learning (Koeyi 2016:4-6). My claim rests on the fact that most of them are still staying with their grandfathers and grandmothers who are unfamiliar with the use technological devices, but they still can add, subtract, divide, multiply and reason logically without the use of these technological devices. The researcher further argues that this form of familial wealth should be transmitted to our children today because it is still relevant. This claim is substantiated by Petersen (2016:10), Bergqvist (2012:6) and Rudhumbu (2014:89-91), who encourage teachers and parents to work very closely because they could learn from one another.

2.2.2.5 *Social capital*

This is an overview of the work presented in the previous sections. Aspirational capital appears to be a vehicle that drives the ambitions of learners to learn mathematical WP with understanding in order to attain their goals (cf. 2.2.2.1). Linguistic capital is a linguistic mechanism that assists learners to communicate and interpret the

terminologies used when solving mathematical WP (cf. 2.2.2.2). Familial capital is an anchor that represents the support they get from their parents and siblings at home in order to learn mathematical WP better (cf. 2.2.2.3). Navigational capital is hurdles representing challenges and victory over those challenges when learning mathematical WP (cf. 2.2.2.4). In the section, we shall see how learners utilise their communication skills to network with other people and the resources available to them around to make their hopes and dreams come true. Liou *et al.* (2009:538) refer to social capital as a network assisting people to communicate with other people and the community resources with the aim of having their goals been achieved

In the context of the study, networking with people and the resources around, implies that learners have to meet with the relevant people in the community, and look for the relevant resources that could assist them in learning how to link indigenous skills with mathematical WP. Ako-Asare (2015:21-23) and Yosso (2005:80) urge teachers and parents to work very closely regarding integration of culture and mathematical WP. Taylor (2008:15), who sensitises teachers to consider the individual backgrounds of learners in the learning process of mathematical WP further supports this version. In addition, Laschike (2013:898) urges teachers to work closely with their learners to see if they are still learning mathematical WP correctly or incorrectly.

In line with o the above discussions, the researcher strongly believes that teachers have to assist them to think and learn fast to observe differences in learning styles from their learners; that is, to observe how individuals respond to the mathematical WP lessons presented in class. Thus, if the dialogue is flat, they have to present the lesson again in order to accommodate other learners (Luna 2012:8). With the view of the researcher, by doing so, they would have considered the fact that the cognitive levels of their learners in learning mathematical WP differ (DBE 2011:296), and considering networking with other people to be relevant, and that could be merged with real practices that relate to societal career roles such as builders, carpenters, scientists, etc. (Ako-Asare 2015:31-35).

2.2.2.6 Resistance and resilience capitals

Liou *et al.* (2009:538) refer to resistance as oppositional behaviour, which shows that people are not satisfied about something, for example, inequality and exclusion.

According to Ako-Asare (2015:23), people might show their dissatisfaction in different ways. Some would not attend to their jobs, while others engage other people to show their anger or dissatisfaction about something. The researcher learnt that, during the apartheid era, South African learners navigated their way through Bantu education throughout the riots (United Nations Educational, Scientific and Cultural Organization 1974:86-88). I also learned from Nelson Mandela, who left us with a legacy, that hopes and dreams are maintained through peaceful negotiations, nothing else (Adebajo 2010:108-109). This is affirmed by Figure 2.1, which illustrates that the six tenets survive because of getting the wealth of knowledge from the CCW. This implies that in the real-life situation, no-one would be able to survive if unwilling to network with other people around him or her; that is to, say success comes through believing in oneself and sharing of ideas (Ako-Asare 2015:25).

However, from the previous forms of capital we have learnt that learners have hopes and dreams to attain, but this could come true only if they network with other learners, parents and teachers to become what they want to be.

When Sepeng (2015:17-18) refers to the classroom environment or context, it indicates that learners show their dissatisfactions differently; that is, by arriving late for class or by not doing their work, or by disturbing others while tuition is in progress (Nasir *et al.*, 2008:15).

In the context of the study, resistance capital means the ability to refuse doing bad things, or undesirable or oppositional behaviour that might hamper the progress of learners to learn mathematical WP in a good way. In my view as a researcher, I claim the following constructs as factors that might hinder the progress or ability of learners to do well in learning mathematical WP: laziness to do mathematical WP tasks; dodging of mathematical WP classes; being inactive or passive during the mathematical WP lessons; and engaging with intoxicating substances such as alcohol and drugs. Adebajo (2010:108-109) further announces family background as one of the major contributing factors, because some children stay with their grandfathers or grandmothers where control is unlimited. In addition, Ako-Asare (2015:23) claims child-headed families as another major and contributing factor because children do as they wish.

However, Ako-Asare (2015:25 -26), raises a point that children must be encouraged to voice their challenges to their parents, and if they are not free to raise them with their parents, they can raise them with their siblings or peers or any community member they feel free to share their feelings with. Nasir *et al.* (2008:15) and the United Nations Educational, Scientific and Cultural Organization (1974:86-88) encourage learners to resist while asking for assistance from other people, support this claim. For this reason, the researcher concludes that resistance and consultation fall in the same category, because learners cannot fight or oppose parental advice and at the same time succeed in life.

2.2.3 Formats of Community Cultural Wealth Theory

This section presents the Feminist, Critical Emancipatory and Ubuntu theories addressing similar issues like CCW as a theory. As a researcher, I have noted that the trio addresses issues related to racial and gender inequalities, for example, issues like:

Who should do mathematics?

or,

Who should not do mathematics: boys or girls?

because some people are of the view that boys are cleverer than girls are, or vice versa. This will be discussed in the next sections.

2.2.3.1 Application of CCW and formats

As point of departure, readers are reminded that CCW addresses the issues related to racial and gender inequality, starting from pre-school to high school (Mackinnon 1982:1-2). This also affects students beyond colleges and universities where the curriculum was designed to disadvantage other racial groups (Yosso 2005:75-77; Dika & Singh 2002:44-45). In addition, and in my view, the curricula were meant to destroy the African epistemological and ontological ways of doing things and left them with the ideology that the best way of doing good things was to align their thinking with western ideologies (Chilisa 2012:174-175; Nkoane 2006:56).

However, from the feminists' perspectives, the researcher learnt that the issue of inequality takes a different shape. This practice takes place between men and women

(Offen 1998:123; Watkins 2000:24-25; Hemmings 2005:20-25; Bailey & Gayle 2003:IX). Vassillou (2010:90-107) further claims that women in this practice are discriminated against, in many different cases, based on their gender, and in relation with power-related issues such as 'man is the head of the family', 'women must always respect men', and so on. In the context of the study, the researcher views gender inequality based on observing how girls or boys are treated in class during mathematical WP lessons. According to Anderson 2005:185), the issue of gender inequality could be removed only if it separates boys from girls when learning the same content in mathematical WP lessons. This is affirmed by Vassillou (2010:97-98), who claims that this feminist inequality forms part of a broader system of racialised education and political oppression, which regard disadvantaged learners and their families as unworthy of the kind of education system offered by the past regime.

Equally important, Watson and Watson (2011:68) state that the Critical Emancipatory theory is relatively involved with inequality of power existing in relation to opportunity, authority and control. In the context of this study, the researcher views the issue of power in relation to opportunity, authority and control as not being handled fairly, because in the past, girls were not permitted by parents to go to school and get educated; in fact, this was the cultural custom (Hall 2012:62; Arleback & Doerr 2015:14). However, under the current government, girls are exposed to new job opportunities that were initially reserved for men only (Houl & Kalsem 2015:262-263). That is why, even if under the current government, one finds few women occupying high positions because culturally they are expected to stay at home. In the effort to bridge the prevailing gap, the Department of Education in South Africa initiated a campaign called, "Take a girl child to work today." This is a campaign where girls are taken to workplaces such as airways, weather broadcasting stations, Eskom, etc. to learn how the theoretical content link with the practical part in the real life situations. This could be one way to enlighten or develop their mathematical skills to become future leaders in their respective societies. The former South African president, Thabo Mbeki, in his State of the Nation addresses, stated that mathematics should form part of a human resource development strategy that prepares women or girls to become technicians, engineers, educators and leaders in the business world (Department of Education 2001:7; 24). In addition, Panthi and Belbase (2017:7) further elaborate that

boys and girls should be given equal opportunities to participate in the learning process of mathematics, particularly mathematical WP.

Lastly, from an Ubuntu theoretical perspective, the issues of social inequalities are addressed (Mdluli 1987:64; Mucina 2013:23; Louw & Wium 2015:22-27; Nafukho 2006:409). In the teaching and learning environmental settings, teachers meet learners with learning barriers that hamper their progress to learn mathematical WP in a hard way (Reynders 2014:24). In the context of the study, the researcher views failure to comprehend mathematical WP terminologies as one of the major challenges. As a result, Mbhele (2015:16-17) encourages teachers to use a language that is understood by learners and Ubuntu as a matter of urgency to assist learners to comprehend with new and difficult concepts in the process of learning mathematical WP. This version is supported by Pooran (2011:40), Ng and Rao (2010:190-194) and Dika & Singh (2002:39-45), who state that by doing so, learners would learn to grasp the concepts for a longer period.

2.2.3.2 The intersection of CCW with the theories

From my studies of the Community Cultural Wealth Theory, Feminist Theory, Critical Emancipatory Theory and Ubuntu Theory, it transpired that these theorists encourage people to work together (Louw & Wium 2015:23; Laschike 2013:899-901; Grange 2011:61-63). Working together implies that people should share ideas (powers), irrespective of the age, colour, race and status in order to attain their common goals in life (El-Amin 2015:10-11; Hemmings 2005:128-129).

Within the context of this study, working together implies that parents and teachers should work closely together to assist learners in reaching their future hopes and dreams, including math-related proficiency. This will set learners on the road to become scientists, engineers, road surveyors, etc. JeongSuk (2003:9-10) and PISA (2012:141-143) agree with this vision, namely to advise parents and teachers to work jointly to share math-related ideas with children.

2.2.3.3 Conclusion

Finally, the researcher reaches the conclusion that the theories presented above share or address the same sentiments that racial and gender inequalities in classroom

settings where mathematics is taught, especially mathematical WP, as well as different occupations, should be avoided at all costs (Bailey & Gayle 2003:viii). These ideas alert all people, irrespective of their colour, gender, equity, etc., to move societies away from the traditional ways of teaching to new ways of teaching and learning mathematical WP (Bailey & Gayle 2003:X; Seehaver 2018:93-94).

2.2.4 Epistemological perspective

Chilisa (2012:20) describes epistemology as a research model dealing with different ways of knowledge. In addition, Clark (1998:1243-1246) further describes it as a study investigating different types or forms of knowledge people have, an intellectual asset used to assist people to think, communicate and interpret what life offers them. Other researchers such Clark (1998:1243-1246) and Beeftink (2005:345-346) view it as a vehicle for thoughts where knowledge can be communicated to other people by means of either a positivist or post-positivist approach, depending upon the angle of approach in a particular study.

The nature of knowledge and truth transmitted by teachers to the learners was located in the use of positivism as an approach to teaching and learning mathematical WP, where the process is one-directional (Takaya 2008:3). A problem becomes one-directional when a mathematics teacher is regarded as the only resource that can use his or her knowledge to teach mathematical WP concepts, whereas other people would also be available to assist him/her. Chilisa (2012:21) classifies this kind of approach under 'dominant paradigm', where the teacher is regarded as the only source. Nicholas, Jones, Clarke and Howard (1986:10) and Waters (1994:181) support this version, classifying this kind of knowledge system as learner-centred and traditional by nature.

For the purpose of this study, the perception is to discourage learners in the new dispensation to move away from the old way of learning concepts in mathematical WP, such as memorising concepts without understanding them, and rather move towards a new state of thinking or doing things (Kumar 1995:66). In my view as a researcher, another new way of doing things is to avoid at all costs situations where learners are permitted to carry out instructions from the teachers without posing questions while lessons on mathematical WP are in progress (Nyirenda n.d:9). The researcher further strongly argues a point that mathematics teachers should create a conducive

environment in the classroom where individual learners are free to learn; that is, free to pose questions and to give inputs when necessary. Chilisa (2012:10) classifies this kind of approach under 'indigenous paradigm'; that is, a case where the study values knowledge from other people or systems as crucial, as well acknowledge this claim. In addition, Strieker and Dooley (2015:11-13) further encourage learners to understand one another, even if all come from different experiences and cultures and believe that no individual can see the world as it really is.

In conclusion, Nicholas *et al.* (1986:10) declare that it is wrong to believe like positivists in the past that epistemology is unique. This leads to African epistemologies being neglected, while European epistemologies prevail. Nkoane (2006:54) supports this view, by stating that it is not about the colour of a skin one has to think logically, but through utilising the knowledge or epistemology grounded in the intellectual inspiration a person has.

2.2.5 Ontological perspective

For the purpose of this study, I view ontology as a study or a body of knowledge displaying the nature of social reality that occurs between objects and human beings. This nature of social reality occurs when people have connections with living and non-living beings, such as land, earth, animals and other beings (Truwant 2014:696; Ozden 2004:11; Chilisa 2012:20; Coustaty *et al.*, 2015:150-151; Knowles 2013:330-331; United Nations Educational, Scientific and Cultural Organization 2005:138). In addition, Waters (1994:186) claims that this nature of social reality is altered from the mental into a material realm where human and other beings interact on a regular basis. From the above background, we learn that human beings, culture and symbols work closely together. The one cannot exist without the other (Popenoe *et al.*, 1998:24-28). Therefore, our principal task is to show the world that these three entities work together in a series of areas that make sense in themselves and relate to one another. Take note how the following practical example relates to the use of mathematical WP.

For example, if at a certain school, there are 788 learners, and 263 of them are boys, how many learners will be girls?

The example provided above shows us that learners, mathematical numbers and a school are three inseparable identical entities that work very closely together.

The non-living object, the school, is important for living organisms, namely the learners, as the place where they learn to acquire and accumulate mathematical WP knowledge for future use. The living organism is also important for the school, because without learners, learning would not be able to take place and schools would be deemed useless. The symbol “are” can be used as equivalent to the equal sign (=) in mathematics. The total number of learners is 788, of which 263 are boys. In order to get the total number of girls, we introduce a new symbol “minus” (-), which is equivalent to subtraction. Therefore, we subtract 263 (the total number of boys) from 788 (the total number of learners) to get 525, the total number of girls. This is a simple demonstration of how the three entities work together in real-life situations.

Against the above background, Nkoane (2006:56) argues that Africans need to transform and refrain from their ancient educational and social legacy and belief in drawing their own African ontologies and epistemologies.

2.2.6 Rhetoric in CCW

Firestone (1986:3) refers to rhetoric as a manner in which we use language to interact with other people. According to Sánchez (2010:13), the sound-working relations between two people are determined by their rhetoric, for example, if their ways of commutating are bad, it is understood that the results will be bad as well.

However, Sow, Balogun, Aguessy and Diagna (1979:12-13) claim that the kind of rhetoric expected to be used by an African child in the past, from the CCW context, was one of love and respect. This is affirmed by Davidson and Onwubiko (1969:1), who also claim that historically, an African child was taught to behave in that manner when talking to other people.

In the light of the above, Plastow (2006:11-12) declares respect as an African rhetoric asset of communication and legacy that were left with an African child to be carried out from generation to generation. That is why even today, whenever we see African children interacting with other people, we still maintain the idea that they would vocalise their thoughts in the traditional, polite way (Igboin 2011:99-101).

However, in the context of this study, the researcher views rhetoric as a way of creating a sound working communication between teachers and learners when lessons on mathematical WP are in progress. Mallows (2014:13), who encourages teachers to

take a dialogic stance of initiating open-ended discussions during the lesson conducted on mathematical WP, affirms this claim. In addition, Godwin-Jones (2013:1) states that this initiative could happen if learners are given platforms to interact and integrate their individual indigenous skills in a variety of contexts. Seehaver (2018:96) claims one of the initiatives that could be taken by primary teachers to make lessons on mathematical WP relevant to their learners' realities of life; that is, to plan their lessons aligned with the environmental sustainability, and that appreciate the nature of the situation their learners are placed in. This claim is supported by the DBE (2011:5), which affirms that by doing so, teachers would produce learners who are capable of using their language skills in a variety of ways.

2.2.7 The role of the researcher and the relationships with the research participants

This part of the study is devoted to show readers the role of the researcher and his relationship with the research participants in the research field. My role is to ensure that my research participants are informed about the purpose of the research study and how each individual would participate in the research proceedings (Postholm & Madsen 2006:51-52). An action plan should be drawn up to guide the research process of the study. This was drawn up in collaboration with the research participants as to how and where these proceedings would be conducted, and who should get involved to make sure that the activities implemented in this plan meet the objectives of the study. In the case of minors who form part of the research participants, their parents received consent forms, informing them about the role played by children in the research study. They were further informed that their children were not bound to participate in the research study and were feel free to withdraw without fear or prejudice at any time during the research sessions (Ki Purehuroa 2015:15-16). Furthermore, the researcher also included people like subject teachers, school management teams, former mathematics teachers, local businesspersons, parents of learners, one traditional leader from the royal family and a mathematics subject advisor as research participants.

In the pre-session meeting, the researcher highlighted the following ethical issues, namely their rights to privacy and the choice to participate in and withdraw from the

research study (*South African Constitution* 1996, Chapter 2, Section10; Merriam 1998:131-132; Mothata *et al.* 2000:19).

In line with the above discussions, research participants were ensured that they would constantly be updated about the progress in the study, and that they would be free to ask questions (Katigbak *et al.* 2016:212).

In view of the above statement, free participations and positive inputs that were made by my research participants, cautioned me to draw a conclusion in combination with my co-researchers (Nussbaum 2003:21-22; Sadler 2004:353-354; Merriam 1998:100-101; Chaplin 2006:1-2; Gurteen 1999:2; Bisschoff 2005:71-74; Anderson 2005:183).

2.2.8 Definition and discussion of operational concepts

This part of the study provides the definition and discussions of the central concepts such as a context-based strategy, mathematical WP and Afromontane learners. The aim of introducing these concepts was to show the prominent roles played by each of these constructs in the study. One of the prominent roles was to connect the general aim of the study with the objectives in order to design a context-based strategy that enhances teaching and learning of mathematical WP for Afromontane learners.

2.2.8.1 A context-based strategy

The Concise Oxford Dictionary describes (1990) 'context' as an environment related to something under discussions and a 'strategy' as a plan that assists people in attaining certain objectives. As defined above, the researcher can further define a context-based strategy as an ideal plan designed by people in order to assist them to address the outstanding issues or the ability to learn real things through practical experience rather than just learning them theoretically (*The Free Encyclopaedia* 2015; *The Concise Oxford Dictionary* 1999).

In the context of the study, I view a context-based strategy as a goal-directed strategy that is used to bridge a gap or address certain outstanding issues that were not addressed with regard to the use of indigenous knowledges in the teaching and learning of mathematical WP (Mikkelsen 2015:117-119). Khupe (2017:27-30) and Mloi (2013:483) declared the use of *morabaraba* (board game), *kgati* (rope skipping), as indigenous games that make a huge contribution to the teaching and learning of

mathematics, particularly mathematical WP. Seehaver (2018:96), who encourages teachers to focus on their own thinking regarding indigenous knowledge to avoid further misuse of this knowledge, supports this claim. Nkoane (2006:55) reprimands African teachers to stop maintaining themselves as fakes of foreign ideologies, but to stick to their African dogmas, also support this claim.

For these apparent reasons, the researcher found it necessary to design a context-based strategy that enhances the teaching and learning of mathematical WP for Afromontane learners. This strategy was intended to connect a learning process of mathematical WP with learners in their indigenous games (Loewen, Rasmussen & Stone 2015:22-23; Seehaver 2018:96). In addition, Johnston (2015:17) and the DBE (2011:8) advance that by doing so, learners would see the beauty and elegance of learning mathematical WP, by learning better and with understanding.

2.2.8.2 Mathematics word problem

This section provides the definition of mathematical WP, the level of learning in which the concept could be taught (elementary level or stage), and from which context it could be taught. This section further presents four developmental stages of theory. The intention is to present all of them in the form of picture and select the one relevant to the study.

2.2.8.3 Defining mathematical WP

The Free Encyclopaedia (2015) defines mathematical WP as a mathematical statement designed to assist learners with thinking logically and abstractly in real-world situations. In addition, Gerdes (1994:348-349) describes mathematical WP as mathematical sentences based on words and symbols. Similarly, Bartolini *et al.* (2012:46), Ladele (2013:17) and Pooran (2011:9) describe mathematical WP as mathematical layers consisting of numbers and words that need to be converted from an abstract level of thinking into a concrete level of thinking. In the next subsection, the researcher will base his discussions looking at the latter definition by the above authors.

2.2.8.4 Defining the elementary stage

Elementary stage from this level of learning, it refers to a level in which mathematical sentences or words are converted from a mental way of thinking into material or tangible substances. The main aim of converting mathematical word sentences into the tangible substances it is that learners from the elementary Grades (R-6), learn mathematical WP better with concrete objects. Rufini, Bzuneck and De Oliveira (2012:53-54) support this viewpoint. Kelly (2006:186) refers to toys, stones, tables, chairs, human beings, chickens, mice, cows, horses, etc., as concrete objects that could assist elementary learners in learning mathematical WP better. From a view that elementary learners could learn mathematical WP better and with understanding through the use of tangible things, the researcher here cites an example of young boys herding cattle in the field as one of the tangible objects from which learners can learn mathematical WP.

Example:

Two herd boys were looking after the four cows and one sheep in the field. If I double the number of herd boys who are looking after this flock, how many herd boys will there be altogether?



Figure 2.2: Boys cattle herding activity (Adapted from Young Boys Cattle Herding Stock. Photo: www.alamy.com)

This figure intends to assess how learners could solve mathematical WP by using tangible, living substances.

Solution



Figure 2.3: Represents total number of boys who were herding the flock

This figure presents the total of boys who were herding the flock in the field.

In order to determine the total number of boys who were there altogether. We need to multiply (\times) the number of herd boys who were already in the field by two or add (+) the number twice. For the purpose of the study, the researcher shall add the number of herd boys who were already in the field twice in order to determine the total number of herd boys who were there altogether. The adding process will be as follows:



plus (+)

Figure 2.4: Total number of herd boys who were already in the field



equal to (=)

Figure 2.5: Total number of herd boys twice added to the number already in the field



Figure 2.6: Total number of herd boys who were in the field altogether

In my view as a researcher, the above presentation denotes that the lessons on mathematical WP could be presented in a concrete way, and further denotes that learners can learn mathematical WP better and with understanding by using concrete living substances within their context (Ladele 2013:13-14). This is affirmed by (Vizzi 2016:10-11), who claims that learners in the elementary phase can learn mathematical WP better by using manipulatives. In addition, Mahofa (2014:1) and (Moloi 2013:486) claim that they learn mathematics, particularly mathematical WP, much easier when they learn it within their known context.

In line with the above discussions, the concept of learning mathematical WP through manipulatives is supported by Piaget, a psychologist and pioneer of the theory named 'Children's cognitive development'. According to Ojose (2008:26-28), this theory is classified into four cognitive developmental stages, namely the Sensorimotor stage, Preoperational stage, Concrete Operations stage and Formal Operational stage. The four stages are presented in the form of a picture to determine how this theory could be linked with the study.

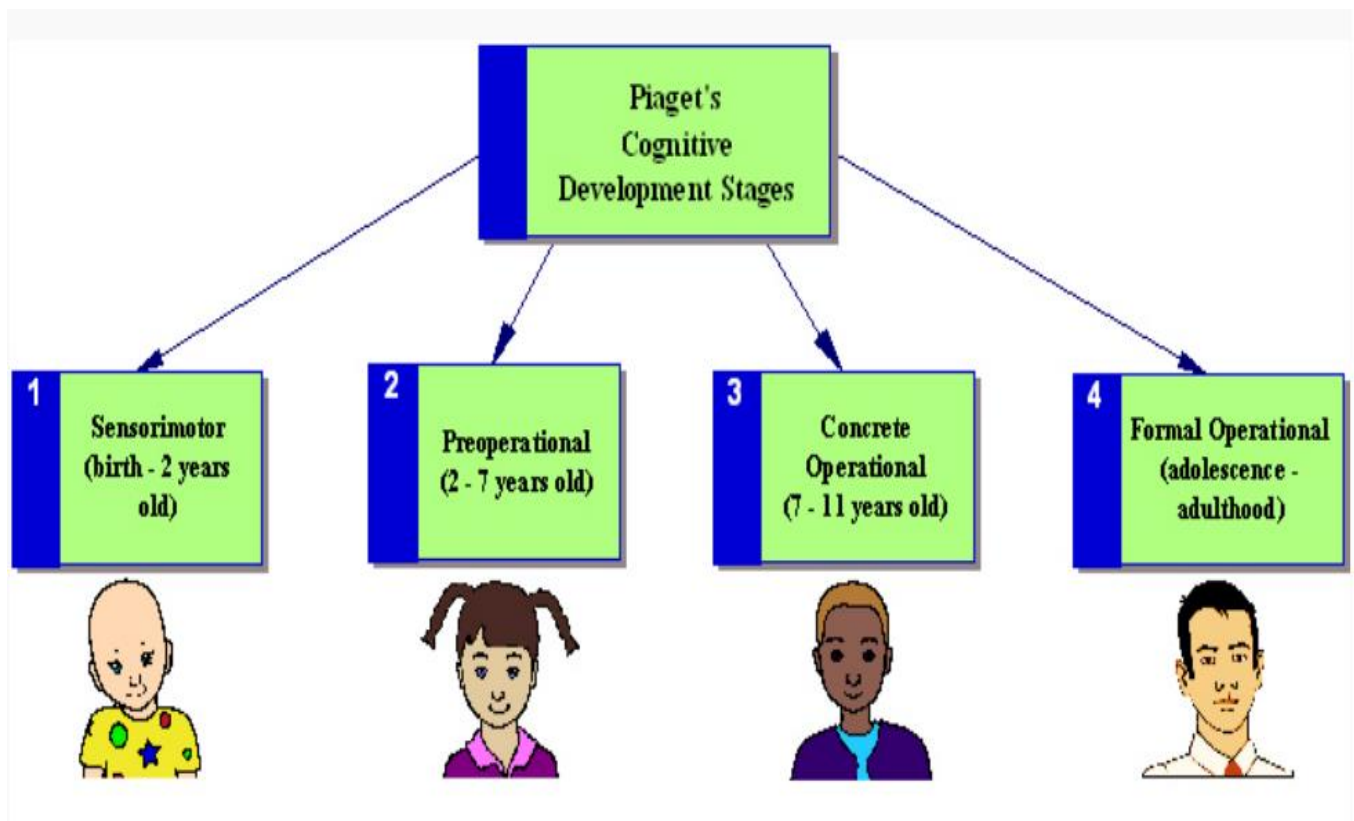


Figure 2.7: Four developmental stages (Adapted from Department of Educational Psychology and Instructional Technology 2014)

This figure illustrates four developmental stages cited by Wood, Smith and Grossniklaus (2014:3) from Piaget's work on developmental theory. This figure further shows how children develop from one stage to the other, that is, from the sensorimotor stage to the formal operational stage. For the purpose of the study, the focus will be on the concrete operational stage, because elementary learners from this stage learn mathematical WP better by using concrete objects. Thompson (1994:3) and Sandwell (2004:1) support this claim.

2.3.1.3 Concrete operational stage (7–11 years)

Muthivhi (2009:7) describes the concrete operational stage as the stage during which children learn to understand the world by using manipulatives. Yee and Bostic (2014:1; 12-13) assert that if children have developed sufficient skills of concretising manipulatives properly, they would be able to conceptualise them and finally reach conclusions in the process of learning mathematical WP.

Jerome Bruner, who designed a model in the 1960s named CPA (concrete, pictorial and abstract), further supports the idea. It was further developed by Hoong, Kin and

Pien (2015:3-11), who believe it to be an appropriate approach that could be used by learners to learn mathematical WP better and with understanding. According to Kelly (2006:186-189), the idea behind introducing this model was to assist learners from the lower grades to learn mathematical WP from the concrete level (e.g. physical materials such as sticks, stones, etc.), the pictorial level (e.g. the use of pictures to learn), and finally develop to the abstract level (e.g. conceptualise the learning materials).

According to Rufini *et al.* (2012:54), the elementary stage is a stage ranging from Grade 5 upwards where learners have developed their level of thinking from the concrete stage to the pictorial stage level of thinking. According to Taber (2013:1-3), at this level of thinking, whatever is asked relating to mathematical WP, learners would fantasise a given mathematical WP and conceptualise it in order to construct a number sentence needed to solve that particular mathematical WP.

2.4 AFROMONTANE LEARNERS

The Concise Oxford Dictionary (1990) describes 'Afro' as kind of a person who stays in Africa and a 'montane' as a person living in the mountains. Therefore, Afromontane refers to people in Africa who are located in mountainous places (Briggs 2005:3).

In the light to the above explanation, and in the context of the study, the researcher refers to Afromontane and rural learners as the same learners because they are situated in mountainous places. Sometimes they use horses and donkeys as their major mode of transport. The researcher also noted that these horses and donkeys play a significant role in assisting them to plough and transport commodities to mountainous places where could be easily reached when one uses cars, taxis and buses (Mwamwenda 1995:71-72 & 431-432), but in most cases to perform their daily duties they use a normal transport like taxis, buses, taxis, etc., on daily basis.

This version is further supported by Da Silva (2015:viii), who describes Afromontane learners as learners who form part of the social construct of people that live and subsist in these mountainous places and draw from the wealth of their cultural and indigenous knowledge. This means that even though they live and survive by using herbs for medication and many have comprehensive knowledge about the medical value of plants, and they use natural items to cure hundreds of ailments without modern

medicine, horses and donkeys to cultivate food, they do not live in isolation, but still form part of the local society (Thompson 2000:14; Metz 2015:257-265).

However, as a researcher and Afromontane teacher, I noted that children from these mountainous places spend most their times playing indigenous games such as horse-racing, stick-fighting games, *kgati* and other indigenous games in their spare time. During my observations, the researcher learnt that they could also use the same games to learn mathematics, particularly mathematical word problems. For example, in the stick-fighting game and from the moves of sticks, they can learn how to formulate mathematical shapes that could be converted into mathematical word problems. This claim of learning mathematics through indigenous games is supported by (Moloi & Chetty 2011; Nkopodi & Mosemege 2006; Francois & Van Kerkhove 2010). It must also be noted that for teaching and learning of mathematical word problems to be meaningful and effective through these indigenous games, family members, educators and peers should serve as pillars of support to assist learners in holding on to their dreams. This could happen if the trio is leaning on the form of capital, like family capital, social capital, linguistic capital, aspirational capital, navigational capital and resistant capital (Yosso 2005:80). A launch prepared in the University of Free State by Afromontane Research Unit for catering the indigenous skills of Afromontane or Indigenous learners indicated that there is a need to these skills in the teaching and learning of word problems (Afromontane Research Unit, *Ke eo taba Qwaqwa Campus Newsletter*, 9 October 2015:4).

However, the wealth of knowledge that has sustained the Afromontane or Indigenous learners is often marginalised in the teaching and learning of mathematics, particularly with regard to word problems (Lucero 2010:127). The Mathematics Curriculum and Assessment Policy Statement (CAPS) defines mathematics as a human activity aiming to build relations in physical and social phenomena and between mathematical objects themselves (Department of Basic Education 2013:8). Thus, this definition creates a platform for Afromontane or Indigenous learners' ways of knowing and teaching word problems that are grounded in their social and physical context. This claim is substantiated by Moloi (2014:486), who argues that learners who are located in mountainous areas do not perform well in mathematics problem solving because the wealth of knowledge they bring within the classroom is marginalised. As a result, the study proposes to enhance the teaching of word sums in such a way that it is

contextualised within the Afrontane context. The researcher hypothesises the expectation that learners should be able to interpret, analyse, convert words into mathematical symbols and correctly apply mathematical operations that will be achieved through context- based pathways of teaching and learning.

2.5 SUMMARY

This research on community cultural wealth addressed all the fundamental aspects of the research framework. The first part of this chapter provided a brief introductory paragraph leading and guiding other fundamental aspects of the study, such as the historical origin of CCW, the tenets of CCW and how they are integrated into mathematical WP to give sense to the study. This chapter further advanced epistemology as a construct dealing with the nature of knowledge and ontology dealing with the nature of being. Rhetoric was used as a communication tool to show the type of language needed in the research proceedings. The role of the researcher and his relations with the research participants were also highlighted. Finally, the central concepts were listed and discussed.

CHAPTER 3:

RELATED LITERATURE REVIEW ON MATHEMATICAL WP

3.1 INTRODUCTION

This study aims to design a context-based strategy to enhance the teaching and learning of mathematical WP for Afromontane learners. To attain this goal, a strategy needs to be formulated. This chapter assisted in reviewing literature from the best practices of teaching and learning of mathematical WP for Grade 4 Afromontane learners from South Africa, the Southern African Development Community, the African continent and globally. This literature review also assisted in extending the discussions of each of the five objectives.

3.2 THE NEED TO FORMULATE A STRATEGY

Having observed the lives of learners who are located in mountainous places, it transpired that they play indigenous games in a skilful manner that could enhance the teaching and learning of mathematical WP. Khupe (2017:29-30), who declares connecting with communities in identifying indigenous games relevant to enhancing the teaching and learning of mathematical WP, supports this claim.

However, this indigenous wealth of knowledge that has sustained them was marginalised in the teaching and learning of mathematics, particularly mathematical WP (Cooper, Gonzalez & Wilson 2014:304). Nkoane (2006:49-53) describes this marginalisation as a segregation that makes some people think and feel that they are better than others. Moloji (2015:25) claims that as a result, they miscalculate the value of cultural wealth brought by other people in teaching and learning in environmental settings. Igboin (2011:97) advises people to treat other people in the same way they wish others to treat them, removing segregation in all respects. Kaya and Seleti (2013:31) reprimand people and urge them to stop gatekeeping the wealth of other people whenever they make inputs when mathematics-related curricula are reviewed.

In the light of the above, I therefore argue that there is need to design a context-based strategy to enhance the teaching and learning of mathematical WP for Afromontane learners.

3.2.1 Teaching and learning mathematical WP to the learners in an Afromontane context

There is a need to pay more attention to and prioritise Afromontane learners' cultural and contextualise realities when teaching mathematical WP. Saleme and Etchells (2016:153) support this view of prioritising realities. As a researcher and mathematics teacher, I support this version, because I have learned that most fourth-graders struggle to interpret and link terminologies on mathematical WP such as, less than by, more than by, as much as, and so on, within their reach, and as a result they fail mathematical WP (Ramharain & Fortus 2013:1). In agreement, Asera *et al.* (2014:4) further state that maybe they are exposed to mathematical WP in this grade for the first time, and also struggle to comprehend these new concepts with English as a language of learning and teaching (LOLT).

From the research conducted by Grussendoff, Booyse and Burroughs (2014:51-52), an overview report was drafted of the comparative analysis of the National Curriculum Statement (NCS) and Curriculum and Assessment Policy Statement (CAPS) for developments across the curriculum on behalf of the Council for Quality Assurance in General and Further Education and Training (UMALUSI). The report indicated curriculum variations as a serious challenge in South African schools, due to the social, environmental and cultural issues that were not addressed in the past. Therefore, a curriculum should cater for time and the space for teachers to teach mathematical WP in an Afromontane context. In the context of promoting teaching and learning within the Afromontane context, African scholars have a struggled to address this issue. Kaya and Seleti (2013:31) indicate that in the work of scholars such as Odora-Hoppers (2000) and Cresswell (1988), teaching and learning in the Afromontane context have been discriminated against by global, dominantly western knowledge systems, thus further supporting this claim.

However, South Africa is not only the country where learners need enhancement to learn mathematical WP within their context. Ladele (2013:9-11) has identified Nigerian learners struggling as well. To my understanding, they still learn mathematical WP through rote learning. In addition, Magidi (2015:4) contends that lessons on mathematical WP are not integrated with learners' daily experiences, and as a result, they perform badly in mathematics, particularly mathematical WP.

In a global context, Dunphy *et al.* (2014:14) refer to the fundamental principle of curriculums in the Australian education system, where mathematics teachers apply the CPA (concrete, pictorial and abstract) as a teaching approach to assist fourth-graders in integrating concepts on mathematical WP easily within their environmental settings. Hmelo-Silver (2013:29-34) and Timss (2015:1-2), when highlighting the mathematics achievement report, agree that this intervention strategy works for Australian learners, but it does not address all the challenges in the learning process of mathematical WP.

Teaching mathematical WP within an Afromontane context reveals prioritisation of Afromontane learners' cultural and contextual realities as a need in planning mathematical WP lessons. However, the remaining challenge is to design a pertinent strategy that would bring about a balance in curriculum variations globally.

3.2.2 The intricacies of using Indigenous games to teach mathematical WP to Afromontane learners

Various studies reveal that fourth-graders could learn mathematical WP better and with understanding by using games (Nabie 2015:224-225; Seeger 2010:210; Way 2011:online; Moloji 2015:23). This account is supported by the DBE (2011:5), which introduced and acknowledged the value of indigenous knowledge systems as significant to enhance the teaching and learning of mathematical WP to Afromontane learners. Indigenous games such as *diketo*, *kgati*, *malepa* and *morabaraba* form part of these indigenous knowledge systems (Moloji 2014:587; Mukhopadhyay & Greer 2015:164; Nkopodi & Mosemege 2009:380; Mutema 2013:59).

However, in the context of this study, I refer to the afore-mentioned indigenous games as games that could complicate the teaching of mathematical WP in a classroom setting (Bose & Seetso 2016:2). In my view, the complication issue commences from

the point where teachers must spend their time arranging tables and chairs to create learning spaces for learners before a game or a lesson could start. I also contend that the reading of procedures and rules of the games by teachers wastes time, because it takes away the time learners could spend studying new concepts on mathematical WP (Adams 2017:online). In addition, Rodriques and Jan (2012:154) claim a 'rush' by teachers when translating rules of the games, converting them into mathematical symbols, despite providing opportunities to learners to understand and comprehend the problem statement themselves as the main challenge.

From the South African context, games are significant, and they play a pivotal role in assisting learners in understanding and comprehending problem-solving (Mutema (2013:59-60). However, as a mathematics teacher and researcher, I deviate from this analogy with the view that games put a lot of pressure on teachers, because they have to determine whether the content of these games is appropriate for the lesson or not, and if not, they have to construct the lesson in manner that would suit the environmental setting where the games take place, which all consume a lot of time (Rus Diana 2010:xxix). Khupe (2014:61-62) claims that even though the indigenous knowledge system is valuable in the DBE CAPS document, it does not give one any clear information of what games to use or specify which mathematics content the games could be taught from. For these apparent reasons, teachers do not know exactly what games to use to teach mathematics (Moloi 2013:124).

Fede (2010:5) indicates that this alarming challenge occurs in countries like America and Europe where one finds that learners fall short of converting the indigenous games they play into mathematical WP. This is confirmed by UNESCO (2016:16), who also indicates that learners globally fail to bring mathematical WP in the form of cultural games into the real-word context.

The intricacies of using indigenous games to teach mathematical WP to Afromontane learners take on different shapes. From the discussions above, it transpires that the results of using indigenous games to teach mathematical WP might harm teachers in the following manner:

- they must spend their time by preparing the learning spaces before a game or a lesson could start;

- they must go through the procedures and rules of the games;
- they have to 'rush' when translating rules of the games to cover time; and
- they might deny learners' the opportunity to understand and comprehend the problem statement themselves due to time and learning space constraints.

3.2.3 Abstract way of teaching and learning mathematical WP to Afromontane learners

It is evident that fourth-graders are not used to converting mathematical WP into numeric form by themselves (Cruz & Lapinid 2014:1; Fatmanissa & Kusnandi 2017:84-85; Abdul & Sarabi 2015:4-5). Therefore, this section provides the challenges experienced by both teachers and learners in the process of teaching and learning mathematical WP in an abstract way. According to Olusegun (2015:67), learning in an abstract way means the ability to think innovatively to create more knowledge, reflect on it and draw a conclusion. In the context of this study, abstract learning or teaching means thinking constructively with the aim of transforming word sentences (abstract words) into meaningful mathematical symbols (Khupe 2017:3; Ukala 2017:20).

In line with the above discussions, Spaul (2013:25) indicates that most South African mathematics teachers do not have adequate problem-solving skills or mathematics-content knowledge to teach mathematical WP abstractly and adequately. This claim is affirmed by Bishop (1988:181) and Nkoane (2006:50 & 54), who assert that South African teachers lack these desirable skills due to the inadequate or undesirable knowledge they have assimilated from the different training institutions in the past. Olusegun (2015:68-69) claims that they have acquired this knowledge in different ways, for example, some were learned to employ rote learning as a best strategy to teach and learn mathematical WP, while others find the reading of textbooks as the best technique to teach and learn mathematical WP.

The research conducted by Olusegun (2015:68) shows that even today, some of these teachers still employ these kinds of practices at their respective teaching and learning institutions; hence, we find most learners still face the very same challenge. This is affirmed by the DBE (2014:17) in the ANA diagnostic report, where the identified challenge was the lack of ability to analyse the mathematical WP sum given in an

abstract manner and convert it into mathematical symbols or equations from where it could easily be solved.

Continentially, Nigerian adults share the same sentiment that mathematics, particularly mathematical WPs, are earmarked for few individuals who are competent and, even worse, is complicated for their children to learn in an abstract way (Okafor & Anaduaka 2013:249). This claim is supported by Udofa and Udo (2013:35), who assert that when knowledge in Nigerian schools is transmitted to learners, they are regarded as empty vessels, with teachers as the sources of knowledge. In addition, Shepherd (2015:1) and Achuonye (2015:2103) state that similar challenges occur in neighbouring African countries like Mozambique, Botswana, Lesotho and Zimbabwe, where learners are not actively involved in the learning process of mathematical WP.

Globally, in places like Pakistan, learners have little knowledge of integrating abstract learning pertaining to mathematical WP with their outdoor environment to make their engagement evident (Rodrigues & Jan 2012:139). Yoong (2010:2), who drafted a Thailand mathematics progress report, affirms that regions like Poland, North Carolina, California and Alabama experience similar challenges to those in Pakistan. As a result, Yoong strongly advises these countries to work closely together with well-performing countries like Singapore, Hong Kong, England and New Zealand to teach their children to think and reason abstractly, enabling them to compete with other learners globally.

Abstract teaching and learning of mathematical WP reveal that South African teachers still lack the necessary skills to teach mathematical WP adequately, due to the inadequate or undesirable knowledge they have assimilated from the different training institutions they have attended. In the same vein, some teachers in the neighbouring countries still use traditional ways of teaching, where they regard themselves as the sources of everything, while their learners are left in a state of being empty vessels or *tabula rasa*.

3.2.4 Intricacies of creating learning spaces for Afromontane learners to learn mathematical WP

It is evident that teachers do not give learning spaces to learners to learn mathematical WP in the classroom (Goos 2015:10; Liljedahl 2015:4). Various studies conducted

assert that children are regarded as empty vessels and their teachers as the source of knowledge (Fahiminezhad, Mozafari, Sabaghiyanrad & Esmaeili 2012:2; Serbessa 2006:130-132; Olusegun (2015:68-69). In the context of the study, I view learning spaces as the conducive learning environment created by teachers in class for learners to learn mathematics, particularly mathematical WP freely, without being ridiculed (Kolb & Kolb 2010:12-14).

However, for the purpose of this chapter, I shall briefly look at the intricacies experienced by teachers to create learning spaces for their learners to learn mathematical WP effectively and efficiently. Kalutskaya, Archbell, Rudasill and Copla (2015:150-152) state that one of the reasons why shy learners take time to answer the questions posed by teachers in class is that they are afraid of being ridiculed by others when they get sums on mathematical WP wrong. In addition, as a mathematics teacher, I have noted that most fourth-graders are not comfortable responding in English as the language of learning and teaching. Sometimes they remain silent when asked to answer questions in English (Reynders 2014:20-22; Mji & Botes 2010:123).

In the South African context, most mathematics teachers rush to catch up with their pacesetters, thus leaving their learners behind. In agreement with this view, Khoza (2016:102) argues that teachers rush to avoid a higher profile of accounting when learners do not perform well in mathematics, particularly mathematical WP. In addition, Bailey (2002:IV) and Suurtamm, Quigley and Lazarus (2015:1-4) raise challenging constraints such as larger classes and difficult behaviour by learners as some of the factors hampering them as well. They further argue that due to these intricacies, they fail to adapt to the curriculum needs and even think of not wasting their time creating learning spaces for their learners to learn mathematical WP. Ukala (2017:20) helps one to understand that, in a situation like this, some learners grab opportunities to do things not related to learning mathematical WP.

Continently, and from the Nigerian point of context, Ladele (2013:68) claims that Nigerian learners learn mathematical WP in a hard way. This account is supported by Udofa and Udo (2013:35), namely that Nigerian teachers regard themselves as sources of knowledge and as a result they do not bother to create platforms for their learners during mathematical WP lessons. Blackmore *et al.* (n.d:2) further indicate that

Nigerian parents have insufficient background on mathematical WP, with the result that they lose interest in educating their children.

Globally, I noted that Indonesian teachers do not do enough to create learning spaces for learners to learn mathematical WP. Jupri and Drijvers (2016:2482), who indicate that fourth-graders in Indonesia have trouble in applying operational signs and understanding different meanings of the equal signs in the teaching and learning of mathematical WP, support this claim. In addition, Preece and Manicom (2015:116-119) have also identified learners from countries like Rhodesia, the Netherlands and the Salford in the UK experiencing a challenge when translating mathematical WP into mathematical symbols. Teachers did not do much to create learning spaces, or to assist them after school hours whenever they need help.

In conclusion, I noted that the intricacies of creating learning spaces for learners to learn mathematical WP effectively and efficiently rest on the fact that curriculum designers do not consult teachers when designing a curriculum. The curriculum seems to have been designed in a manner that it overlooks the intricacies of teachers when teaching mathematics in class. The intricacies included, among other things, class overcrowding in the mathematics lessons, family background of learners and parental intervention programmes where teachers meet with parents to discuss learners' problem-solving challenges regularly.

3.2.5 The intricacies of using English to teach mathematical WP to Afromontane learners

English is used as the language of learning and teaching (LOLT) in South African schools; in fact, teachers and learners are forced to communicate mathematical concepts in English (Khutso 2012:17-19; Alenezi 2010:3-4). The DBE (2011:9) in the CAPS document developed the correct use of the language in the teaching and learning process of mathematics, that is, by encouraging teachers to assist learners in making use of number vocabulary, number concept, calculation and application skills correctly to enhance their reasoning and application skills gained previously.

However, I also noted that mathematical word problems (WPs) are not taught thoroughly because of the language challenge and due to the intricacies experienced by learners in solving mathematical WP; thus, teachers decide to ignore teaching this

phenomenon of interest (Ladele 2013:5; Moscardini 2010:131). Fatmanissa and Kusnandi (2017:84-85) state that one of the major reasons could be that the language used to teach and learn concepts in mathematical WP is unique and complex. As a result, learners find it difficult to confine with the use of the language to connect the mathematical operational signs to the given solutions.

In line with the above intricacies, I found necessary to illustrate by means of the figure below, the importance of communication and how it affects individuals in the teaching and learning process of mathematical WP.

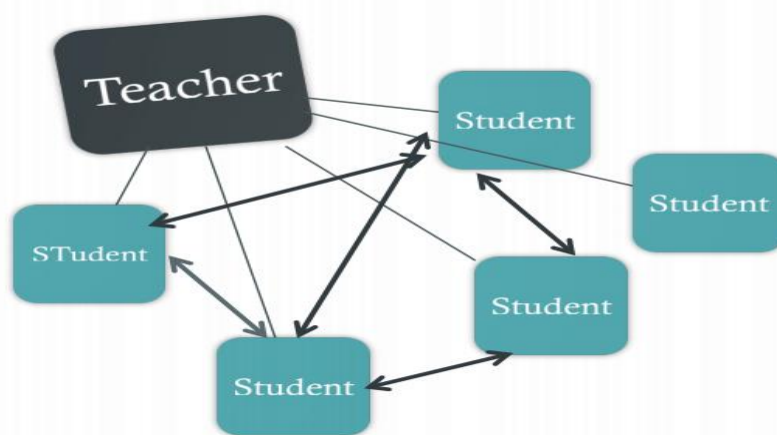


Figure 3.1: Communication flows in the teaching and learning of mathematical WP (Adapted from Suurtamm et al. 2015)

This figure intends to show that communication flow related to teaching and learning of mathematical WP always occurs between a teacher and the learners. This figure further puts the teacher on top of the learners with the arrows pointing to each learner, as an indication that networking starts from the teacher to learners. However, other arrows indicate that this communication could also go to the extent of allowing learners to network with one another, and this communication flow moves from the learners to the teacher.

In the context of the study, I view this communication flow as a vehicle that plays a significant role that drives connecting the communication skills of the teacher and learners together so that learners may learn mathematical WP effectively (O'Regan 2013:39-40; Yaghoubi-Notash & Karafkan 2015:74-75; Kumar 2015:380; Makoelle & Malindi 2014:80). Serious challenges are facing our teachers today, which might hinder this communication flow in the mathematics class (Nyambura 2015:70; Uys

2010:6-7; Gwee n.d:2). The majority of these teachers face serious challenges related to the use of English because they are not proficient enough in the use of this language. As a matter of fact, some find it very difficult to teach or explain mathematical concepts in English (Halai & Durrani 2016:60-63). This claim is supported by King (2015:38-39), who also indicates that one would find the majority of them using code-switching concepts on mathematical WP to make themselves clear to their learners in class.

In the South African context, Taylor and Coetzee (2013:1-5) claim that primary school learners in South Africa have serious challenges because the majority of them do not speak English as their mother tongue, but they are expected to understand mathematical instructions in the language. Hence, we find that they struggle to translate some of the mathematical concepts into their mother tongue. As a result, they fail. Bunyi, Wangia, Magoma and Limboro. (2011:3-4), Magidi (2015:20-21) and the Namibian Ministry of Education (2015:130) indicate that learners from the Namibian schools experience similar challenges as South African learners do, and most of them appear to rely on code-switching as a best strategy to learn mathematical WP better and with understanding. Globally, Moscardini (2010:135) indicates that learners from countries like Scotland have trouble recalling concepts on mathematical WP sentences in English and restating them their mother tongue.

In conclusion, I noted that teachers and learners still face the intricacies of teaching and learning mathematical WP by using English as LOLT. Whenever learners are forced to communicate sums on mathematical WP in the language they are not comfortable with, and when they are incapable of handling subject content through English instead of their mother tongue, they might start resisting to cooperate or working closer with their teachers when solving the sums on mathematical WP (Setati 1998:34).

3.3 COMPONENTS OF THE SOLUTIONS FOR THE CHALLENGES IDENTIFIED

This section provides the components of the solutions identified through the literature review to respond to the challenges identified in Section 3.2 above. In addressing these challenges, teaching and learning of mathematical WP should be conducted

within the Afromontane context, the reason being that learners from this context appear to be learning the phenomenon of interest better and with understanding by using indigenous games. Teaching and learning become more effective and very interesting if these learners absorb mathematical WP through concrete objects. Furthermore, the creation of learning spaces by teachers and code switching of complex mathematical concepts that need clarity and emphasis can be of great importance to enhance teaching and learning of mathematical WP.

3.3.1 Teaching and learning mathematical WP in an Afromontane context

According to Watkins, Carnell and Lodge (2007:3-4) teaching and learning of mathematical WP become meaningful and make sense when prepared within the context of Afromontane learners. This is affirmed by the Ontario Public Service (2013:14) that claims that it becomes more significant when integrated with the environmental setting of the learners. In addition, the DBE (2011:5) further confirms that it becomes helpful and useful to learners if it does not exist in isolation.

However, in the context of this study, I view teaching and learning of mathematical WP in an Afromontane context as the ability to think critically in terms of converting mathematics activities on physical substances such as horses, cows, trees, stones, *kgati*, *diketo*, etc., into mathematical WP to make sense of it (Molefe & Brodie 2010:3-4; Dunham 2010:3).

However, in addressing the challenge identified in Section 3.2.1 above, Kenney and De Oliveira (2015:9-10) point out that one of the best solutions that could be used by teachers to address the identified challenge is to make use of the indigenous skills and ideas brought by Afromontane learners to class. Dunley-Owen (2015:6-7) pronounces that by so doing, teachers would teach mathematical WP meaningfully and learners will learn concepts on mathematical WP boldly and with understanding. Mahlomaholo (2013:320) qualifies that not only learners, but teachers as well would benefit from learning mathematical concepts within their context.

In the light of the above, Jupri (2016:24-87) lists activities such as horseracing, boxing and athletics as relevant examples of teaching mathematical WP within the context of Afromontane learners. For this study, horseracing is used as an activity to demonstrate

how we could best learn mathematical WP within the context of Afromontane learners. Below is an example of a horseracing activity.



Figure 3.2: Horse racing (Adapted from Lesotho King Letsie III horse race.youtube.com)

This activity intends to show us how we could possibly use horseracing as an activity to teach and learn mathematical WP within the context of Afromontane learners. Readers should take note that in the race, horses are named for various reasons (Evans *et al.* 2009:1-11). For the purpose of this study, I must state that horses are named for learning about the integration of mathematical WP with the environmental settings of the Afromontane learners. Therefore, I shall name the first horse in the front row Sephadi, the second one Tobaka, and the third one Lebelo. The next part is guided by an example of this activity.

Example:

Sephadi, Tobaka and Lebelo were the top three horses in the horse racecourse. The horses had to run a distance of 100 metres. These were the times given for each horse.

Horse	Time
Sephadi	± 00:00:10
Tobaka	± 00:00:14
Lebelo	± 00:00:15

Table 3.1: Horseracing results

This table intends to show how teachers can teach learners about the order of time that time is measured in hours, minutes and seconds.

Questions:

- a) According to the horses' times, which came first?
- b) What is the time difference between the first and second horses?

Solutions:

- a) Sephadi
- b) The first horse finished a race in ten seconds while the second one in fourteen seconds, then the difference is four seconds.

From Table 3.1 above, it transpires that Sephadi managed to run a race of 100 metres in 10 seconds, and Tobaka in 14 seconds, while Lebelo completed the same racecourse in 15 seconds. This suggests that Sephadi was the fastest of the three horses. Having noted that the speed ran by the three horses varies, the first solution of the first question suggests that learners can easily determine, by observing the times provided in the Table 3.1 above, that Sephadi was the first horse to arrive at the finishing line. To determine the time difference between the first and the second horses, learners have to think of introducing a minus sign (-) that will work as a navigator to the solution. They have to subtract the time ran by Tobako from the time ran by Sephadi. For example, they have to say, the time ran by Sephadi minus the time ran by Tobako is equal to four seconds.

In line of the above discussions, learners can also learn the following mathematical conversion skills from the table below.

1. Learn to covert mathematical symbols to mathematical WP, for example:

Mathematical symbols	Mathematical WP
1 st	First
2 nd	Second
3 rd	Third

Table 3.2: Horse-racing conversions

2. Arrange the times recorded ran by different horses in the racecourse in ascending order and descending order, for example:

- **ascending order (from the lowest to the highest speed)**

± 00:00:15, ± 00:00:14, ± 00:00:10

- **descending order (from the highest to the lowest speed)**

± 00:00:10, ± 00:00:14, ± 00:00:15

3. Learn to compare the times ran by the three horses using < and > signs, by looking at the order of times they can compare times in the following manner: for example:

± 00:00: 15 < ± 00:00:10 or ± 00:00:14 >± 00:00: 15 or ± 00:00:10 > ± 00:00:14

Having noted from the presentation on the horse racing activity that learners can understand mathematical WP better, I suggest that the Grade 4 mathematics teachers supplement or couple their daily plans with activities similar to the one presented above, because it is evident that horse-racing is global (Donato 2008:online; Van Putten *et al.* 2010:137; Parks & King 2010:40). Finally, I am also of the opinion that this activity could assist those struggling learners in comprehending better in the learning process of mathematical WP and ordering of the times (Rodrigues & Jan 2012:137-138, Raford & Roth 2011:11; Young 2015:2).

Teaching and learning of mathematical WP in an Afromontane context reveal that mathematical WP could be learned through sequencing time, namely by learning that from seconds we have minutes and from minutes we have hours. Not only Afromontane learners, but all learners worldwide could benefit from learning mathematical WP sums through the horse racing courses.

3.3.2 Use indigenous games to teach mathematical WP to Afromontane learners

According to Stern (2016:156), the first step towards building a network of indigenous games is to acknowledge the fact that Afromontane learners have indigenous knowledge and skills to offer, even though some are not presented in textbooks and other materials. However, Ronyak (2015:4) advises teachers to select and learn from

the relevant ones and leave the rest. On the contrary, Msila and Gumbo (2016:122) argue that even if the relevant ones have to be picked out from the irrelevant ones, the remaining challenge is how teachers could utilise them to teach mathematical WP effectively.

However, Moloji (2013:482) lists indigenous games such as *diketo* (coordination game) and *kgati* (rope skipping) as indigenous learning aids that could be employed by teachers to enhance teaching and learning of mathematical WP. Nkopodi and Mosemege (2009:380-381) also point out *morabaraba* (board game) as another indigenous game that could be used to develop the mental skills and ability of learners to think logically and critically when solving mathematical WP.

In the context of this study, the purpose is to show that the indigenous game of *papadiya melamu* (a stick-fighting game) has the potential of being used with success in the teaching and learning of mathematical WP (Ronyak 2015:3). As a researcher, I learnt that a stick-fighting game creates a sound working relationship between mathematical WP and indigenous games to a greater extent, and in the process assists learners in overcoming their fear of mathematics (Moloji 2015:23-24). Next, it will be described how this game makes an impact on the study.



Figure 3.3: A stick-fighting game (Adapted from Dot.Gone.Music 2011)

This figure intends to show that from a stick-fighting game that learners can learn to draw or shape geometric shapes that can be converted into geometric statements that can be written down through reasoning.

The next part is guided by the definition of a stick-fighting game. This definition is provided as follows:

The game is played by two or more people where the one is the attacker and the other one the defender. Both opponents are expected to hold two sticks, the long and the short one, the long one is being used to attack while the short one to defend. The game is controlled by a referee who will stop it when time is up. The timekeeper uses a stopwatch to assist the referee to count the number of rounds. Every game consists of the number of sessions the team agreed upon before the game commences. A session consists of three rounds of one minute each. The flat surface is organised for fighters to assume their positions and fight. Rules are put in place to disqualify the misbehaving players. The player who scored the most points is declared the winner (The Department of Sport and Recreation 2006:1-30).

This enlightenment of a stick-fighting game was intended to define what a stick-fighting game is and how the game is played. This enlightenment further discloses that from the fighting sticks that hold by attackers and defenders in Figure 3.2 above, geometric angles such as alternate angles (\hat{A}_1 and \hat{C}_1 & \hat{A}_2 and \hat{C}_2), co-interior angles (\hat{A}_1 and \hat{C}_2 & \hat{A}_2 and \hat{C}_1), straight angles (\hat{C}_1 and \hat{C}_2 & \hat{A}_1 and \hat{A}_2) and vertical opposite angles (\hat{B}_1 and \hat{B}_2) can be formulated. It is also evident that learners could acquire a variety of geometric skills from playing this indigenous game (Nabie 2015:219). However, as a mathematics teacher, I noted that other mathematics teachers and learners experience challenges with regard to integrating geometry with algebra (Badger *et al. n.d.*:132-137). Gaye (2010:11) introduced GeoGebra as a technological device that could assist teachers and learners from elementary schooling to the tertiary level of learning. Bu *et al.* (2010:2) describe GeoGebra as a collaborative software program used for learning and teaching mathematics from primary school up to university level, support this description. In addition, Bayazit and Akasoy (n.d:95-96) further claim that teachers can use dynamic GeoGebra applets that could directly be uploaded onto the GeoGebra materials platform. This platform is programmed to upload geometric concepts like points, vectors, segments, lines,

polygons, etc., to algebraic concepts such as number patterns, problem solving, data handling, time, etc.

For the purpose of this study, GeoGebra works as a technological device with applets used to assist learners and teachers to upload and covert geometric lines to the algebraic problem solving or mathematical WP (California Department of Education 2013:4-5). In addition, Motsoane, Motsamai, Maraka and Sekokotoana (2016:63-65) encourage teachers and learners to learn mathematical WP through indigenous games, because they keep traditional culture alive, assist learners in developing their mathematical skills and their ways of reasoning. This is affirmed by Van Wyk and Dewah (2014:190-191), who point out that the indigenous games are not confined to a specific group, or to local contexts, but are also used globally. Torkey (2012:8) claims learning and teaching of mathematical WP from the local and global contexts as a process, and for this reason, advises teachers to play mathematical games to keep them in contact with their lessons.

Using indigenous games to teach mathematical WP reveals a stick fighting as a game appropriate to enhance teaching and learning of mathematical WP to Afromontane learners. It further discloses that most of the teachers and learners have no idea how to integrate indigenous games with mathematics, particularly mathematical WP. For these apparent reasons, GeoGebra was introduced as a technological device to assist in that regard.

3.3.3 Teaching mathematical WP through concrete teaching to address abstract teaching challenges to Afromontane learners

Abstract teaching and learning of mathematical WP remain a serious challenge to fourth-graders (Hoong *et al.* 2015:2-3). This claim is supported by Moloji (2014:585), who indicates that learners in the elementary grades learn mathematical concepts in a hard way through abstract teaching. In contrast, Dunley-Owen (2015:6) states that abstract teaching and learning of mathematical WP develop the ability of learners to think and reason logically when doing problem solving. Little (2009:10), who advances problem solving as a skill that creates critical thinkers, supports this version.

However, in the context of the study, I view abstract teaching as a challenge that reduces the pace of learners to learn mathematical concepts fast and with a drive to

grasp the concepts for the future use (Machaba 2013:22; Pausigere 2014:7). Long and Dunne (2014:139-140) affirm that primary school learners learn mathematical WP better and with understanding by using solid or physical objects. In addition, Bradley (2008:61) claims that they learn even better when they sense, see and touch objects such as chairs, tables, chickens, potatoes, etc. Equally important, Torpey (2012:7) encourages teachers to create conducive learning spaces in class and cite real-life or realistic examples that keep them always active in their respective lessons.

The next part is guided by the example of concrete objects that could be used in the teaching and learning of mathematical WP to address the abstract teaching challenges.

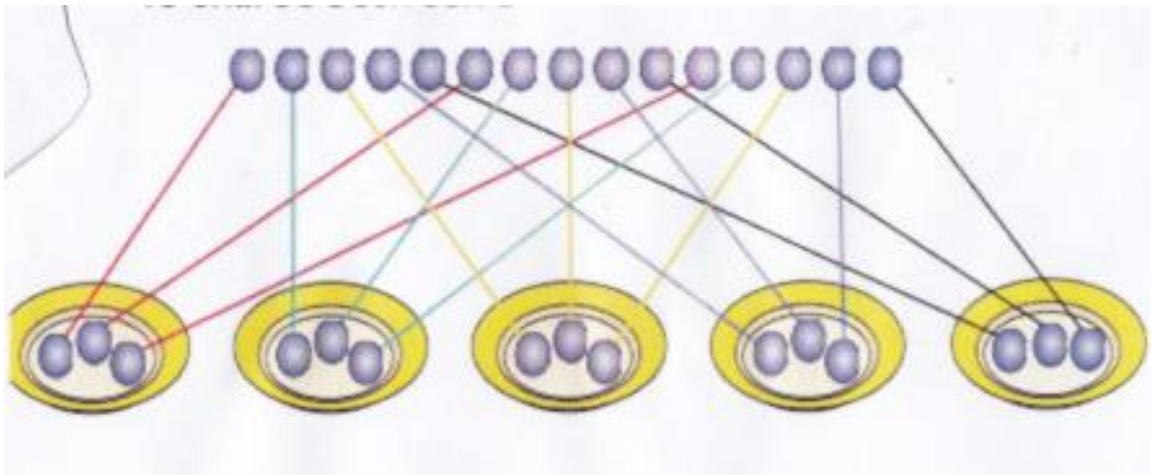


Figure 3.4: Problem-solving on sharing (Adapted from Muswell Hill Primary School 2014)

This figure intends to show how learners can possibly learn mathematical WP better and with understanding by using beads as concrete objects. To support this claim, I present a beads lesson as an example.

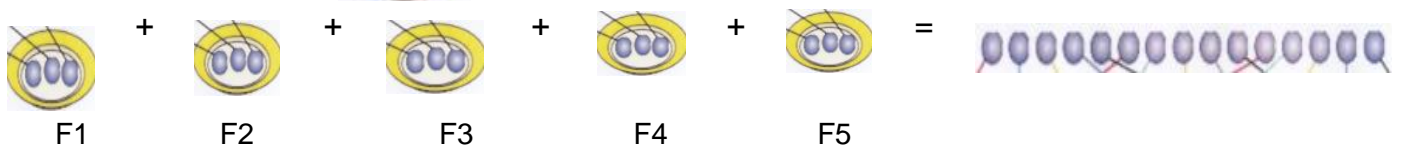
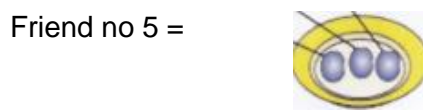
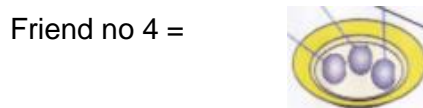
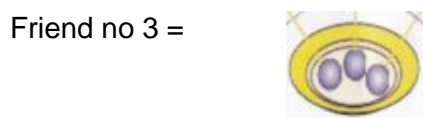
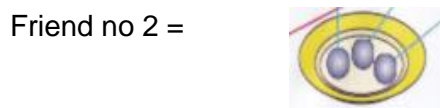
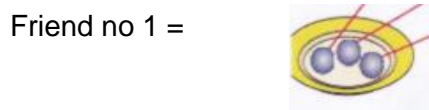
Question

Thabo has five friends and decides to give his friends three beads each. How many beads does his friends have all together?

In my response to the question, I present Figure 3.4 above to emphasise that my lesson is presented in a concrete way. In this figure I also present 15 small beads, representing the total number of beads owned by Thabo. The arrows moving from the small beads to the five bowls represent the total number of beads shared by Thabo

with his five friends, of which each was able to get a share of three beads (cf. Figure 3.4 above). To enlighten further I present the solution in the form of beads as follows:

Solution



In the light of the above discussions, Hott, Isabell and Montani (2014:3) advance that concrete learning of mathematical WP is not confined to African epistemologies but is also found in Western ideologies. McNair (2015:20), when reporting on behalf of a Sabbatical school, claims that teaching of mathematical WP in Singapore and Hong Kong is founded on the ideas of Bruner (1960:86), who believes that learners could learn mathematical WP through the concrete-pictorial-abstract (CPA) approach. My deductions from Bruner show that learners could learn mathematical WP through physical objects (concrete learning), pictures (pictorial learning), and learning by conceptualising the objects (abstract learning). This is supported by Torpey (2012:8) and Cockett and Kilgour (2015:1-3), who advise mathematics teachers to employ variety of approaches when teaching mathematical WP to avoid at costs going back to the traditional ways of teaching and learning.

3.3.4 Creating learning spaces for Afromontane learners to learn mathematical WP effectively

Hayakawa (2015:4-5) describes learning spaces as environmental settings created for learners to learn how to connect the real world (actual world) with the conceptual world (mental world). In addition, Alexander (2015:19-26) asserts that the learning area is created to allow to meet with other learners to discuss and gain new knowledge on how to solve mathematical WP competently.

However, for the purpose of this study, I define learning spaces as learning offers or learning opportunities created by teachers to encourage learners to meet with others in a view to acknowledge their viewpoints relating to challenges on mathematical WP, so that they may modify or develop their problem solving skills. In agreement with my views, Lash and Gilmour (2015) list three ways in which the viewpoints of other people could be perceived, namely **This way**, **Another way** and **That way**.



Figure 3.5: Different ways of learning mathematical WP (Adapted from: Lash & Gilmour, 2015)

Figure 3.5 above suggests three different ways that could be used by learners to acknowledge the viewpoints of other learners in mathematical WP-related discussions. It further emphasises that this could happen if learners familiarise themselves with the three ways listed and demonstrated by Lash and Gilmour above. However, in my view as a researcher and mathematics teacher, ‘*This way*’ might imply that learners are not flexible in their choice of strategies; that is, they might only stick to the procedures (Bishara 2015:2316; Cheng 2012:78-79). ‘*Another way*’ might imply that learners are flexible in their choice of strategies (Raoano 2016:9; Liljedahl, Santos-Trigo, Malaspina & Bruder 2016:8). Lastly, ‘*That way*’ might imply that learners

are flexible to skip certain important steps and rush towards the answers (Kavkler, Magajna & Babuder 2014:28; Ali, Hukamdad, Akhter & Khan 2010:68). For example:

Question

Thakalane has saved R120,00 in the bank account. He puts R110,00 more in his bank account. How much did he save altogether?

Solutions

This way (Normal way)

R	C
1 2 0	0 0
1 1 0	0 0
2 3 0	0 0

Amount of money deposited in the bank altogether = R 230,00

MacDonald (2016:1-13) in the Spinney school describes this approach as a normal or usual way of adding whole numbers, and one that has been used by mathematics teachers and learners in the past years to add numbers, as it was found to work for them. This idea is supported by Taylor (2015:6) of Washoe County School District, which describes user friendly as a conducive place created by learners themselves to learn mathematical WP, with or without the presence of teachers. In addition, Chaudhary (2015:5) of Welbeck Primary School agrees to say that through the guidance of columns they could be able to work on their own towards adding the numbers correctly.

Another way (first alternative)

$$\begin{array}{r}
 \text{R120, 00 (money already saved)} \\
 + \text{R110, 00 (more money he puts into the account)} \\
 \hline
 \text{R230, 00 (amount of money altogether)} \\
 \hline
 \end{array}$$

Harris (2000:8-10) claims that this approach is unreliable, because some learners might at some stage be tempted to place rands under cents or cents under rands. Hence, Dunley-Owen (2015:3) regards the approach not to be user friendly, especially to learners in the lower grades where teachers are not there to give them guidance.

That way (second alternative)

Hundreds Tens units

R100 + R20 + 00 = R230,00 (amount of money deposited in the bank)

Chaudhary (2015:4) has declared this approach reliable, because learners were found to be guided by place values (e.g. hundreds, tens and units) in order to add the numbers correctly. The South African Institute (2008:25) supports this for Distance Education and clever learners in class

However, in the context of this study, I prefer learners to engage in the '*That way*' method to learn mathematical WP, because in my view learners are not confined to follow certain procedures when doing problem solving. Instead, they are flexible; they skip certain steps to reach solutions (Douglas, Clements & Michael 2009:6-7). From the local context, Carter and Greenough (2015:12) and Sharples *et al.* (2015:3-5) urge South African mathematics teachers to create learning spaces for learners to meet other learners to improve, develop or modify their mathematical WP learning skills. From a continental and global point of view, Liljedahl *et al.* (2016:6-10) encourage creativity in learning, because it creates creative thinking skills that will provide an opportunity to improve the creative thinking based on the nature of subjects. This is affirmed by Preece and Manicom (2015:115), who claim the use of the different approaches by teachers and learners as a gain, because they could pick up any strategies that they are well conversant with and leave the rest.

The creation of learning spaces by teachers in class reveals that learners can learn mathematical WP in three different ways, namely *This way*, *Another way* and *That way*. However, '*That way*' is the preferred method to use to teach and learn mathematical WP, because it creates a platform for learners to skip some procedural steps and recover more general ideas than specific details.

3.3.5 Mathematical WP teaching in English as a language to Afromontane learners

It is evident that learners who learn English as an additional language are likely to experience language-related difficulties in mathematics, particularly mathematical WP. This claim is supported by Olugbara (2008:14), who advances language barriers as some of the major language-related intricacies that hinder progress of learning

mathematical WP by learners. For this reason, Shinn (2015:15, 17) sees the use of a variety of strategies by teachers to assist learners with language acquisition, and enhancing their mathematical WP learning as superlatively good.

However, in the context of this study, I view mathematical WP teaching as a vehicle of thoughts that assist learners in acquiring new mathematical language communication skills to visualise and draw mathematical symbols in different ways to enable them to listen and think logically (DBE 2011:5). In agreement with the above view, Mahofa (2014:44) perceives mathematical WP teaching in English as a useful tool that assists teachers in teaching and giving instructions in multilingual classroom settings. Gulzar (2010:27-28) also claim that it could assist children in creating relations between their own language with mathematical ideas. This knowledge is accepted by Ahmad and Roziati Zainuddin (2007:1-3), who also advance the idea that it could be used by learners and teachers to make connections between concrete, pictorial and abstract concepts in teaching and learning. According to Vula and Kurshumlia (2013a:2), these mathematical language communication skills could easily be developed when learners are allowed to code switch difficult mathematical WP concepts into the language they understand better.

In the South African context, mathematical WP teaching in English as a second language takes a different view. According to Kelly (2010:2), English in South African schools is used as a language of learning and teaching (LOLT). It has been introduced to be developed by all the teachers across the grades to disseminate mathematical knowledge or skills to learners. In support, Jegede (2011:46) claims it as a means of encouraging learners to express their views freely when learning mathematical WP. Sepeng (2015:24) describes it as a user-friendly communication tool creating conducive learning platforms where learners could learn mathematical WP freely and on their own, avoiding at all costs to be restricted to learning sums on mathematical WP in English.

Continently, Modupeola (2013:91-92) advances that in African countries like Nigeria and Ghana English is used as a tool for creating and developing linguistic harmony between people who share the same trust or confidence when dealing with mathematical WP. Globally, Chowdhury and Kabir (2014:1-4) declare the use of English as a compulsory subject from Grade 1 to Grade 12 in places like Asia, India,

Bangladesh and other neighbouring countries. Burghes and Robinson (2010:11), indicate that despite communication challenges other countries might have had in the past, others opted to use strategies that have been used by other high-performing countries to interact with other countries in the global world.

In conclusion, it is noted that English is used as a compulsory subject to teach and learn mathematics, particularly mathematical WP around the globe.

3.4 CONDITIONS CONDUCIVE TO DESIGNING A CONTEXT-BASED STRATEGY

In Section 3.3, ample solutions were identified in the teaching and learning of mathematical WP, and five were found to be relevant to the theoretical framework. In the same way, the relevant conducive conditions for those solutions were also identified. These conducive conditions aimed at enhancing teaching and learning of mathematical WP within the thinking box of Afromontane learners. Furthermore, they were meant to advance the conducive conditions of employing the indigenous games as an approach to teach and learn mathematical WP; moreover, to embark on creating the conducive conditions to enable Afromontane learners to learn mathematical WP in the abstract way where the learning space is not conducive.

3.4.1 Conducive conditions for teaching and learning mathematical WP within the context of Afromontane learners

Liljedahl (2015:4) claims that conditions are conducive when teachers create learning spaces for their learners to learn mathematical WP on their own. In addition, the Ministry of Education and Employment (2012:IX) further claims that they could even learn better because they would learn together with their peers or classmates. However, Liledahl (2015:4) announces that these conditions need the supervision of teachers and parents to keep order. Furthermore, Hattie (2015:V) adds that teachers, parents and learners need to put their heads together to draft guidelines that would be used as a means to instil discipline in the learning environment. However, in cases where learners misbehave, Cronin, Becher, Christians, St. Paul Public Schools, Maher and Dibb (2015:8-10) advise that rules or guidelines should be set in place to gain control over the culprits. By so doing, Van Niekerk and Venter (2011:245-248) claim

that parents and teachers would show fairness, warmth, strength and positive coping when addressing or dealing with matters like these.

However, in teaching mathematical WP within the context of South African schools, the DBE (2012:11-12) advances the idea that when teaching mathematical WP from the context of the learners, teachers should consider the indigenous skills our learners already have and develop them in such way that they are used effectively inside and outside the classroom. In countries like Australia, Denmark, Iceland, Italy, Korea, Portugal and Slovenia, the Organisation for Economic Co-operation and Development (2009:7) highlights a point that the knowledge gained by teachers in the teachers' professional development should go hand in hand with the collection of methods used in the classroom when teaching mathematics, particularly mathematical WP. In efforts to update conditions of the curricula from the various developing countries, Timss (2015:7-9) calls for countries' updated curricula describing conditions underpinning learners' achievements in mathematical WP.

3.4.2 Using indigenous games as a strategy to teach and learn mathematical WP under the conducive conditions created for the Afromontane learners

The DBE (2011:5), in the CAPS document, values the conditions under which the indigenous knowledge systems (IKS) acknowledge the richness of indigenous skills and knowledge of learners as a yardstick to assess whether they could be taught properly. This was acknowledged by Afromontane Research Unit in the *Ke eo taba QwaQwa Campus Newsletter* (9 October 2015:4) when it prepared its launch called Afromontane Research Unit at the University of Free State on the condition to cater for the indigenous skills and knowledge of the learners located in rural and mountainous places.

In addition, the General Manager, Economic Development and Culture (2017:3) claims indigenous games to be the learning approach that could be used to promote teaching and learning of mathematical WP with the sole aim of providing learners with the opportunity to explore how to integrate cultural activities such as traditional dances or arts, crafts and youth athletics to create conducive conditions.

In line with the above, Nkopodi and Mosimege (2009:379) agree that it is possible to create conducive conditions for learners to learn mathematical WP through indigenous

games only if they are given platforms to apply their mathematical skills by competing with others in games such as puzzles, board games, dice games, card games and word games. This is acknowledged by Awopegba, Oduolowu and Nsamenang (2013:43), who believe that Nigerian children learn mathematical WP better through indigenous games such as hide and seek, sand play and children's dances. This is also affirmed by Rupere, Muzirura, Zanamwe and Munyaradzi. (2013:249), who encourage teachers from Zimbabwe and across the world to adopt indigenous games as learning aids in their mathematical WP lessons. In the same way, Loewen *et al.* (2015:21, 42) acknowledge the acceptance of the use of the indigenous games by the Canadian Universities by opening indigenous centres where students could learn more about the games and how conducive conditions could be created so that they could integrate them with mathematical WP, as well as stimulate their interest further on celebration days for indigenous games and indigenous skills.

3.4.3 Conducive conditions for teaching and learning mathematical WP in an abstract way

According to the Michigan Department of Education (2011:5), conducive conditions for teaching and learning mathematical WP in an abstract way are possible only if teachers at school and parents at home jointly work together to create learning environments where they could learn on their own and explore new things. In addition, Edwards, Maloy and Anderson (2011:3) state that the learning conditions would be more relaxed or conducive when learners learning mathematical WP from their contexts. Anne Watson, University of Oxford (2007:21), claims that learning from their contexts is when they learn mathematical WP in a conducive environment where activities are linked with what they can see and touch. Tambychik and Meerah (2010:146) refer to this kind of learning as learning through manipulatives.

From the South African context, learning through manipulatives for learners in the elementary grades were found to be the best strategy because they could learn mathematical WP from concrete objects (Miranda & Adler 2010:16). This is confirmed by Ladele (2013:17), who claims that Nigerian elementary learners, using manipulatives, are able to read, interpret and convert mathematical statements into a symbolic form to be able to solve them.

In a similar way, Merttens (2012:33-34) claim that learning through manipulatives is the best strategy using by the leading countries such as Singapore and Japan in mathematics and sciences. In addition, Hoong *et al.* (2015:1-3) agree that Jerome Bruner devised CPA as a model that could assist teachers in teaching to develop the cognitive thinking of learners from the C-concrete (learning through physical objects), P-pictorial (learning through the use of pictures) and lastly A-abstract (learning through perceptions) thinking in the teaching and learning of mathematical WP to assist both teachers and learners to learn and understand WP better.

3.4.4 Creating learning spaces under conducive conditions to teach mathematical WP to Afromontane learners

According to Bhattacharjee (2015:66), learners could learn mathematical WP better in a constructivist classroom environment where the learning space is created by teachers to engage them in their lessons.

OECD (2009:6) asserts that this could possibly happen when teachers look into the range of features that could suit and possibly shape their learning progress. The Department of Education and Early Childhood Development (2015:1) stipulates some of the features that could be utilised to teach and learn mathematical WP was to teach them in a way that they own a phenomenon of interest, concretise it, and then integrate it with the physical objects around them. In addition, Boggan, Harper and Whitmire (n.d:3) claim that conditions are conducive when learners are given time to use their prior knowledge to connect old information with the new knowledge and beliefs in order to progress.

In the light of the above, the DBE (2011:8) proclaims that South African learners could learn mathematical WP better and will be able to see the beauty of mathematics when a conducive learning environment is created to allow them to learn on their own, but under the supervision of teachers. This idea is supported by Robinson (2010:6), who also reflects that European and African teachers should have the same approach to designing lesson plans in such a way that they should reflect the beauty and creativity that are at the heart of mathematics spaces, where students can use manipulatives to solve problems and record their solutions. This is confirmed by Boyd and Simonsen (2015:25), who encourage teachers to establish a positive learning space in which learners can learn and grow jobwise in the process of learning about the phenomenon

of interest. By so doing, Plass, Homer and Kinzer (2015:274) claim that learners would be in the position of feeling that they are part of a lesson, own the lesson and are also at liberty to construct and contribute their ideas related to the use of WP in real-life situations.

3.4.5 Using English to teach mathematical WP to Afromontane learners under conducive conditions

Shilamba (2012:8) describes English as a communication strategy teachers and learners can rely on to communicate how conducive conditions could be created for learners to learn mathematical WP. In our context, we use English and some code-switching to allow learners to express their problem-solving challenges in the language they understand better (Lugoloobi-Nalunga 2013:7). For this reason, Simasiku (2016:163) argues that code switching should be used as a stimulating tool because it creates a conducive learning environment for shy learners. In addition to the above views, Zazkis (2000:42) and Khutso (2012:18-19) claim it as very useful, because it could assist our learners and teachers in translating difficult concepts on mathematical WP and it give sound meanings. Setati, Molefe and Langa (2008:20) describe it as a breakthrough, because it helps teachers and learners to proceed, even if they do not find a way out.

In the light of the above, Mahofa (2014:32), from a South African context, argues that teachers should create conducive conditions that would afford a chance to discuss WP in their mother tongue to develop mathematical thinking or as a weapon used for learners to understand the concepts taught in Language of Learning and Teaching (LOLT). Auckle (2015:1) declares it a tool that could be used as a resource to teach and learn mathematical WP from the continental perspective. Internationally, The European Commission (2015:57) argues that it is a strategy that is used to connect and support migrant learners to learn mathematical WP in the central or mainly used language.

3.5 THREATS AND RISKS FOR DESIGNING A CONTEXT-BASED STRATEGY

In Section 3.4, several conditions conducive to designing a context-based strategy were identified. This section intends to embark on the anticipated threats and risks

that could hamper the process of designing a context-based strategy for teaching and learning of WP and how they could be avoided. The anticipated threats and risks such as teaching and learning of mathematical WP within the context of Afromontane learners, the use of indigenous games as a strategy to learn mathematical WP, abstract teaching and learning of WP, teaching and learning mathematical WP in learning spaces created by teachers for learners to learn mathematical WP and finally, the use of code switching as a strategy to teach and learn mathematical WP will be discussed.

3.5.1 Afromontane learners who receive teaching and learning of mathematical WP within their context as threats and risks

The research conducted by the Center for Mental Health in Schools at UCLA (2015:2) indicates the major prevailing threat as focusing on the content taught and knowledge acquired by learners rather than teaching mathematical WP within their contexts. This is affirmed by Samkange (2015:1861), who claims the most shocking part is to see most of the learners coming to school on a daily basis dealing with what the teacher is ready to teach and demonstrate, accepting the presentation of mathematical lessons as planned by their teachers. Dietrich and List (2015:16) claim teachers as privileged to have classrooms where the majority of the learners just accept lessons without questioning them. Bhattacharjee (2015:69) declares it as the traditional way of teaching where the main concern is to focus on the mathematical WP content rather than on the views of the learners about the content presented whether it is within the context of the learners or not.

However, in line with the above, Moodley, Adendorff and Pather (2015:2-3) declare learning within one's context as a risk, because learners do not learn mathematical WP in isolated classrooms within their contexts, but with others with different contexts. Thus, this becomes a threat, in the sense that learners in multilingual and multicultural classrooms might want to learn mathematical WP only within their own contexts, but the environment would not allow them to do that.

Harouni (2015:8) declares the state of teaching mathematical WP within the context of learners in a multicultural and multilingual classroom as risky, static and confusing because learners might never know from which context they should learn mathematical WP. According to Liljedahl (2015:2), the nature of the content from which

they learn mathematical WP and the type of textbooks that are used by the teachers might not be within the context of the learners. Hence, we find Sepeng (2015:25) appealing to the parents and teachers of these learners to plan together with the DBE, the publishers and the policy-makers in their process of designing, amending and developing policies on how they could teach mathematical WP effectively and efficiently. Dickie and Shuker (2011:107-108) find it risky to see some of teachers teaching the phenomenon of interest within the context of the learners without having appropriate guidelines, teaching and learning materials to do so. That is why, in support the above, the European Commission (2015:3) argues that the end products, skills and knowledge acquired by these learners from schools are found to be irrelevant most of the time when it comes to the jobs available in marketplaces, leaving the majority of them unattended with their qualifications in their respective societies.

In the light of the above, Fede (2010:5) reports that the mathematical skills of learners in the universe were found to be falling short of what is needed in the workplace. This is affirmed by Gay (2013:63) who claims that the same challenge applies to other learners globally.

3.5.2 Threats and risks to communicate mathematical WP through English to Afromontane learners

The DBE (2011:5), in the CAPS document, values the use of the indigenous games in the teaching and learning of mathematics, particularly mathematical WP, but it does not explain how they could be used in the teaching and learning processes of mathematical WP. For this reason, Mukhopadhyay and Greer (2015:181) declare the use of the indigenous games in urban schools to be inconsistently acknowledged and valued. Because of the mere fact that these were found to be inconsistently acknowledged and valued, Kaya and Seleti(2013:35-38) discourages teachers and learners to use them consistently and value them as reliable in the process of teaching and learning, because doing so could be risky.

However, according to the studies done on the use of indigenous games as teaching and learning technique, Xin, Jitendra and Deatline-Buchman (2005:183-184) discovered that factors such as negative opinions about the teacher, incomplete assignments, the lack of effort to make sense of the mathematical WP learnt and the

lack of desire to be successful academically, as well as not fearing failure all contribute a lot towards learning mathematical WP with the risk of failing.

In line with the above, Awopegba *et al.* (2013:6) discourage teachers and learners in South African, sub-Saharan African and continental schools to rely too much on indigenous games when learning and teaching mathematical WP, because this contradicts the acknowledgement by the DBE (2011:5). For that reason, they could not be consistently employed in the teaching and learning of the phenomenon of interest. By so doing, Moloji (2013:125) claims that by doing, so teaching and learning of mathematics, particularly mathematical WP would have been put at a risk, while globally we find that Kelly (2006:184-185) advances the idea that studies that find teaching and learning of mathematical WP using indigenous games are risky. Are true only when the cited examples by teachers in the class are not taught and integrated with concrete objects learners are well conversant with, particularly learners in the elementary grades (Mukhopadhyay & Greer, 2015:52-53; Cope, 2015:11-15; Furner & Worrell, 2017:3-21).

3.5.3 Threats and risks of teaching and learning mathematical WP abstractly to Afromontane learners

Zawaiza and Gerber (1993:67) describe abstract teaching and learning of mathematical WP by using procedures as algorithmic. Various studies relate an algorithmic way of teaching and learning with the traditional way of teaching and learning mathematical WP, because they regard this approach as one of the approaches where teachers would go to class to impart knowledge to learners (Riccomini *et al.* 2015:244-245; Owusu 2015:45-46; Pongsakdi 2017:19-21). Alipio (2014:24-26) describes this kind of approach as behaviourist teaching, where a learner in the classroom is regarded as a tabula rasa. Olusegun (2015:67) argues that if teachers consistently apply a behaviourist approach, they would put the lives of slow-progressing learners at risk, because they normally take time to think and to draw conclusions.

On the basis of the above, Vizzi (2016:2-3) appeals to mathematics teachers to minimise their abstract teaching methods, but to maximise concrete ways of learning, because learners in the elementary grades believe in teachers who concretise their lessons. This is affirmed by Alipio (2014:11-12), who suggests concretising of lessons

as one of the best ways to assist fourth graders in learning mathematical WP better and with understanding.

In line with the above, Young (2015:3-4) declares the conditions of teaching and learning of mathematical WP in South Africa and neighbouring countries like Zambia, Lesotho and Nigeria as static, in the sense that studies that have been conducted indicate that the majority of the learners in the elementary and middle grades in those countries learn mathematical WP the hard way. This is because most teachers still employ the traditional way of teaching (Young 2015:4; Owusu 2015:46) where learners are not given time to raise or vocalise their challenges in the process of learning the phenomenon of interest. However, in leading and high-performing countries like Singapore, Finland, Japan, Hong Kong, England and the Netherlands (Tambara 2015:72-78; Programme for International Students Assessment – PISA 2015:4-10), the studies conducted pertaining to mathematics and sciences indicate that most of the learners do extremely well in mathematics, particularly mathematical WP, because their approaches centre around the following components: skills, concepts, processes, attitude, metacognition and cooperative learning.

3.5.4 Threats and risks of creating learning space to teach mathematical WP to Afromontane learners

Sepeng (2015:25) advises teachers and parents to identify and provide safe and welcoming learning spaces in the curricula where learners could learn mathematical WP without any fear of prejudice. He further advises them to create learning spaces in a manner that would address the sociocultural situations faced by and known to learners who were disadvantaged by learning mathematical WP through Western ideologies rather than their own (Nkoane 2006:58-62). This is affirmed by Bishop (1998:179-180), who claims that the Black Education System (BES) was designed in a manner that would not cater for teachers to create learning spaces for their learners to learn mathematical WP on their own and within their contexts. It rather placed them in the situation where they would take the risk of educating African learners mathematical WP from a Western context. Msila and Gumbo (2016:122-124) assert that African teachers were left with a threat that if they should teach WP from an African context, learners would fail mathematics.

However, Sepeng (2015:18) raises a prevailing connection gap or a complex issue of connecting school mathematics and home mathematics as a remaining challenge and threat in the teaching and learning of mathematical WP. Fein *et al.* (2002:74) state that it becomes a threat and at the same time a challenge, because the responsibilities of teaching and assisting learners in mathematical WP are not carried by teachers only, but also by the parents. Therefore, if teachers lack adequate skills to connect school mathematics with home mathematics, obviously, parents would experience more problems and children would end up failing mathematical WP.

This ideology of fear was removed by writers who claim that learning and teaching of mathematical WP could occur everywhere in the world. The threat of creating learning spaces for learners to learn them effectively and efficiently is not local. It was also found to be global, because teaching and learning are subjected to human activities and occur in all walks of life worldwide (DBE 2011:8; Young 2015:2; Msila & Gumbo 2016:163-165; Timss 2015:62-73).

3.5.5 Threats and risks to communicate mathematical WP through English to Afromontane learners

Reynders (2014:29, 72-73) conducted a study in relation to code switching mathematical concepts, and articulated the following,

South Africa's indigenous languages use many words borrowed from English and, therefore, certain principles used in Mathematics cannot be translated directly. Learners whose mother tongue is not English, but another of South Africa's eleven official languages, cannot relate certain mathematical concepts to concepts in their mother-tongue language, for example, more than or less than has different meanings in Sesotho, where they only refer to something that is small or big.

The above text suggests that out of 11 official languages, English is central. It is the language commonly used by South Africans as their means to communicate their feelings to themselves and immigrants. According to Coleman (2017:169-173), from an educational perspective, in mathematics, for example, English is used as a means to communicate mathematical concepts like mathematical WP, place values, factors, multiple of numbers, 2-D and 3-D shapes by teachers and learners with the intention to acquire certain mathematical skills that would assist them to attain their goals in life.

In the light of the above, Nordin, Ali, Zubir and Sadjirin (2013:4-5) argue that code switching becomes a threat when it is misused or overused. Gulzar (2010:31) describes the misuse of code switching as a condition where teachers switch from the LOLT into another language for the rest of the period and by allowing learners to code switch whenever they discuss mathematical sums on problem-solving.

According to Nordin *et al.* (2013:4), misuse of code-switching as a worrying factor not only affects learners and teachers in South African schools, but also learners in African countries like Nigeria, Zambia, Lesotho, Namibia and other countries on the African continent. In Namibia, for example, Shilamba (2012:12-16) found that learners in the elementary and middle grades experience lot of challenges if teachers do not code-switch to their mother tongue when teaching mathematical WP. From the various studies conducted internationally (Setati 1998:34; Mahofa 2014:13-14; Timss 2015:17) it transpires that learners at the same level or phase experience similar challenges. It comes as a shock to find that even learners from high-performing education systems and leading countries like Hong Kong, England, Australia and Japan also struggle.

3.6 INDICATORS OF SUCCESS FOR DESIGNING A CONTEXT-BASED STRATEGY

The success of the study is guided by the contributions made by various scholars through the literature review to show how teaching and learning of mathematical WP could be taught within the context of the learners and how indigenous games could have an impact on the teaching and learning. It further reflects the best strategies that could be used by teachers to teach mathematical WP in the abstract way, as well as code-switching could be used as one of the communication strategies to bring about harmony in the communication processes of teaching and learning mathematical WP.

3.6.1 Success of teaching and learning mathematical WP from an Afromontane context

Despite the fact that learners have shown that they experience challenges in identifying and connecting mathematical WP with physical objects within their contexts, and the curriculum imbalances that create undesirable pedagogical content knowledge on the side of teachers, successes gradually emerged (Fein *et al.* 2002:66-

67). However, The Department of Education and Early Childhood Development (2015:4) indicates that teaching will be successful when learners are able to communicate mathematical ideas in diverse ways. In addition to that, the Department of Education United States of America (2015a:33) advanced an idea that success comes through a well-defined lesson with realistic goals to be attained. The Stanford Center for Assessment Learning and Equity (SCALE) (2015:23) claims that a well-defined lesson should create a learning support where learners are given platforms in mathematics lessons to air their views with regard to the issues, like learning mathematical WP within their contexts, their engagements, their performances and possibly their future hopes and dreams, bringing about learning this phenomenon of interest from their contexts. In the same way, according to the First Nations Education Steering Committee (FNESC)(2011:16), this kind of success could happen when children are given opportunities to interact directly with teachers, community elders and other people around them (collaboration).

However, the studies conducted by Raoano (2016:24), Phang (2013:4, 9) and Murray (2012:55-56) indicate that the introduction of the Annual National Assessment (ANA) was to improve the 23 educational achievements of South Africa (DBE, 2010). The results serve as a commission for the quality of education in the intermediate band in South Africa (DBE, 2014), creating learning spaces to let learners learn mathematical WP within their contexts. This is affirmed by the various studies conducted by Young (2015:2) and Dunley-Owen (2015:4), who claim that the studies conducted in Africa by SACMEQ and NAEP declared learners in Africa learning mathematical WP better within their context in conducive learning environments created by teachers and parents jointly. In a similar way, Phang (2013:4, 9) and Harouni (2015:8) indicate that the studies conducted by Pisa, Timss and Pirls led by the International Association for the Evaluation of Educational Achievement (IEA) confirm that learners in the global world are able to connect mathematical WP with their environmental settings. For that reason, they continually perform extremely well.

In the light of the above, Mukhopadhyay and Greer (2015:13, 16) confirm that at the subsequent Mathematics Education and Society (MES) conferences held in Portland, Oregon in the United States from 2000 to 2012, with countries like Montenegro, Portugal, Denmark, Australia, Algeria, Germany and South Africa, the results of the learners from these countries improved because teachers acquired more and effective

skills assisting their learners from their respective countries to learn mathematical WP better and with understanding.

3.6.2 Success of teaching and learning of mathematical WP through indigenous games to Afromontane learners

Despite the fact that there were challenges implementing the indigenous games effectively in the teaching and learning of mathematical WP globally (King & Schielmann (2004:6-10), the DBE (2011:5) took the initiative of valuing and acknowledging them as the best practices in the teaching and learning of mathematical WP. Loewen *et al.* (2015:14-15), MacDonald and Zezulka (2015:20) and the Department of the Prime Minister and Cabinet (2015:7-8), regarded this acknowledgement as a breakthrough in the teaching and learning of mathematical WP globally.

In the light of the above, Nkopodi and Mosimege (2009:380-389), Moloi (2013:124-125) and the DBE (2011:5) are of the same view that indigenous games are valued and acknowledged in the South African education system as well as continentally to be one of the best practices that could be used to enhance teaching and learning of mathematics, particularly mathematical WP. However, it is not yet ready to be placed in the curriculum and because of that, no improvements have been made so far.

From a global context, according to Mutema (2013:59) and Ladele (2013:6), there are two main knowledge systems, namely Indigenous Knowledge Systems (IKS) and Western Knowledge Systems (WKS). IKS was meant for the use of disadvantaged communities, while the WKS was meant for advantaged communities. However, of late, indigenous institutions have been opened to address or redress the imbalances of the past. For that reason, learners are doing extremely well. This is affirmed by O'Keefe, Olney and Angus (2012:viii), who advance the idea that The National Indigenous Reform Agreement and the related National Partnerships have been designed to implement a government approach to Indigenous service delivery.

3.6.3 Success of teaching mathematical WP in abstract ways to Afromontane learners

Studies conducted by various researchers reveal that learners globally experience serious challenges of learning mathematical WP abstractly (Kaulinge 2013:5-7;

Siyepu 2013:1-2; Timss 2011:22). For that reason, various strategies were put in place and implemented. However, apparently, the effected changes only partially addressed the challenge (Bokar 2013:14-18). Nevertheless, Marist Lower School (2015:2) has advanced an idea that success in teaching and learning of mathematical concepts, particularly mathematical WP, comes through the use of concrete objects when they are kept and taught as concretely as possible until learners are prepared to accept the symbolic, for the mere reason that elementary children progress so well through the series of materials as they move towards learning mathematical WP abstractly.

In addition, the Department of Education and Early Childhood Development (2015:4) claim that in order to effect changes, communication of teaching and learning mathematical WP in an abstract way between teachers and learners should flow in such a way that it connects abstract teaching and learning of mathematical WP with concrete objects around them.

In the light of the above, the study conducted by Dunley-Owen (2015:4) indicates that most South African Schools learn mathematical WP by following George Polya's steps. This was affirmed by the DBE (2011:8), which encouraged learners to learn through deep conceptual understanding to make sense of the process of learning. According to Cope (2015:11-15), the introduction of the Annual National Assessment (ANA) was to improve the 23 educational achievements of South Africa (DBE, 2010). The results serve as a commission for the quality of education at the intermediate band in South Africa (DBE 2014).

The survey conducted by SACMEQ III (Young 2015:2) indicates that countries like Botswana, South Africa, Lesotho, Zimbabwe and Zambia's mathematics results have increased tremendously through efforts made by the education sectors, for example, the "Education sector plan" was designed with the intention to assist schools with plans how mathematics could be taught to improve the results. One of the best strategies suggested and recommended for implementation was teaching and learning problem solving through manipulatives. South Africa was ranked 10th, while Botswana, Lesotho and Zambia were ranked 14th out of 15 countries participating.

Globally, Hoe and Jeremy (2014:103) indicate that advocating the use of CPA as a learning and teaching tool assisted learners who learned mathematical WP from the concrete level (learning through manipulatives), pictorial level (learning through the

pictures) and finally the abstract level (learning through imaginations) in the best-performing and leading countries in mathematics and sciences like Singapore, Japan, China and others. This is affirmed by Brandt, Leece, Trushkowsky and Appleton (2015:13), who claim that the report released by Timss (2015) asserts that.

3.6.4 Success of teaching and learning mathematical WP by creating learning spaces for Afromontane learners

According to Rushton and Larkin (2001:28-29), a successful learning environment is achieved by providing a warm and welcoming atmosphere where learners are free to learn mathematical WP at their own pace and feel free to participate. This is confirmed by Swarchuk, Sowinski and LeFevre (2014:64-67), who claims that the environment should be shaped in a manner that it offers a wealth of materials that could easily and freely be accessed by every person, but under certain guiding rules to be adhered to in order to maintain control. In addition, the Department of Education and Early Childhood Development (2015:4-5) agrees that their learning environment should be created in such a way that learners are given opportunities to read about, listen to and to debate mathematical ideas, particularly problem-solving ideas.

By contrast, the South African Numeracy Chair – SANC (2013:1) is of the opinion that classrooms could also be created for afterschool mathematics clubs where learners will be given the opportunity to learn and enhance their mathematical experiences in ways that are free from curriculum and assessment-driven teaching practices.

However, from a South African context, Dunley-Owen (2015:3) and Makgakga (2015:357) argue that the South African curriculum and those of neighbouring countries like Botswana, Zambia and Zimbabwe are not yet ready to assist learners who live in poor rural areas in accessing mathematical learning materials in their homes. They often live in societies without public library facilities and as result of that are affected (Mohiddin 1971:571). Therefore, if affected, the results will also be affected, but according to Spaul (2012:1-20), the highlights of the report released by SACMEQ III show that the results from the African countries gradually grow.

The Department of Education in the United States of America (2015b:26) claims that through collaborative efforts by teachers and parents in creating conducive learning spaces for their children and the effort of encouraging them to learn word problems

collaboratively, results will improve. Timss (2015:7) indicates an improvement in the results in 2015, being higher than in 1995 and 2003. This is confirmed by Dunphy *et al.* (2014:23-24), who claim the international mean scores between 537-527 were achieved in over 50 countries like Ireland, Belgium, England and Denmark.

3.6.5 Success of using English to teach mathematical WP to Afromontane learners

The research studies conducted by the researchers state several reasons why teachers and learners do not comprehend well in English (Gulzar 2010 31-32; Olugbara 2008:13; Setati 1998:35; Pooran 2011:4). According to Mahofa (2014:32, 41), for several reasons, teachers often switch to their mother tongue when presenting their lessons in English “to explain new concepts; to clarify statements of questions; to emphasize points; to make connections with learners’ attention, for classroom management and discipline”.

This affirmed by Zazkis (2000:38), who claims that code switching occurs in instances where the teacher or the learner is not able to find out an appropriate word that could be used to further up the prevalent discussions. In addition, Mqadi (1990:2-14) and Ramsay-Brijball (2004:156-159) describe it as the best communication strategy ever used, not only in the classroom setting, but in public places like churches, hospitals, clinics, radios, newspapers, etc. with the aim of communicating one’s views in a manner that would be heard.

However, from a local, continental and global perspective, various studies conducted describe it as the same communication strategy having or serving the same reasons or purposes alluded to by Mahofa and other scholars from the above paragraphs. It has been described as the best communication strategy ever used to improve results and enhance teaching and learning of mathematics, in particular mathematical WP (Auckle 2015:42-43; Henderson 2015 2-8; Shay 2015:464-466).

3.7 SUMMARY

This chapter presented the descriptions of the five research objectives where figures and tables were used to indicate how teaching and learning of mathematical WP could possibly occur within the context of learners, learning spaces be created, indigenous

game be incorporated in teaching and learning, abstract teaching and how English could be used under the conditions and threats.

CHAPTER 4:

RESEARCH APPROACH TOWARDS DESIGNING A CONTEXT-BASED STRATEGY ENHANCING TEACHING AND LEARNING OF MATHEMATICAL WP FOR AFROMONTANE LEARNERS

4.1 INTRODUCTION

This study aims to design a context-based strategy for the teaching and learning of mathematical WP for Afromontane learners. The preceding chapters provided an overview of the study, literature review and theoretical framework to describe Afromontane learners. These chapters showed that Afromontane learners' skills and ways of knowing were marginalised in epistemological discourses (Yosso 2002:94; Ako-Asare 2015:4; Makonye 2015:363). This chapter focuses on the use of PAR as a research method, its originality, the objectives of PAR, the formats of PAR, epistemology and ontological perceptions, the role of the researcher in relation with the research participants, the profiles of research participants, rhetoric in PAR, code of ethics, research design, and action plan and, finally, a summary.

4.2 PAR AS A RESEARCH METHOD

MacDonald (2012:35) describes Participatory Action Research (PAR) as a collaborative approach whereby a researcher works with the participants to collect data and analyse it with the goal of attaining a common goal. Edwards and Hollard (2013:4) raise the fact that these participants are considered as subjects, respondents, informants and interviewees, because they are not afforded opportunities to raise their voices in the research proceedings. This is affirmed by Little Child, Taner and Hall (2014:4), who state that they are treated like objects, because a researcher would come with a pile of questionnaires and ask participants to complete them without saying anything and then vanish with the information collected. In this study, PAR will be employed as a method whereby the research participants will be treated as co-researchers (Chilisa 2012:229-234). According to Sanginga, Kamugisha and Martin (2010:696-697), research participants could be viewed as co-researchers when they are given time to air their voices in the study. In addition, Barturo, Norton and Cooper (2004:93-94) state that when participants feel that they own a study, they are unlikely

to withdraw from the study. Below is a networking picture illustrating how important it is to communicate with other people around us.

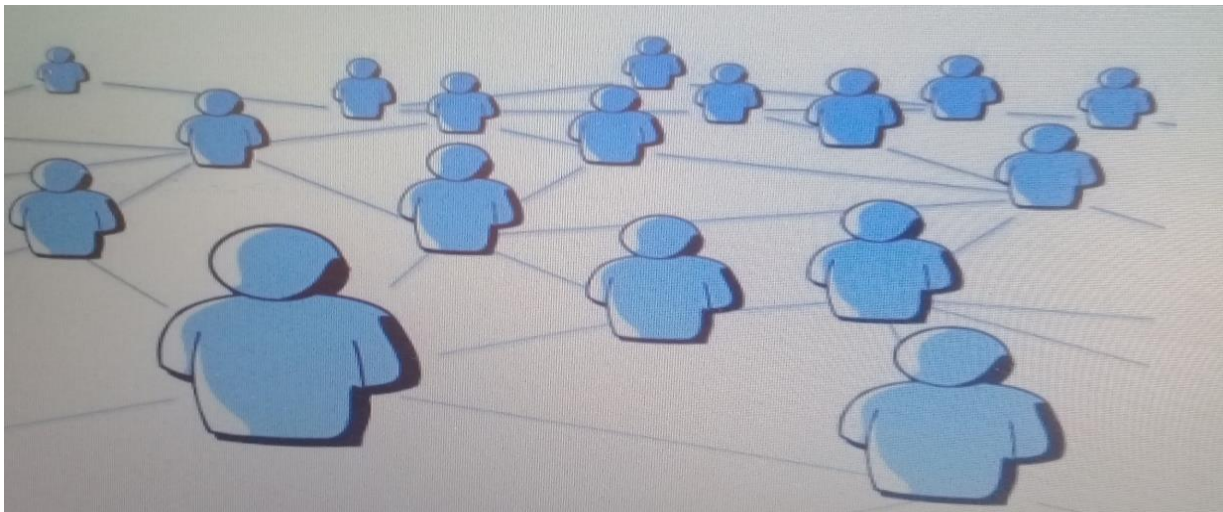


Figure 4.1: Networking with the co-researchers (Adapted from Hunter Multicultural Community Drug Action Team, Drug, and Alcohol Multicultural Education 2015)

This figure suggests that networking of some kind takes place amongst the people, and it could move from one person to the other. This figure further advises people to pursue creating pleasant-sounding relations with others since, they could get assistance in the form of advices from them, and learn from their expertise at some stage. Furthermore, a picture of people facing in the same direction might imply that by having the same vision, one should face in the same direction (think parallel) to accomplish the same goal.

However, in the context of this study, networking implies that the research participants should work together as a team to attain the research goal (Janice *et al.* 2011:5; Hasson 2015:65-70). The following people were selected to form part of my focus group, working with me to make my study a success, namely (1) the researcher, (2) Grade 4 mathematics teachers, (3) Grade 4 learners, (4) mathematics head of department, (5) the school principal, (6) the school governance, (7) parents of the learners, (8) former Grade 4 mathematics teachers, (9) the subject advisor, (10) teachers from the neighbouring schools, (11) a local businessperson, and (12) a member from the royal family. This communication process was based on selecting the research participants according to their expertise (Cook, Ensor & Blanchet-Cohen 2015:3, Juujärvi & Lund 2015:11). The next part is guided by the historical origin of PAR.

4.2.1 Historical origin of PAR

According to MacDonald (2012:37), PAR originated from the work of Kurt Lewin, a founder, psychologist and Jewish refugee in Nazi Germany (1944). MacDonald further introduced Lewin as a pioneer of social change who designed the social system to motivate and show people how they could possibly impart changes by working together as a team, also by engaging themselves in the decision-making processes. According to MacDonald, Lewin was informed by separation, discrimination and assimilation occurred amongst the racial community members, which forced him to initiate and effect social changes. This was affirmed by writers like Arellano *et al.* (2015:1202) and the United Nations Educational, Scientific and Cultural Organisation (2015:115-116) that claimed the motive behind this was to address the social imbalances emanating from the point where other community members were marginalised in terms of their societal and cultural eminence. In the light of the Lewin's experiences, I found these experiences merging with the Community Cultural Wealth (CCW) as my theoretical framework, because Yosso (2002:93) declared race curriculum as a weapon designed in a way that it places certain groups of students in certain classes where teaching and learning of mathematical WP occurred differently. According to Bishop (1988:181-184), these practices caused social imbalances between the racial groups.

However, in addressing these racial imbalances, the DBE (2011:4-5) has introduced the CAPS policy document in South African schools to equip learners with a variety of skills. These include indigenous skills and knowledge to cater for all learners, irrespective of their sex, race, colour and gender in the teaching and learning of mathematical WP. This is affirmed by Lucero (2010:127-128), who claims recognition of teaching and learning mathematical WP from the cultural context of learners as a gain on the side of learners, because they would be able to get a chance of learning mathematical WP from two environmental contexts, namely a home and school context. In addition, the Department of Sport, Arts and Culture (2015:1) asserts that learning and integration of mathematical WP could also be achieved through indigenous games. Barturo, Norton and Cooper (2004:93) further claim that once one sees learners integrating their play with mathematical WP, one must know as a mathematics teacher that one has disseminated one's learners' mathematics skills properly.

In the context of this study, the effort of Kurt Lewin of bringing social system in place correlates with the purpose of this study, because the initial aim of this study was to design a context-based strategy to enhance teaching and learning of mathematical WP to Afromontane learners. As a researcher, I have learned that it was not possible to attain this goal alone. As a result, I had to work with my research participants to assist me in reaching this goal, and this goal was in line with one of the principles PAR, which encourage people to work together to attain their goals (DePalma 2010:218-219; Pain & Francis 2003:47-48; Jordan 200:186-187).

However, I opted for PAR as my research method to address the segregation challenge of the Afromontane learners, because I noted that their indigenous knowledge and cultural, which had sustained them in the past were marginalised. I adopted PAR because it has been proven that it is a powerful approach to working with oppressed groups to improve their circumstances within the society (Hertz-Lazarowitz *et al.* 2010:270).

4.2.2 Tenets of PAR

PAR is guided by the notion that members of the team work together to focus less on challenges, but more on collaboration to learn about new avenues by sharing ideas to accomplish goals (Sherwood & Kendall, 2013:88-89). In addition, Pacheco (2012:121) describes PAR as a voice of oppressed people who have been denied the right by autocrats to participate freely in their respective societies.

It is through these oppressive kinds of behaviour that the hard-pressed Nkoane (2006:50-52) pleaded with Africans to settle or dwell on their African ideologies. One of the African ideologies raised by Sepeng (2015:18-19) is that learners should be given a choice to integrate mathematical WP lessons into the classroom with concepts they know and experience in life.

In the context of this study, I view this integration as an entity by which learners are guided by mathematics teachers to work together as a team to learn, absorb and apply new skills employed by others to solve mathematical WP (Bishop 1988:188-189). In view of the above, Brydon-Miller (1997:660-661) listed three tenets of PAR, which are discussed next.

4.2.2.1 PAR originated from communities where indigenous skills were marginalised

Aligned with the above sub-topic, Robert (1994:1) states that PAR originated from a community where members were denied opportunities to have a say in decision-making processes. In addition, Nkoane (2006:50-51) justifies a point that even though they developed indigenous ideologies and innovations to survive, they were not permitted to employ them. However, Lucero (2010:127) claims that PAR came into existence to address those social challenges that emerged or prevailed in past years. In a similar way, the DBE (2011:5) introduced the CAPS policy document to merge and value the indigenous knowledge system by acknowledging the fact that learners have indigenous skills and knowledge that should be developed or cherished.

However, having noted that the indigenous skills of the mountainous learners have been marginalised, I decided to design a context-based strategy to show the importance of these indigenous skills in the teaching and learning of mathematical WP (Seehawer 2018:96). In the process of digesting the strategy, I learnt that I needed people to assist me (MacDonald 2012:36-37; Khanlou & Peter 2004:2334), treating them as my equals and making their contributions valuable so that they may always contribute positively towards the study (Juujärvi & Lund 2015:2).

4.2.2.2 PAR works to address the fundamentals of oppression, aiming to achieve positive social change

Young (2004:2) advances two key fundamental causes of oppression as the lack of decision-making power and exposure to ill treatment. According to Fired and Delux (2015:5-7), these fundamentals manifest themselves in the dimensional power relations in the community of colour from the educational, traditional, political and religious realms. O'Neil and Domingo (2015:2) describe the lack of decision-making power as a lack of ability to influence other people to make positive decisions about themselves and their lives. According to Navarrete *et al.* (2015:10), these oppressive ideologies emanated from the mental ideologies where, in the past, people believed that teachers and other educated people in their societies could draw certain conclusions on their behalf. In support, Liljedahl (2015:4) claims that an episode like this seems to have occurred in the traditional classrooms where teachers made

decisions on behalf of the class, and encouraged their learners to work in isolation or independently to solve mathematical WP.

However, the context of this study differs, because teachers create learning spaces for their learners to share ideas and put their differences aside to work together towards finding solutions when solving mathematical WP (Kenneth & De Meuse n.d.:4)

4.2.2.3 PAR creates spaces for all participants to contribute their unique skills and knowledge in a project

Ritchie *et al.* (2013:184) describe PAR as a method that creates spaces for people to share their expertise and make decisions together on an equitable basis. Sepeng (2015:18), who alleges that PAR allows people to share ownership in research projects, affirms this.

However, in the context of this study, I view PAR as a method by which teachers create learning spaces for learners to air their views in the mathematical WP class (Pacheco 2012:121). The contributions made by learners in this instance are valuable; they become active participants in the mathematical WP lessons, and always contribute positively (Skwarchuk & Sowinski 2014:65).

4.2.3 The formats of PAR

This part of the study is guided by the formats of PAR, namely Participatory Action Learning and Action Research (PALAR), Collaborative Action Research (CAR) and Community-Based Participatory Action Research (CBPAR), which in my view as a novice researcher interrelate with PAR as a research methodology. In the next section I will briefly indicate how these formats could be joined together to make sense in the teaching and learning of mathematical WP.

As a novice researcher, interlinking the formats of PAR means that the formats have similar or common principles with PAR; that is, the three formats work in relation with PAR towards encouraging people to work together to attain certain goals in life (Cherrington 2015:43). Janice *et al.* (2011:5-6) describe CBPAR as a format of PAR that drives people to put their differences aside and work together towards achieving a common goal. Zuber-Skerrit (2015:6) describes PALAR as a format of PAR that encourages people to build the sound working relations amongst themselves to reach

their target, while Zuber-Skerrit (2015:6) declares CAR as a format of PAR that also encourages people to work in collaboration towards attaining their objectives.

The next section is guided by Figure 4.2, illustrating how PAR interacts with the formats.

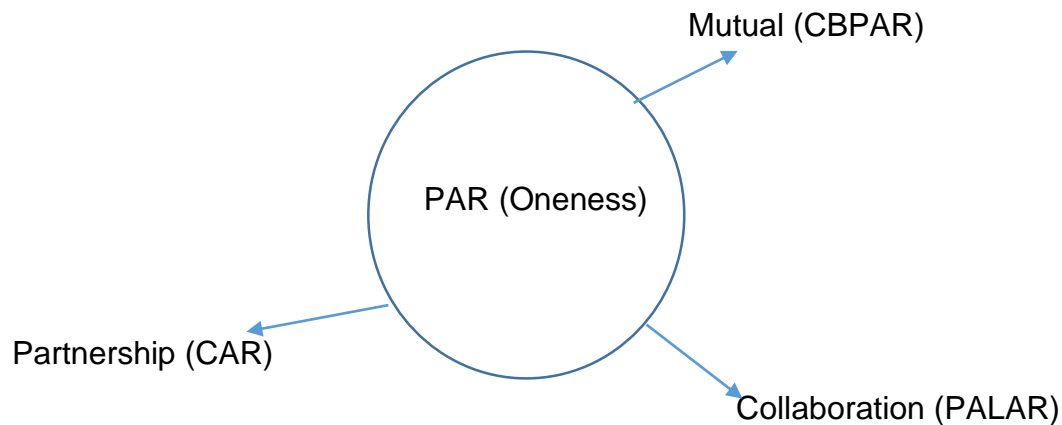


Figure 4.2: The formats of Participatory Action Research

Figure 4.2 places PAR at the centre with three arrows moving from PAR, pointing at the three different formats. This placement suggests that the formats are interconnected with PAR, that is, the language PAR speaks is the same language spoken by the three different formats (Cherrington 2015:43-44). For instance, when PAR speaks about working in oneness to attain goals, the trio also speaks about oneness, but use similar words like mutual, collaboration and partnership (cf. Figure 4.2 above).

In the context of the study, these similarities imply that mathematics teachers should work in partnership with other mathematics teachers to develop the potential values of learners to cultivate their logical thinking so that they might be able to analyse and interpret any situation before any action is taken (O'Brien 2010:15). This claim is confirmed by Co'rdoва (2011:30) and Pastor and Maria (2014:4), who state that their potential values might also assist them in thinking logically in terms of choosing their future careers. For example, if they want to become pilots of aircrafts, they must always remain calm, and be sensitive in terms of controlling a flight, because it carries the lives of the innocent people (Smith *et al.* 2010:18-20).

4.2.4 Perspectives on epistemology and ontology in PAR

This part of the study is guided by the transformative paradigm where the constructivists, believing in the idea that people construct their views of the world based on their perceptions (Nakpodia & Okiemute 2011:152-153). However, for the purpose of the study, I shall focus on the epistemological and ontological sentiments working in relation with PAR. I shall also look at how learners perceive both the nature of knowledge and of being in the process of learning mathematical WP (Burghes & Robinson 2010:11). Most importantly, I shall use the word 'learners' in plural form relative to 'learner' in singular form, attempting to show the importance of learning mathematical WP by sharing their skills (Dopfer 2015:4). From this background, Pons *et al.* (2014:834) urge teachers to use cooperative teaching when structuring their lessons to consider and cover the family background of learners.

As a researcher and mathematics teacher, I noted that most of the learners came from different family backgrounds (Schmid 2012:7). I also noted that others came from child-headed households with limited control; backgrounds where family members do as they wish, and as result, perform very badly in the process of learning mathematical WP (Pillay 2016:n.p). However, the DBE (2010:62) introduced cooperative learning as a learning strategy to address the challenge. Truwant (2014:698-699) describes cooperative learning as a way of teaching where learners are given a platform to share their knowledge of a specific subject, e.g. mathematical WP, to solve.

According to Akipan and Beard (2016:394-395), by so doing, teachers would create an atmosphere where every learner will be free to share knowledge in mathematical WP-related activities. This was affirmed by Mokotso, the executive mayor of Maluti-A-Phofung Municipality on Heritage Day, when he encouraged the residents to retain and share their knowledge on culture with their children at school (Nyaka, *The Quard* local newspaper, 28 September 2018:5). According to Webster-Stratton and Bywater (2015:13-14), this knowledge could be of great help to learners and teachers at school if it is used to show an integration of teaching mathematical WP at school and at home.

From an ontological perspective, we view nature of reality as a crucial fact. The nature of reality in this effect is viewed from the point where we look at the social reality that occurs between objects and human beings (United Nations Educational, Scientific and Cultural Organization 2005:138). This social reality occurs on a daily basis in real-life

situations and reality should not be taken as reality until it drives people to interact with objects – not only seen as reality when it drives people to communicate only with other people. For example, when you give a child R10, 00 and ask him or her to rush to the tuckshop to buy a loaf of bread, the child applies a lot of mathematical skills there. Firstly, the child represents a human being, while the R10, 00, tuckshop and a loaf of bread represent the objects. In a real-life situation, human beings interact with objects and rely on them. Conversely, objects cannot exist without human beings (Sepeng 2015:2). From rushing and buying, we could create examples of WP, for example, to calculate the number of kilometres or hours spent by a child going to and from the tuckshop. We will also be able to work on the total money given to a child to buy bread (for example, how much a loaf of bread costs and the change).

In conclusion, Truwant (2014:696) indicates that no individual can see the world perfectly as it really is without consulting others; an individual knowledge or reality is not perfect until it has been shared or tested by other people.

4.2.5 Role of the researcher and the relationship with the co-researcher

According to Katigbak *et al.* (2016:212-214), the key role of the researcher is to work with the co-researchers to ensure that the activities conducted are planned. In addition, Chilisa (2012:295) raises the identification of the research problem. The generation and interpretation of data should be a frequent point of contact between a researcher and co-researchers and be applied in a manner that reveals a collective decision-making power. According to McIntyre (2003:30-31), Botha and Lamprecht (1997:17), a collective decision-making power is attainable only if team members work together and strive towards building a cohesive spirit amongst themselves. The Department of Basic Education, in the *South African Schools Act* (1997:8), asserts that the spirit of cohesion is built upon mutual respect, shared decision-making, open communication, respect for the roles of different partners and a common vision amongst the team members, with the intention of attaining the set goals.

Aligned to the above background, in this study we worked as a team towards building a spirit of teamwork amongst ourselves. Individual team members were persuaded to preach unity amongst themselves. It was believed that unity would be solid when it rested upon the following solid words, “even though we might have differences and view things differently, let’s put our differences aside and work together as a team”.

These words were meant to build cohesion amongst the team members where individuals are treated with respect and equally (Jervaes 2008:21).

Through this unity, members of the team managed to work together to identify the research problem and to work towards identifying ways in which they could design a context-based strategy to enhance the teaching and learning of mathematical WP for learners (Atchoarena & Gasperini, 2003:21, 24; Sepeng 2015:17). Most importantly, Ako-Asare (2015:16-18) and Despina and Harikleia (2016:13) state that the prevailing unity amongst the parents of Afromontane learners in terms of assisting them with indigenous skills taken from their funds of knowledge, plays a significant role in the teaching and learning mathematical WP (Sibanda 2013:22).

4.2.6 Rhetoric in PAR

Majava and Haapasalo (2015:203-204) caution researchers that they should be mindful of the language they employ when conducting their studies or projects. Similarly, researchers like Okeke and Van Wyk (2015:24), and Edwards (2016:19) claim that if the language employed is disrespectful and besmirches the status of co-researchers, and is not respectful of all the members of the team, team members may withdraw from the study any time without fear of prejudice. In addition, other researchers are of the view that the language employed to communicate aims and objectives should be comprehensible to everyone in the team to allow free participation by team members in the study (Sunday 2015:20; Godwin-Jones 2013:5; Derese n.d:33).

In the context of this study, I observed the language employed as playing a significant role, because the research activities were communicated with respect and love to everyone in the team, and the free flow of communication amongst the team members made this study possible (Hurrell 2013:62; Kenny & Hobbs 2015:7-10).

4.3 ETHICAL CONSIDERATIONS

This section attempts to define ethics and show the ethical processes I underwent to get an ethical clearance certificate to conduct this study. Various researchers define ethics as escorts or guides that secure the involvements of co-researchers on the issues pertaining to their privacy and confidentiality in the research proceedings

(Chilisa 2012:229-236; Denzin & Lincoln 2008:192-193; Merriam 1998:131-132). In addition, Williamson (2015:7-10) encourages the observation of ethics during team engagements and consultations with other members in the same group to remain visible and open to avoid misconceptions. Similarly, Nobari (2015:92-93) and Katigbak *et al.* (2016:212) describe the sharing of ideas and differences as anchors or pillars that co-researchers could talk about and rely on during the research proceedings when things get tough. Equally important, the Hunter Multicultural Community Drug Action Team and Drug and Alcohol Multicultural Education (2015:21) advances one of the major roles of a researcher, namely to ensure that the relation between co-researchers are dependent on trust in order to foster and sustain their engagements in the research proceedings.

In the light of the foregoing, I conducted my research study based on the conditions that the ethics of team members are secured at all times, ensuring that they work collaboratively as a team, with respect, and all members are treated equally (Purehuroa 2015:9; Buckles & Chevalier 2013:33; University of South Africa 2013:9, 11; Saxena 2015:33). I also had to ensure that ethics are not used as bailing factors, for example, by adults, to disrespect learners on the basis that they are children, for instance, sending them everywhere they want to during the research proceedings (Dunphy & Dooley 2014:96, Langeness 2011:18; The South African Council for Educators 2011:17-18).

I went through the following processes to get ethical clearance to conduct this study. I wrote an application letter and addressed it to the ethics committee at the University of the Free State and the Provincial Free State Education Department, where I indicated precisely how I was going to conduct my research proceedings. In my applications, I listed and explain the following research features as my backups to conduct the study, the duration of the study, the location of the study, research participants and the ethical considerations I had to consider when conducting my study. Finally, I waited for their approval before I could start on my research (Pooran 2011:37).

4.4 RESEARCH SITE PROFILE

As a novice researcher, I noted from other researchers that research studies could be conducted, either locally or continentally nor universally (Creswell 2014:58-59, Tjabane 2010:2-4; Mnisi 2011:34-35). Nonetheless, for the purpose of this study, I decided to conduct my study locally, based on investigating how the indigenous skills and cultural wealth of local learners situated in mountainous places were marginalised in the teaching and learning of mathematical WP (Kaya & Seleti 2013:36). For this reason, I selected a school situated in a mountainous area, named Makhaloaneng village. This village, in the Eastern Region of the Free State Province, is surrounded by mountains and trees. The school was founded in 1977. The majority of the parents are unemployed. Most of the learners are from child-headed households, or stay with their grandparents, who earn their living through foster grants (Blaauw, Viljoen & Schenck 2011:1-2; Nziyane & Alpaslan 2012:290-304). The school was allocated five post-level one (PL1) teachers, one head of department, the principal, administrative clerk and the cleaner. The total number of learners was 267. I selected learners and parents from the mountainous areas, with the hope that with their indigenous skills and knowledge they would assist in designing a context-based strategy that enhances teaching and learning of mathematical WP within their context (Khupe & Keane 2017:27; Moloji 2015:25).

4.5 THE RESEARCH PARTICIPANTS

I selected the participants of the focus group on the merit of their expertise of the indigenous knowledge related to my research topic. O'hEocha, Conboy and Wang (2010:120) indicate that data generation could be done through group interaction on a topic determined by the researcher. I also selected a facilitator whose job was to keep the group on track, ensuring that the discussion produced the desired outcome (Krueger 2002:4; Morgan 2013:2-3).

The selection was based on gathering the sentiments on indigenous knowledge and mathematical WP from my research participants (Padilla 2014:76-78; Hansson 2015:65-67). The aim was to check whether the integration thereof would make sense in the learning process of mathematical WP (Moloji 2015: 25). In support of this view, Perry and Howard (2008:7-8) claim the integration of this nature as relatively superb,

because it gives learners the opportunity to learn mathematical WP within their context.

Based on the above discussion, I selected my research participants as follows.

4.5.1 The researcher

The researcher was a teacher by profession who had attended his teaching courses at Tshiya College of Education for three consecutive years (1984, 1985 and 1986), majoring in Mathematics and Sesotho for teaching in the FET band. He started his teaching career at Qibing Secondary School at Wepener as a post-level one teacher (PL1) in 1987 for a period of five months. He taught mathematics classes from Grade 10 to Grade 12. Towards the end of 1987, he went to Evungwini Secondary School at Vrede, where he taught mathematics from Grade 10 to 12, and was later promoted to post-level 2 (PL2), to become the Head of Department (HOD) in the language department. From there, he went to work at Dikgakeng Senior Primary School (Grade 7-9) teaching mathematics to Grade 9, at the same time heading all the subjects for a period of four years. From there he went to Makong Senior Primary School (Grade 7-9), teaching mathematics to Grade 7-8, heading all the subjects at the same time. Lastly, he went to Majara Intermediate School (Grade 4-6), teaching mathematics in Grade 6, heading all the subjects at the same time.

Teaching mathematics classes from Grade 4 to Grade 12 was an amusing experience with a bunch of expertise, and it was from this delightful experience that he noted that the fourth-graders had indigenous skills and knowledge that could assist them in learning mathematical WP better and with understanding. However, they were marginalised, although not clear for what reasons. Then he decided to design a context-based strategy that would enhance teaching and learning of mathematical WP for these learners, namely that they would learn mathematical WP within their context.

4.5.2 Grade 4 mathematics teacher

This section provides the profile of the of the mathematics teacher. The teacher completed her teacher-training course at Bonamelo College of Education in the Eastern Free State where they were trained to teach all the primary school subjects. The teacher started by teaching numeracy to Grade 1 to Grade 3 at Diphakweng Primary School for 10 consecutive years. At the beginning of the 11th year, she came

to our school, teaching mathematics for Grade 4 and technology for Grade 5. During the class visits, I noted that she could integrate prior knowledge of learners with existing knowledge, and she was flexible in creating learning spaces to listen whenever her learners wanted to air their views. Because of her expertise in this regard, I requested her to join me in designing a context-based strategy that enhances teaching and learning of mathematical WP to learners.

4.5.3 Grade 4 learners

The learners I dealt with came from mountainous places where the majority of them were orphans who stayed with their grandparents, earning their living through foster-care grants, or who originated from child-headed families. Academically, I noted that the majority of them struggled with their classwork and homework, because they lived with their grandparents who were illiterate. I also noted during my lessons on mathematical WP that they struggled to convert mathematical sentences into symbols. I thought that maybe some of the examples cited in their mathematics textbooks were not within their thinking box. During break times, I went outside to check what kind of indigenous games they were interested in. I observed that they played indigenous games such as *morabaraba*, *kgati*, *malepa*, etc. I then decided that I would design a context-based strategy to enhance their learning of mathematical WP.

4.5.4 Mathematics head of department

This teacher completed his three-year teacher-training course at Mphohadi Teachers Training College in Kroonstad, majoring in mathematics and English. He started teaching at Monontsha Primary School, teaching mathematics for a period of 12 consecutive years. He went to Sebatatso Secondary School to teach mathematics from Grade 10 to Grade 11 for three years. Next, he went to Koali Secondary School to teach Mathematics and Biblical Studies from Grade 10 to Grade 11 for another six years. Finally, he was redeployed to our school, teaching mathematics and social sciences to Grade 4 and Grade 5 classes. Upon learning of his expertise and experience, I requested him to become one of my research participants.

4.5.5 The school principal

The principal completed his three-year training course at Sefikeng College of Education. From there he went to Kgotsong Primary School to teach social sciences

and English to Grades 3 and 4 for 10 years. From there he went back to lecture social sciences at Bonamelo College of Education for five years. After that, he went to teach at Lekgulo Secondary School teaching English and social sciences for six years. He also taught social sciences at Sentinel Primary School for another four years, where he was promoted to deputy principal. Next, he became the principal of our school. He lived in an urban area from where he used to travel almost 10 km daily to and from the school using his car as a mode of transport. He used to play chess games with the schoolboys after school hours with the strong belief that boys could learn mathematical skills from the games. When I was invited to watch these games, I realised that boys were able to integrate the games with mathematical skills. For this reason, I requested him to assist me in designing a context-based strategy to enhance the teaching and learning of mathematical WP.

4.5.6 The school governance

We had two members from the school governance body who represented the entire body. The first member was a former teacher of the school who had taught mathematics for about ten years. He had also been involved in the Community Policing Forum (CPF) for 15 years. The second member had worked in the mining industry as a surveyor for a period of 18 years and later became a supervisor of mining surveyors. These parents were also actively involved in community projects. With the parental exposure and expertise they had in the real-life situation, I decided to include both in my research study with the hope that they would assist me in designing a context-based strategy.

4.5.7 Parents of learners

I chose to team up with two parents of the learners because they had indigenous skills and knowledge we did not have as a team. Some have acquired various general life skills, which were not really close to the indigenous skills and knowledge mentioned in the previous sentence. For example, some might have been actively involved in the political sphere of life; others in the business world and others in sports, etc.

For this study, I chose to work with parents that had knowledge of indigenous games, hoping that they would have a huge impact on the process of designing a context-based strategy for the teaching and learning of mathematical WP. I noted that parents

were running traditional shows based on *mokgibo* (traditional dances), *morabaraba* (board games) and *kgati* (rope skipping games) in the community. Having observed the wealth of expertise and experience these parents had, I requested them to join my research participants, hoping that they would assist in integrating the games with mathematical WP.

4.5.8 Former Grade 4 mathematics teachers

I asked two former school mathematics teachers to contribute by designing a context-based strategy that enhances teaching and learning of mathematical WP to the learners.

The first teacher completed his three-year teacher-training courses at Tshiya College of Education, majoring in mathematics and English. He started his teaching profession at Seanakwena Secondary School, teaching mathematics for 10 consecutive years. From there, he went to Tseki Secondary School by promotion to serve as the head of department (HOD), teaching the same subject for nine years. Due to illness, he applied for incapacity leave and stayed at home.

The second teacher was also a mathematics teacher who completed her three-year teacher-training courses at Bonamelo College of Education. This teacher was trained to teach all the junior primary school subjects. She started teaching numeracy and literacy at Lebohang Primary School for 11 years. From there, she went to Dibe Primary School to teach mathematics and Sesotho for eight years, whereafter she resigned to run her own businesses.

In view of the above information, I requested them to join my research team, hoping that they would assist us in designing a context-based strategy that enhances the teaching and learning of mathematical WP.

4.5.9 The subject advisor

The subject advisor attended his teacher training courses at Tshiya College of education for three years where he specialised in Mathematics and English. He started teaching Mathematics and English at Dikwena Secondary School from Grade 10 to Grade 12 for eight years. At the beginning of the ninth year, he was promoted and went to Makabelane Secondary School as the Head of Department in the Science

Department. From there, he applied for the subject advisory job. He is currently working closely with AMESA, trying to encourage teachers to attend AMESA conferences to develop their teaching skills. For these reasons, I requested him to come and assist us with his expertise in the subject in the process of designing a context-based strategy that enhances teaching and learning of mathematical WP.

4.5.10 Teachers from the neighbouring schools

I included two teachers from the neighbouring schools in my research study. The first one participated in mental mathematics competitions and attended several AMESA conferences, while the other person ran a mathematics club as a project intended to assist learners with learning barriers in mathematics, particularly learning barriers in mathematical WP. This encouraged me to ask them to come and assist us in the research study.

4.5.11 Local businessperson

This person was running a local tuckshop. She had attended several meetings conducted by a Small Enterprises Development Agency (SEDA) previously where she had developed her business skills. Then she started her business career by selling clothes and groceries and investing R600,00 per month. Of late, she was also running a “car wash” business where she managed to earn R200,00 per week. She also told me that both businesses were running so well because she was able to save R1 600,00 per month. I decided to include her in the team, since she could maybe assist us with the adding, subtraction, division and multiplication basic skills we did not have as mathematics teachers.

4.5.12 Traditional leader

I co-opted one member from the royal family because he oversaw the community traditional projects run by community members. I noted that there were only two local traditional projects, namely Hlokomela Setso and Botjhaba ba Rona. The major role played by this traditional leader was to ensure that the two projects run smoothly, and that no-one was offended because he or she belonged to another ethnic or cultural

group. In view of the above, I co-opted this traditional leader to assist us with the rules and regulations regarding the use of culture in public spaces such as schools.

4.6 RESEARCH DESIGN

The Bridge School-Profile-Guide (2015:3) claims that research studies could be conducted and designed in different ways. This version is supported by Edwards (2016:19), who indicates that even the settings would vary according to the research plans. In line with the above sentiments, I divided my research activities into seven stages so that they were attainable and easy to discuss, namely,

Stage 1: Pre-meeting (purpose of the study);

Stage 2: Team establishment;

Stage 3: Formulation of the research problem;

Stage 4: Identifying teaching and learning approaches for teaching and learning of mathematical WP;

Stage 5: Lesson preparations and presentations;

Stage 6: Assessments; and

Stage 7: Reflections on the lessons presented.

The next part provides a summary of a plenary table, showing how the research proceedings unfolded.

Activities	Responsibility	Allocated Time
Stage 1: Pre-meeting/plenary meeting	Research participants	1 hour 30 minutes Monday
Stage 2: Establishment of the team/team establishment	Research participants	1 hour Wednesday
Stage 3: Formulation of the research problem/challenge	Research participants	2 hours Fridays
Stage 4: Identifying teaching and learning approaches for WP	Research participants	60 minutes Thursday
Stage 5: Lesson preparations and presentations	Research participants	2 hours Saturday mornings
Stage 6: Assessments	Grade 4 mathematics teachers and other research participants	45 minutes Saturday mornings

Table 4.1: Plenary timetable for the research proceedings

Stage 7: Reflections	Grade 4 mathematics teachers and other research participants	60 minutes After every presentation of a lesson
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This table shows how the research proceedings were conducted. It displays forms of activities that were divided into seven stages so that they could easily be attainable or controlled. It further displays the time allocated for each activity. The next section provides discussions of the seven stages.

Stage 1: Pre-meeting or plenary meeting

Chilisa (2012:254) defines a plenary meeting as a route to be taken by the research participants in the research proceedings. In addition, Mosia (2016:96) highlights that a research route should give a clear indication how progress should be made.

However, for the purpose of the study, I highlighted the following thoughts as my route package to the research participants: goal of the research project, the objectives and strategies to be attained, time-frame for the proceedings of the study, allocation of duties for the research participants, resources required, monitoring and evaluation framework (Chilisa 2012:253-254; Creswell 2012:31-32).

Stage 2: Establishment of the team

Before I could establish a research team, a discussion leader was needed to lead discussions in the research proceedings. I indicated to the team that we needed to have a person who would assist us in facilitating the research proceedings as the discussion leader (Palmer, Larkin, De Visser & Fadden 2010:107-108).

From the background above, I had to provide the team with the three requirements needed for a person to qualify for the position, I listed them as follows. It should be (1) a person who allows multiple of voices to be heard, (2) a person who keeps discussions on track, and (3) finally, a person who always keeps the team updated about the research proceedings (Stalmeijer, McNaughton & Van Mook 2014:9-10). One parent volunteered on the grounds that he would learn from others how to run the research process (Mayo 2003:16-17). Team establishment was done on the merit of selecting research participants who were experts in indigenous knowledge systems, and who also would assist in putting data generated within the context of the study (O'hEocha, Conboy & Wang 2010:120-125; Stalmeijer *et al.* 2014:6-7).

Stage 3: Formulation of the research problem

The purpose of this section is to set out the research problem used in the study. This study was based on Afromontane learners who form part of the social construct of people who live and subsist in mountainous places, drawing from the wealth of their cultural and indigenous knowledge (Da Silva 2015:viii). The Mathematics Curriculum and Assessment Policy Statement (CAPS) defines mathematics as a human activity aiming to build relations in physical and social phenomena and between mathematical objects themselves (DBE 2013:8). This definition creates a platform for Afromontane or indigenous learners' ways of knowing and teaching mathematical WP, grounded in their social and physical context.

However, as a novice researcher who formed part of these people, I noted that the wealth of knowledge that sustained Afromontane or indigenous people was often marginalised in the teaching and learning of mathematics, particularly with regard to mathematical WP (Lucero 2010:127). This claim is confirmed by Moloji (2014:486), who argues that learners who are located in mountainous areas do not perform well in mathematics problem solving because the wealth of knowledge they bring to the classroom is marginalised. The research problem was formulated on the above stipulated discussions.

Stage 4: Identification of teaching and learning approaches to mathematical WP

For the purpose of this study I opted for cooperative learning as the best way to assist learners in learning mathematical WP. Khupe and Keane (2017:27-32) describe cooperative learning as an approach that creates learning flaws or platforms for learners to learn on their own. Bhattacharjee (2015:68-69) declares it a learning strategy that centres around playing central roles in mediating and controlling learning. In the context of the study, I defined cooperative learning as a learning approach whereby teachers create learning spaces for learners to learn mathematical WP on their own, while observing and identifying their cognitive levels of thinking, so that they may be assisted accordingly (Dunley-Owen 2015:6). In addition, Nabie (2015:219) encourages the provision of learning spaces in class and the adoption of teaching through cultural games, as they enhance children's mathematical imagination and thinking. Similarly, Nkopodi and Mosimege (2009:378) advance *morabaraba, diketo*

and other indigenous games as essential games, because they make the teaching of mathematics relevant to the lives of learners.

In line with the above sentiments, I noted that learners could learn mathematical WP better and with understanding when parents are actively involved in the teaching and learning process of mathematical WP. Their contributions in this regard would provide their children with mental skills so that they can think logically in terms of integrating mathematical WP with indigenous games (Co'rdova 2011:37; Kentucky Department of Education 2015:1).

Stage 5: Lesson presentations

During the plenary stage, the team decided that lesson presentations would take two different shapes, namely lesson presentations by teachers and lesson presentations by learners. These lesson presentations were teacher-learner driven, where learners, teachers and other research participants were encouraged to participate actively (Chilisa 2012:254-256).

Lessons were presented in manner that the viewpoints on the nature of knowledge, and truth were shared amongst the research participants before any conclusion was made (Philipp & Williams 2010:1). This nature of knowledge was not transmitted by other research participants to the learners who formed part of the research participants. That means that lessons were not one-directional in the sense that other research participants were only taken as the sources of knowledge (Takaya 2008:3).

Ganly (2012:6) announces positive participation by research participants in the research study as a gain, because the participants could be able to discover new ways of solving sums on mathematical WP. The DBE (2011:8), which encourages teachers to collaborate closely with parents in linking the social, environmental, cultural and economic aspects with mathematics, particularly mathematical WP, supports this claim.

Stage 6: Assessments

This section provides types of assessments that were presented in the research proceedings. It was agreed by the research participants in the plenary stage that these

assessments would take two different forms, namely peer assessment and teacher assessment.

In the peer assessment, learners would be given time to present their lessons. This type of assessment is reflected in the DBE (2011:294) CAPS document, where it states that teachers should create a learning environment or a platform for learners to present their lessons in the form of activities to assess themselves and to reflect on their performance.

Teacher assessment may be used by teachers when they wanted feedback on the success of the approaches they used (Department of Curriculum Management – Malta 2014:17). The research participants further agreed that these assessments would be presented in the form of classwork and homework to identify the problem-solving challenges as early as possible.

Stage 7: Reflections

This section provides the reflection on planning as stipulated in Table 4.1 above. The aim was to check whether the activities went as planned. The next figure provides the reflection process interlinked with teaching and learning of mathematical WP.

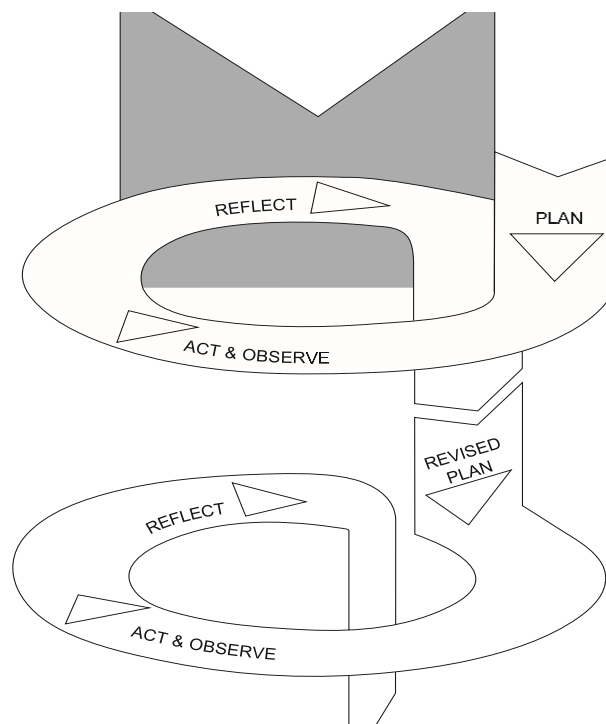


Figure 4.3: Self-reflective cycles (Adapted from: Kemmis & McTaggart 2007)

This self-reflective cycle intends to show that in the research study, proceedings commence from planning, then observation leads to action to be taken, finally to reflect on planning. The cycle further suggests that if the initial planning has failed, it must be revised and observed again before another action is taken. Finally, a conclusion is drawn based on reflecting on the initial planning (Kemmis & McTaggart, 2006:276; PAR Report 2015:3).

However, in the context of this study, the reflection cycle was done on the basis whether learners understood the lesson presented on mathematical WP or not (Nobari 2015:154). If not, the research participants had to reflect on the initial planning, revising and observing it again before another action was taken. Then, a conclusion is drawn based on reflection on the initial planning (Tavares & Parner 2015:7).

4.7 DATA ANALYSIS

This study is part of a series on African epistemology research and gives practical guidance on qualitative data analysis and the presentation of qualitative findings. After an overview of qualitative method in the preceding sections, the study focuses on the fieldwork analysis by using Critical Discourse Analysis (Yasemi & Aghagolzadeh 2015:2). Critical Discourse Analysis (CDA) is used as a tool to analyse the spoken words by the research participants in the study. According to Van Dijk (1995), these spoken words are classified and analysed into three levels, namely textual analysis, (analysing a linguistic text through your own understanding or interpretation), discursive practices (analysing a text by showing power relations), and social practices (analysing a text by showing social inclusion or exclusion). This claim is supported by other scholars stating that CDA is very useful when analysing qualitative data because it builds relationships between people and groups of people, and further analyse the words spoken by these people in different levels, textually, discursively and socially (Wodak 2010:12; Ferati 2012:9; Breeze 2011:493-495). However, Van Dijk (1995:18) further lists a few characteristics, addressing the analysis of CDA, indicating that they might not be sufficient to cover all the work in CDA. In my understanding, this claim indicates that these three levels would not be enough to interpret and analyse all the spoken words by research participants in a given text.

However, in the context of this study, I view CDA as an approach that allows learners to understand their own conscious life so that they may vocalise their problem-solving skills to their teachers to be analysed and interpreted (Ahmadvand 2011:84; Alexander 1985:2). Weiss and Wodak (2003:15) claim the issue of providing learning space for learners to vocalise their problem-solving skills as of vital importance in the learning process of mathematical WP, because it aligns the giver-presenter of the lesson (teacher) and the receiver of the lesson (learner). According to Irigara, Cunh and Braz (2016:14), this alignment brings a mutual understanding between the teacher and learner in the process of learning mathematical WP.

4.8 SUMMARY

This chapter commenced with an introductory part that serves as an orientation. This orientation includes a brief discussion on PAR and its originality. The principles underpinning PAR and the three related theories that were integrated with PAR were discussed. Furthermore, the focus was on epistemology and ontology, the role played by the researcher with the co-researchers in the project, rhetoric, ethics, the research site profile and the research design. Finally, CDA was presented as a tool to show how it was possible to generate and interpret the data from the field analyses.

CHAPTER 5:

ANALYSING DATA, PRESENTING AND INTERPRETING RESULTS ON THE FRAMEWORK TO CULTURE IN THE TEACHING AND LEARNING OF MATHEMATICAL WP

5.1 INTRODUCTION

This study aims to design a context-based strategy to enhance teaching and learning of mathematical WP to the Afromontane learners. This chapter focuses on the presentations, discussions, analyses and interpretations of the empirical data aligned to the five objectives of the study. In the same line of thought, it unfolds and analyses the challenges experienced by the Grade 4 learners in the teaching and learning of mathematical WP. Furthermore, it identifies the solutions addressing the challenges experienced by these learners. Moreover, it entails the analysis of the conditions conducive to the implementation of a context-based strategy for the purpose of sustainability beyond the duration of the study. Equally important, it relates the investigation into the threats and the risks for the implementation of a context-based strategy for teaching and learning of the mathematical WP. Finally, it identifies indicators of success for the implementation of a context-based strategy in the teaching and learning of mathematical WP.

In the same way, this chapter further applies CDA as a tool to get deeper meaning of the text through three different operational levels, namely text, discursive practice and social structure. This is in line with the Community Cultural Wealth as a framework (Van Dijk, 2014:111; Dukes 1993:7-13). This application is presented in the form of written words, pictures, scenarios, theories, research findings, policy and legislation (Crichton, 2013:167). Finally, a conclusion will be drawn from each of the five objectives.

The next section is guided by the need to formulate a context-based strategy to enhance teaching and learning of mathematical WP.

5.2 THE NEED TO FORMULATE A CONTEXT-BASED STRATEGY FOR THE TEACHING AND LEARNING OF MATHEMATICAL WP TO AFROMONTANE LEARNERS

During the plenary meeting held (cf. 4.6.1) with team members, it was noted that the school faced various challenges regarding the teaching and learning of mathematical WP. For this reason, I noted that it was necessary to check the levels at which mathematical WP was taught. It transpired that word problems were taught outside the thinking range of the learners; that is, indigenous games were not considered important; abstract teaching was a game of the day; learning spaces were not created for learners to learn mathematical WP on their own; and for that reason, learners struggled to express their views in English. In addressing these challenges, the empirical data were presented in the form of discussions, pictures, lessons, figures, tables and conversations to show that there was a need to design a context-based strategy that enhances teaching and learning of mathematical WP for learners (Anderson 2010:3; Wills 2015:11-35; Matsikaris, Widmann & Jungclaus 2015:83-85). For ethical reasons, I used pseudonyms in this section to maintain safety and the identities of my research participants, in order to maintain the value and integrity of the data (Saunders, Kitzinger & Kitzinger 2015:617-618). Next, the challenges anticipated by the team during the research proceedings will be discussed.

5.2.1 Challenges of teaching and learning mathematical WP within the context of Afromontane learners

The DBE (2011:3), in the Curriculum and Assessment Policy Statement (CAPS) Grades R-12, based on the principles of social transformation, stipulates that the educational imbalances of the past should be redressed in a way that gives Afromontane learners equal learning opportunities. It further advises teachers to include contextual issues such as social, cultural and environmental issues in the teaching of mathematical WP. In addition, Philipp (2010:25) and Kimaryo (2011:25-26) suggest that whenever teaching of mathematical WP takes place, the lessons presented by teachers should be connected to the environmental setting of the Afromontane learners. In the same way, Morley and Higgins (2014:1) advance the idea that they should also create a conducive environment where Afromontane

learners will be given the opportunity to relate mathematical WP within their contexts in the open discussions.

In a meeting held in the school hall by the research participants, in an attempt to identify the challenge regarding the teaching of mathematical WP outside the context of Afromontane learners, it became clear that mathematics teachers struggled to identify and teach with confident mathematical WP activities relevant to the environmental settings of learners. However, when the proceedings of the meeting were over, Mrs Dikeledi requested me to join her in her Grade 4A mathematics class for lesson observations. During my observations, Mrs Dikeledi presented the lesson in the form of classwork on the chalkboard, and learners used the same board to respond to the question. The lesson was presented as follows:

Mrs Dikeledi: *Learners, I will be going to the chalkboard and writing a mathematical WP to solve. So, then I will be asking one boy and a girl to go to the chalkboard to respond.*

Class: *Ok, Miss!!!*

The next part is guided by an activity presented on the chalkboard in the form of a classwork.

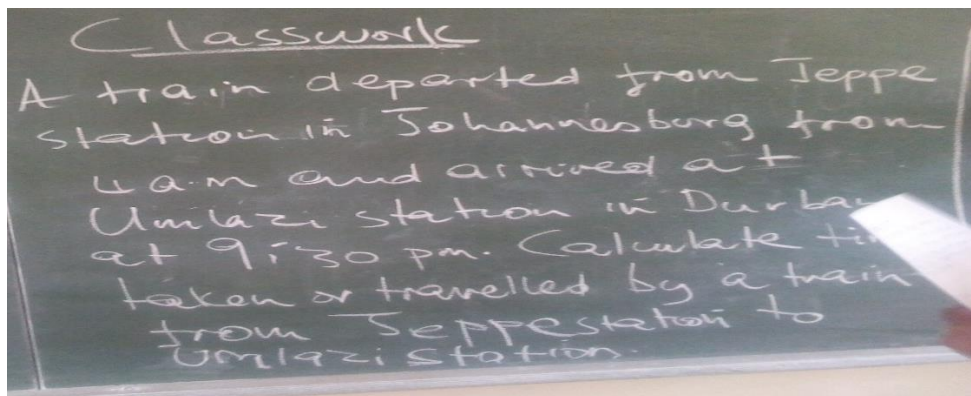


Figure 5.1: Mathematical WP assessment on travelling by train

This activity intends to assess the ability of learners to calculate the time and distance a train from Jeppe Station in Johannesburg to Umlazi Station in Durban. It further intends to show how far Afromontane learners could experience challenges when attempting to use their linguistic skills to interpret activities that are not related to their environment.

Before Mrs Dikeledi's lesson could even start, learners raised their concerns as follows:

Molato: Ma'am, *this activity is going to be difficult because some of us have never been in those places.*

Mrs Dikeledi: *Molato, keep quiet and do your work.*

Dibuseng: *But it is true, Ma'am, we have never been there before!*

Mrs Dikeledi: *I said you must do your work, Busi.*

In the next section, the responses by Monko and Leeto are reflected. However, before they could answer the question, they engaged in a brief discussion with their teacher in the following manner.

Monko: *My friend, do you know the places?*

Leeto: *My friend, a guesswork.*

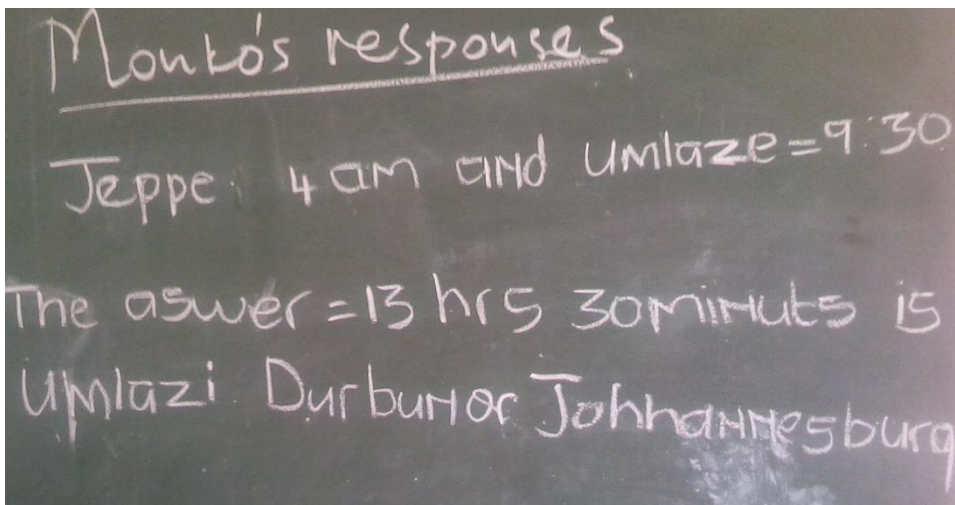


Figure 5.2: Monko's responses

Figure 5.2 intends to show the responses by Monko on the chalkboard, while the next figure provides the responses by Leeto.

Figure 5.3 below shows the responses by Leeto.

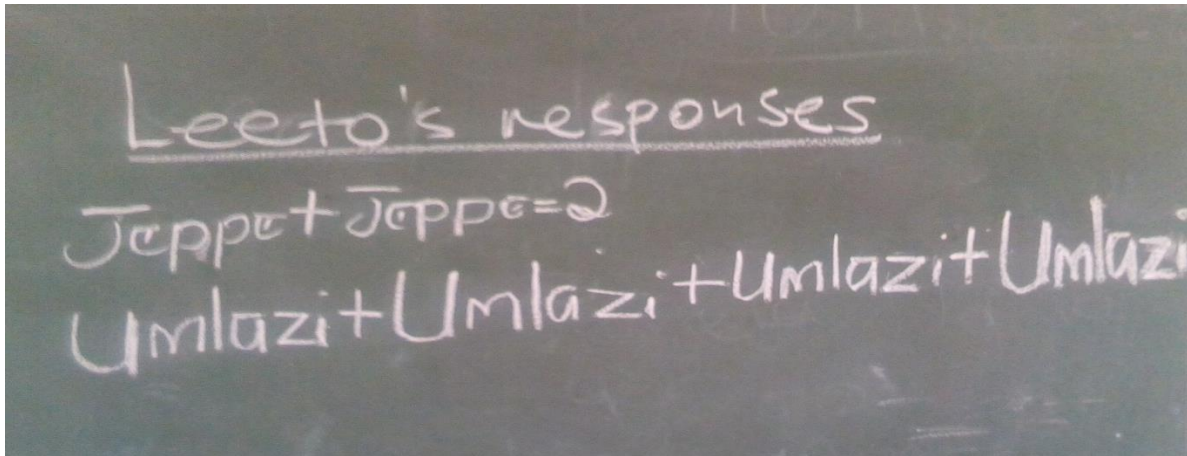


Figure 5.3: Leeto's responses

The next section provides the analysis of a lesson presented by Mrs Dikeledi in the classroom.

In the light of the empirical data presented above, it transpired that the teacher presented the lesson by using the names of places like “Jeppe Station”, “Johannesburg”, “Umlazi” and “Durban” with which the learners were not familiar. During the presentation of the lesson, I walked around in the class to check the learners’ responses. The entire class got the sum wrong, because, to my knowledge, they lack the linguistic skills to interpret the sum correctly. This indicated that Mrs Dikeledi’s teaching was abstract. In view of this claim, Molefe and Brodie (2010:2-3) describe abstract teaching as disruptive, in the sense that elementary learners learn mathematical WP better from concrete teaching to abstract teaching.

In view of the above discussion, the activity presented by Mrs Dikeledi in Figure 5.1 above met its objectives. Next, learners’ responses are discussed.

When looking at the responses made by Monko, the reflected answer on the text was “13 hrs 30 minutes”. This response suggests that Monko estimated the answer by adding the time of departure by train from Jeppe Station in Johannesburg (4 am) to the arrival time of (9:30 pm) to Umlazi Station in Durban (cf. Figure 5.2). The mere fact that Monko estimated the answer, as he articulated the following words, “do you know the places?” suggests that he was unable to use his mathematical skills to find the correct answer. Similarly, Leeto estimated the answer by adding “Jeppe” twice and “Umlazi” four times, which was completely incorrect (cf. Figure 5.3).

In the light of the analysis above, I noted that the teacher's use of unfamiliar names of places in the text might have caused confusion, as could be seen from the learners' responses. This confusion might have led them to reach the wrong solutions. They could at least have estimated their responses to the nearest or acceptable solutions (cf. Figure 5.2 & Figure 5.3). Bad and spontaneous lessons like the one presented by Mrs Dikeledi really kill or fail the future of our children, which should not be tolerated. The lesson itself does not even encourage learners to become creative in class; rather, it derails their future aspirations; that is, they might not even think big about their hopes and dreams (cf. 2.2.2.1). I also noted the learners in the class worked in isolation. Only two learners appeared to be actively involved in the lesson, while the rest were inactive (cf. Figure 5.2 & Figure 5.3), refuting a principle of PAR (cf. 4.2.2.3).

Section 3.2.1 concurs with Section 5.2.1, revealing the same sentiment, namely that mathematical WPs are not taught within the context of the learners (Murray 2012:56-57; McTighe & Seif 2011:7; Alkhalifa 2005:42-43). Surprisingly, an indication that I got from some of the mathematics teachers during my observation time was that they could teach mathematical WP within the context of learners, but they did not have sufficient resources that they could utilise and save as backups.

In conclusion, the teaching and learning of mathematical WP within the context of learners still remain a serious challenge.

5.2.2 Inadequate skills to use indigenous games as teaching aids to teach mathematical WP to Afromontane learners

The Department of Basic Education (2011:5), in the CAPS document, values the implementation of contextual issues such as social, cultural and environmental as key in the teaching and learning of mathematics, particularly mathematical WP. It further acknowledges the richness and inheritance of these additions in the indigenous knowledge systems as important. For these apparent reasons, Nkopodi and Mosimege (2009:397-378) found it necessary to incorporate *morabaraba* as an indigenous teaching and learning aid to teach mathematical WP. In addition, Moloji (2013:38) lists a number of indigenous games such as *dibeke* (a running ball game), *morabaraba* (a board game), *kgati* (a rope-jumping game) and *diketo* (a coordination game) as alternative indigenous approaches that could be utilised by creating a learning space to teach mathematical WP in the classroom. Similarly, Schaelling and

Barta (1998:389) value indigenous games as part of skills and a living tradition that could be stimulated by mathematics teachers to create a culturally relevant environment to teach and learn mathematical WP.

The norm of the school under research was to hold traditional festivals on heritage days, based on looking how they could possibly be linked with mathematics, particularly mathematical WP. During these proceedings, Mr Kodu presented his mathematical WP lesson and Mr Nkgekge (a traditional leader) was given a platform to make his contributions. Mr Kodu presented the lesson in a form of a question.

Mr Kodu: *Class, I am going to present a lesson in a form of a question on indigenous game, hopefully you will respond well in your respective groups.*

Class: *Yes, Sir.*

Mr Kodu: *Ok! Let us see.*

Example:

There were 2 825 spectators at the local soccer match. If 1 215 of the spectators were children, how many were adults?

Lerato: *Sir, is this kind of a mathematical WP sum including indigenous games were you talking about?*

Mr Kodu: *Hopefully so!*

Mr Kodu instructed his learners to divide themselves into two groups, namely Group A and Group B, in order to respond to a question.

Group A's responses

Learners from the group engaged in brief discussions and gave the following solution.

Lerato: *Gents, how can we do this?*

Mpho: *On behalf of the group, we don't know.*

Ultimately, they ended up by responding as follows:

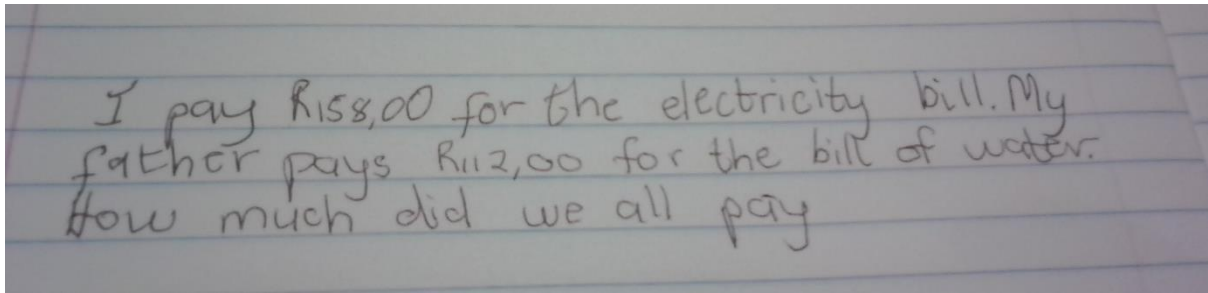


Figure 5.4: Group A's responses

Figure 5.4 presents the responses made by learners from Group A.

Group B's responses

Learners from this group were also engaged in brief discussions, and came up with the following solution.

Morena: *Guys! This is a problem.*

Mokopu: *Keep quiet, Meneer (teacher) is coming.*

The group responded as follows:

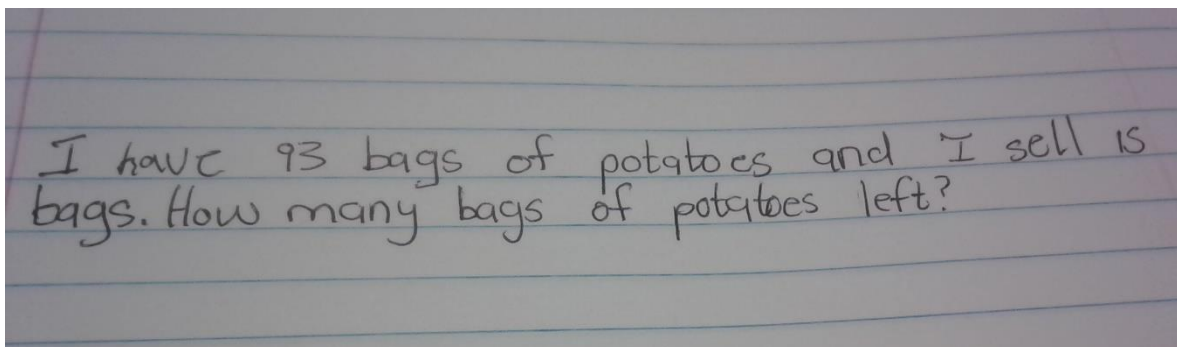


Figure 5.5: Group B's responses

Figure 5.5 above presents the responses made by learners from Group B.

When Mr Nkgekge was given a platform to present his contributions, he stated,

I am appealing to our mathematics teachers to work with us. Seemingly, the integration of indigenous games with mathematics, remains a serious challenge.

Referring to the lesson presented by Mr Kodu above, I noted that Mr Kodu did not integrate his lesson with any indigenous game. His focus was mainly on the number of spectators watching a soccer match on the sports field. In my opinion, viewing of spectators has nothing to do with cultural games and the environment as contextual

factors in the teaching and learning of mathematical WP. The teacher should at least have converted a soccer game into an indigenous game, and thereafter considered how this indigenous game could be linked with mathematical WP (cf. Mr Kodu's lesson above).

When one looks at the learners' responses, it transpired that they seemed totally lost. Instead of responding to the question, Group A talking about the electricity bill (cf. Figure 5.4), while Group B' responses dealt with the selling of potatoes (cf. Figure 5.5). The appeal raised by Mr Nkgekge was an indication that teaching of mathematical WP by using indigenous games remained a serious challenge. Thus, in a democratic country like South Africa today, we do not need to have teachers like Mr Kodu who mislead our children (Kaya & Seleti 2013:31-33). This is contrary to our aspirational capital (cf. 2.2.2.1), which forms part of CCW as our framework.

However, from the empirical data presented in Section 5.2.2 above, merged with studies by Emerson and Fox (2012:19-20), Peercy, Martin-Beltrain, Rebecca and Daniel (2015:868), the Michigan Department of Education (2011:5-14) and PTA 2015:3-4), all agreed with Section 3.2.2 that some teachers still have insufficient skills to integrate mathematical WP with indigenous games. Equally important, during my research observations I noted that some teachers could not believe that indigenous games could be merged with mathematical WP. Others said that an integration could be possible if there were sufficient learning aids to apprehend teaching of mathematical WP.

In conclusion, I noted that teachers and learners are still struggling to combine the teaching and learning of mathematical WP with indigenous games. As a result, learners learn mathematical WP in a hard way.

5.2.3 Abstract teaching in learning mathematical WP becomes a problem to Afromontane learners

Martin (2009:140), in the theory of 'Physically Distributed Learning', adopted an idea that learners located in mountainous places learn mathematical WP much better when they learn new concepts in a concrete context and transfer these concepts to abstract situations. The idea is further supported by Hoe and Jeremy (2014:102), who advance the Concrete-Pictorial-Abstract (CPA) as an approach that mathematics teachers

could employ to achieve the abstract conceptualisation of mathematical WP. That means working towards citing mathematical WP examples from the level where Afromontane learners could see and touch things they talk about, then in the form of pictures and finally, by citing abstract examples. In agreement with the views above, Banegas (2015:61) maintains that the teacher's knowledge in teaching mathematical WP becomes appropriate if he or she engages learners timeously in the lesson. Additionally, the idea is advanced by Ishimaru *et al.* (2015:2), who encourage teachers to work closely and collectively with parents of learners, as they play a key role in developing abstract identities that shape and develop the engagement of learners in the teaching and learning of mathematical WP in the school setting.

In the meeting held in the Grade 4A mathematics class, brief discussions took place regarding abstract teaching as a challenge in the teaching and learning of mathematical WP. To investigate this abstract teaching challenge further, Mr Mothofoela (School Governance Chairperson) and myself as a researcher, took the initiative to join Mr Kodu's class to observe his lesson.

Mr Kodu: *Class! In our lesson today, I am going to present to you a problem-solving lesson based on a division sign.*

Class: *Yes, Sir.*

Mr Kodu: *So, please, everybody must listen carefully.*

Mr Kodu: *If a plumber has toolboxes to work on and each box contains 8 tools, how many toolboxes are needed for 200 tools?*

Mr Kodu: *Now, in order for us to arrive to a solution, we have to say*

$$200 \div 8 = 25$$

Then 25 boxes are needed

Nko: *But Sir, how did you arrive to the answer?*

Mr Kodu: *You have to know division rules.*

Moorosi: *Can you remind us about those rules?*

Mr Kodu: *Nko, can you remind the class?*

Nko: *Sir, It is very hard to remember!*

Mr Kodu: *Ok, Class, go back to your mathematics notes books and check what we did previously.*

Moorosi: *Thank you, Sir.*

Mr Kodu: *Ok, class, let us take out our classwork books and try to answer the following question.*

Activity

Mr Kodu: *Class! Imagine yourself sitting on the banks of the Mississippi River in North America watching the cowries, winkles, bivalves and whelks flying over and over in this river. The cowries, winkles and bivalves took 60 minutes to fly while the whelks took 35 minutes far more to fly. How far more did the whelks fly?*

Learners were talking among themselves. Two of the learners, Lepu and Moleko, articulated the following:

Lepu: *Moleko, I don't understand this question.*

Moleko: *It is hard to understand because we don't know anything here and we have never been in America before.*

Mr Kodu: *class, I hope that you are all done. Now we shall be getting the responses from Lebo and Thabo.*

Lebo and Thabo responded in the following manner in their respective mathematics exercise books:

Figure 5.6 below shows the responses by Lebo in the class.

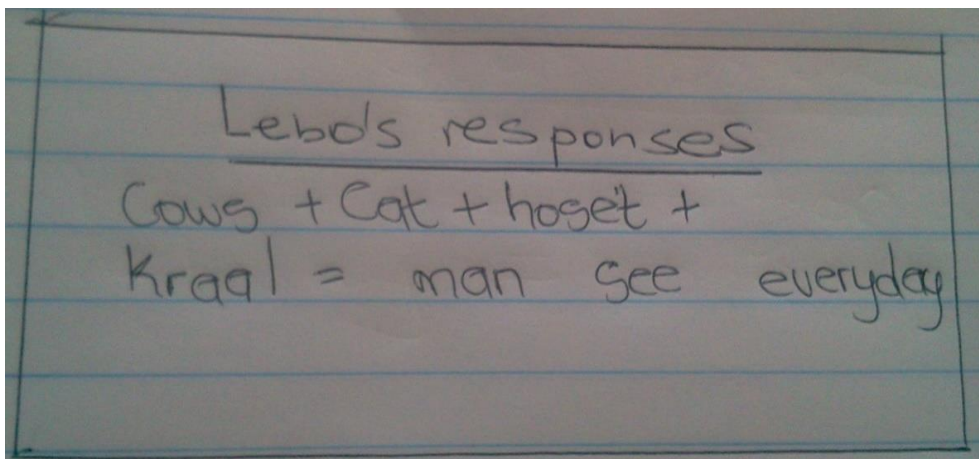


Figure 5.6: Lebo's responses

Figure 5.7 below shows the responses by Thabo in the class.

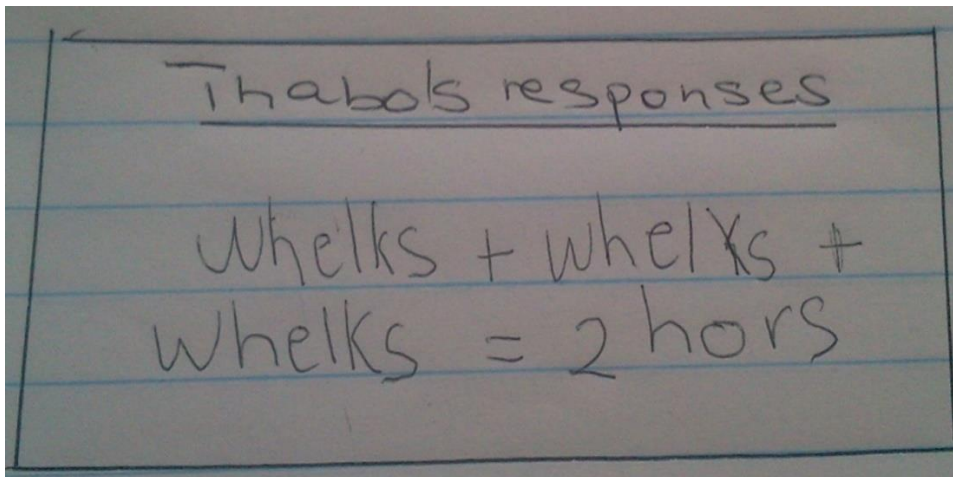


Figure 5.7: Thabo's responses

When Mr Mothofoela was given a platform to make his contributions, he stated,

Teaching mathematical WP in the abstract way remains a challenge because our children are not coping well.

By referring to the lesson presented by Mr Kodu in the class, I noted that the teacher fenced his question with names of places and creatures of that some of the learners would not know. For example, the text,

I don't understand,

suggests that Lepu was trying to figure out a strategy that could assist her in giving with the correct answer, but she failed, while, the text:

never been in America,

from the words articulated by Moleko, suggests that he was also trying to draw mental pictures of the places that would assist in determining the distance between the flying birds on the Mississippi River, but he could not, for the mere reason that he has never been in America before.

When I look at the responses made by Lebo, I noted that the learner was totally lost, because instead of answering a question, she added cows, cat and horses together, which, in my opinion, indicates she was trying to show that these cows, cats and horses were domestic animals, some of which belonged to the kraal, and were always looked after by men on daily basis (cf. Figure 5.6).

Thabo, on the other hand, responded by just adding wheels three times as an indication that they were the same, and he was absolutely wrong (cf. Figure 5.7).

However, the impression that I got from these learners' responses was that the teacher did not teach them how to read and interpret mathematical word problems correctly and with understanding so that they were able to convert them into mathematical symbols (Khupe & Keane 2017:27-31). For this reason, I regard the teacher as a person who constructs knowledge through encoding and decoding information on mathematical WP concepts in an abstract way and, as a result, his learners fail to convey and encode mathematical WP concepts meaningfully through the combination of signs (Cruz & Lapinid 2014:2). This pedagogical practice largely discourages the advancement of mathematical WP, and as a result, learners will not be able to attain their hopes and dreams (cf. 2.2.2.3).

In the light of the above, Section 3.2.3 concurs with Section 3.2.3, as both sections argue that learners in the elementary grades learn mathematical WP in a hard way through abstract teaching (Cope 2015:11-14; Cockett & Kilgour 2015:2-3;; Madden 2010:276-278; Kelly 2006:4).

In conclusion, I noted that abstract teaching and learning of mathematical WP remains a serious challenge. Most of the mathematics teachers maintained that the teacher knowledge in teaching mathematical WP became appropriate when engaging learners in abstract mathematical WP concepts.

5.2.4 Creation of learning environment to learn mathematical WP remains a challenge to Afromontane learners

The Department of Basic Education (2011:13) stipulates in the CAPS document that teachers should create a learning environment for learners to learn mathematical WP freely in class. The National Senior Certificate Examination Diagnostic Report encourages teachers to create learning spaces to accommodate various levels of thinking of learners and motivate them to construct their own contextual meanings during mathematical WP lessons (DBE 2015:7). In addition, Ojose (2008:26-29) advances that by doing so, these learners could even learn the concepts of mathematical WP better and with understanding; equally important, to learn at their

own pace how to integrate their daily activities with concepts on mathematical WP (Young 2015:5-6).

During the open discussions that were held in the school hall by the research participants, the issue on the table was the challenge of creating a learning environment for learners to learn mathematical WP in class. During the discussions, it was noted that the best way to deal with the challenge was to create a learning environment for learners in the hall, ask a teacher to present a lesson while everyone observed, so that at the end of a lesson, the team reflects and reaches a conclusion. Mrs Dikeledi volunteered to present the lesson. The team also requested Mr Lebaka as the mathematics subject advisor to contribute.

Mrs Dikeledi: *Class! Today my lesson is going to be on the application of multiplication sign in problem solving. So, I am not going to allow anyone to ask me questions at this stage.*

Thato: *Why, Ma'am?*

Mrs Dikeledi: *Sometimes you ask funny questions.*

Class: *Everyone was quiet.*

Mrs Dikeledi: *Let me start.*

Lesson:

Mr Brown bought 35 aeroplanes to run his business. His friend bought seven times as many aeroplanes as Mr Brown. How many aeroplanes did his friend buy?

Toloki: *Ma'am, you mean Mr Brown bought helicopters?*

Mrs Dikeledi: *Toloki, are you crazy? Keep quiet, you're disturbing me!*

Mrs Dikeledi: *Ok, Class, let us quickly move to our solution.*

Solution:

Our answer will be $35 \text{ aeroplanes} \times 7 = 245$

Therefore, Mr Brown's friend bought 245 aeroplanes.

Mrs Dikeledi: *Now, let us quickly take out our classwork books and do the following activity from our Grade 4 mathematics Platinum textbook: p. 84, exercise 15.4, no 1.*

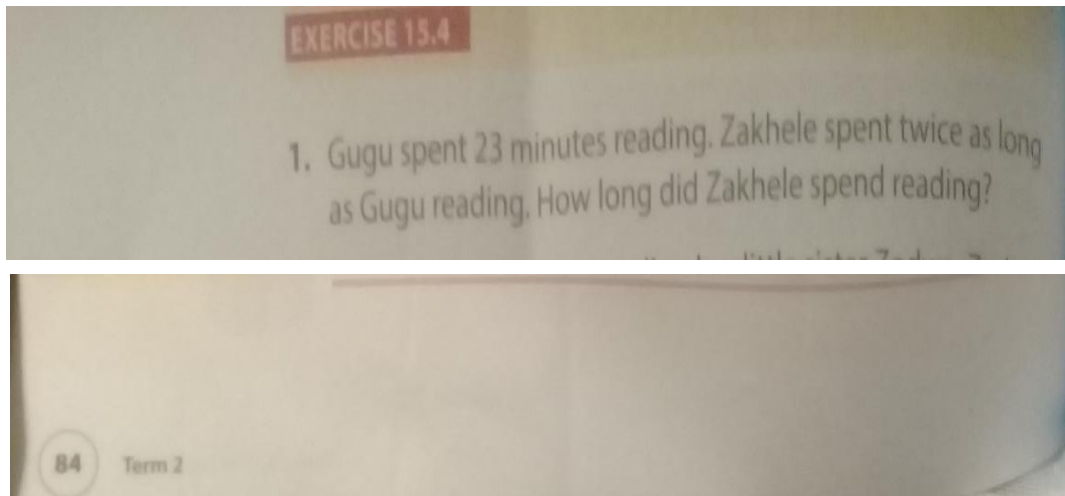


Figure 5.8: Example of an activity given to learners

Figure 5.8 presents example of an activity given by the teacher to the learners in the hall.

Mofoko: *Teacher, I do not understand the meaning of "twice as long as"?* (Before starting to write)

Mrs Dikeledi: *Mofoko, wait, you are disturbing my class.*

Figure 5.9 below presents Mofoko's responses.

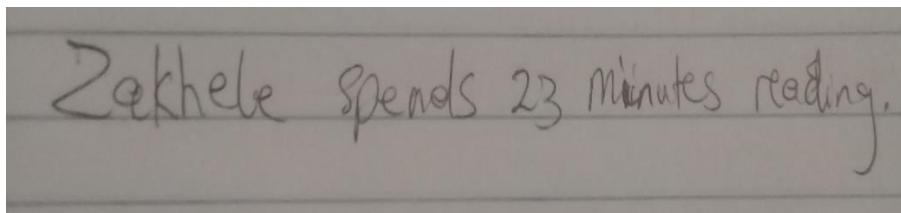


Figure 5.9: Mofoko's responses

Figure 5.10 below presents Nthatuwa's responses.

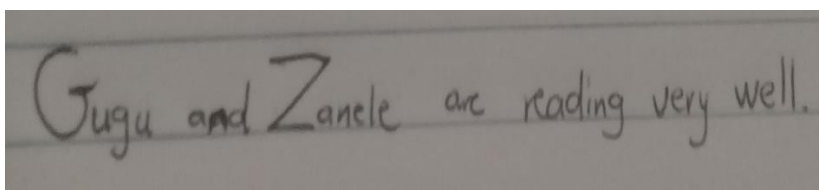


Figure 5.10: Nthatuwa's responses

When Mr Lebaka was given a platform to contribute, he said:

I am appealing to our mathematics teachers to work together with their learners when doing mathematics, particularly mathematical WP.

I noted that the lesson presented by Mrs Dikeledi was self-defensive and teacher-centred, because learners were not given learning spaces to air their views during the lesson. This is affirmed by words articulated by Mrs Dikeledi to Toloki,

Toloki, are you crazy? Keep quiet, you're disturbing me

The text suggests that Tokoki asked the teacher a relevant question, but the teacher was not prepared to listen or to give this learner a learning space. In my view, the fact that a learner was told that he was crazy, was an insult. The team members should have reprimanded the teacher, because I failed to understand how a learner could become crazy when asking a relevant question. In my knowledge, this lesson was against our linguistic capital, because I presume that the learner wanted to use his interpretative skills in language to say that the word 'helicopter' could also be used as 'aeroplane', but was denied a platform to raise that with a confidence (cf. 2.2.2.3). Again, when we look at the words articulated by Mrs Dikeledi to Mofoko,

Mofoko, wait, you are disturbing my class.

The text suggests that the learner wanted to get clarity as far as "twice as long as" appears in the text, but he was denied the right to do so. As a result, he responded in a wrong way (cf. Figure 5.9). I observed that the teacher was wrong, because she should not have treated a Grade 4 learner in that manner. The learner was still young, and deserved to be treated with dignity and respect, so that she would feel free to participate in the next lessons. In my view, this behaviour appears to be destructive, and it is against the aspirational capital (cf. 2.2.2.1) where the objective is to develop the hopes and dreams of learners. Again, when we look at the responses by Nthatuwa, one could see that he was also treated badly (cf. Figure 5.10). However, Mr Lebaka, recognising that the lesson was not presented well, made an appeal that teachers should work together with learners. In my view, the practice was not in line with the principle of PAR (cf. 4.2.2.3), which stipulates that teachers should create learning spaces for all learners to participate in the teaching and learning of mathematics, particularly WP. The practice was also against the epistemological stance (cf. 2.2.4),

where the idea was to create a conducive learning environment for learners to share their ideas in order to reach a common goal.

The ideas of Morley and Higgins (2014:3-10), Ojose (2008:26-29) and Brown (2002:5-7), in Section 3.2.4 concur with the ideas of the other scholars in Section 5.2.4. The scholars are of the same view that creating a of learning environment still remains a challenge in primary schools. However, during my research observations, I was quite shocked to hear from the teachers that they failed to create a learning environment for learners within the 30 minutes allocated for lessons.

The creation of learning environment remains a challenge in the teaching and learning of mathematical WP in primary schools. The majority of learners could fail mathematical WP, not because of their ignorance, but because of lack of time for teacher to create a learning environment.

5.2.5 The difficulties of using English to teach mathematical WP to Afromontane learners

It is evident that mathematics is a language and that this language is an essential tool in the communication of mathematical ideas (McIlwraith & Fortune 2016:16-17). According to Shilamba (2012:26), communication in mathematics becomes an essential tool in class, when both the teacher and learner are actively engaged in the lesson. In addition, Long and Dunne (2014:148) advance that learners' active involvement in the lesson enhances the ability of teachers to identify, inspire and shape the success of communication in the mathematics class. In agreement with the above views, Molefe and Brodie (2010:5-6) declare this enhancement as a gain on the side of the learners, because they would learn how to make sense of topics in mathematics taught by teachers in class, and learn how to eliminate unnecessary mathematical miscalculations, when they try to communicate with the language they understand to get relevant thoughts. To avoid these miscalculations, Machaba (2013:32-33) encourages teachers to create learning platforms for their learners to pose questions or engage in problem solving activities in order to attain both conceptual and procedural understanding of mathematical WP. Belibi Enama (2016:22) states that by so doing, they would stop memorising the algorithms and then reproduce them during tests or examinations.

This part of the study is led by the discussions held in the Grade 4B class around the issue of difficulties regarding the use of English in the teaching and learning of mathematical WP. Mr Kodu volunteered to present a lesson regarding the matter on behalf of the research participants. Mr Katiba (parent) and Mrs Lesiba (former Grade 4 mathematics teacher) were also involved in the lesson.

Mr Kodu: *Morning, Class.*

Class: *Morning, Teacher.*

Mr Kodu: *Fine, I am going to present one example on problem solving and thereafter you will be given one activity to write.*

Class: *Yes, Teacher.*

Lesson:

Example

Find the difference between 36 322 and 12 211 and then double your answer.

Kemedi: *Teacher, what do you mean by a difference?*

Mr Kodu: *Wait, you shall see.*

Solution

$$\begin{array}{r} \text{Difference} = 36\ 322 \\ - 12\ 211 \\ \hline 24\ 111 \end{array}$$

Then the difference is 24 111

By doubling the difference we shall have: $24\ 111 \times 2 = 48\ 222$

Activity

Say your father has 95 couches. Your mother has twice as many couches as your father. The son has three times as many couches as his mother.

2.1 How many couches does the mother have?

2.2 How many couches does the son have?

Figure 5.11 below illustrates the responses by Morongwe, who portrays “mother” as a woman and “son” as a boy.

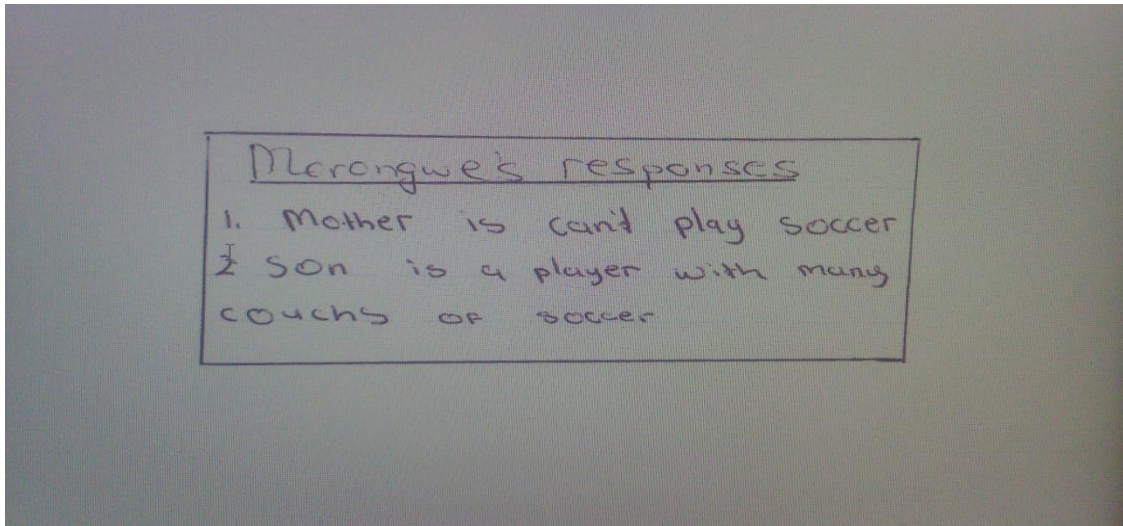


Figure 5.11: Morongwe's responses

Figure 5.12 below illustrates the responses by Morena, who portrays “mother” as a woman and “son” as a boy.

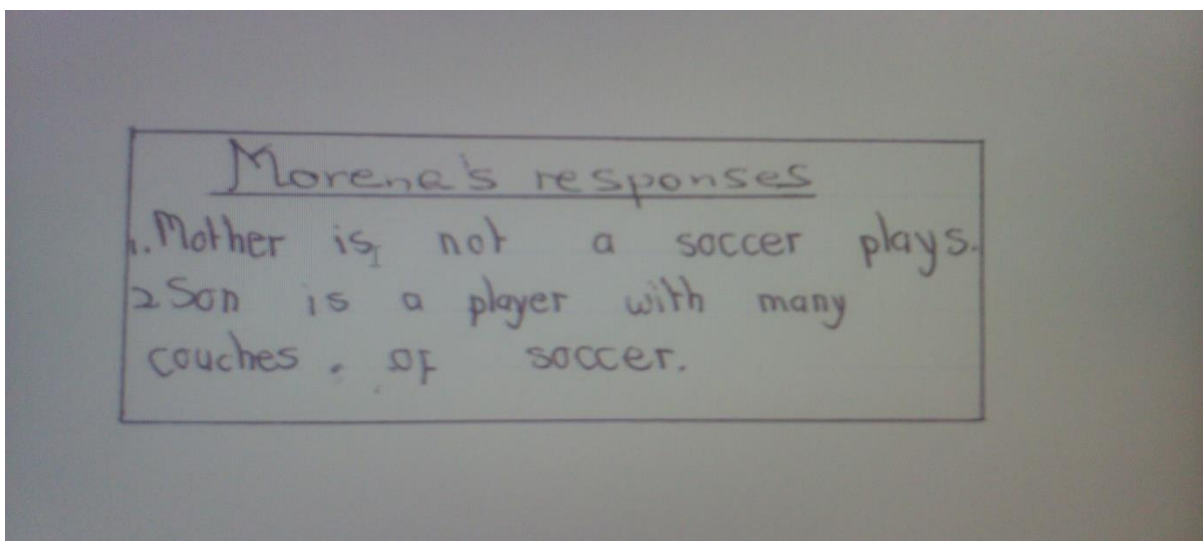


Figure 5.12: Morena's responses

When Mr Katiba was given a platform, he stated,

Matitjhere a rona a sebediswe English boholo ba nako bana batle ba e tlwaele ha ba ithuta diWP. (Let our teachers use English more often so that our learners get used to it when doing mathematical WP.)

When Mrs Lesibe contributed the following words,

Ke bona bana ba rona ba na le bothata ba ho utwisisa diWP ka sekgowa. (I noted that our children learn Mathematical WP in the hard when using English.)

I assume that, with mathematics as a subject, which has its own language, the most important thing is to define the key concepts in teachers' lesson plans. I learnt from the lesson presented by Mr Kodu above that he could not clarify some of the mathematical WP concepts, for instance,

'twice as many'; 'three times as many'; 'difference'; and 'double',

to put his learners in the picture of what is happening in the lesson (cf. a lesson presented by Mr Kodu above). To my mind, justice was not done to the learners. This is against our aspirational wealth, where the aspirations of learners should be considered when teaching mathematical WP (cf. 2.2.2.1). The responses by learners suggested that they were not able to differentiate between the texts

'couch' and 'coach'.

This indicates both thought the teacher was talking about a *'coach'* on the soccer field (cf. Figures 5.11 and 5.12 above), and both were wrong. The teacher should be blamed, because the use of the phrases such as

'difference', 'double' and 'couch'

denied them the opportunity to get a correct version of the lesson, and the teacher failed to create a platform to share their knowledge and understanding. This is against the epistemological ideology (cf. 2.2.4), namely to create a platform for learners to share their knowledge on mathematical WP. I also noted that the lesson was exclusive, in the sense that the teacher did not respond positively to the question posed by Kemedi:

mean by a difference?

This text suggests that Kemedi wanted to get clarity on behalf of the class about the concept,

difference

but he could not, and as a result, he failed to assist his classmates in solving the sums correctly.

However, the contributions made by Modupeola (2013:93) and George (2015:56) agree with Section 5.2.5 above, and Section 3.2.5, namely that elementary learners

still experience challenges of learning mathematical WP through the use of English as a language of learning and teaching.

In conclusion, I noted that elementary learners still learn mathematical WP in a hard way when using English as LOLT.

5.3 SOLUTIONS FOR THE CHALLENGES IDENTIFIED

In Section 5.2, ample challenges were identified in the teaching and learning process of mathematical WP, and five were found to be relevant to CCW as the framework. In addressing these challenges, mathematics teachers attended developmental workshops and cluster of Professional Learning Committees (PLCs) to enhance their existing skills in mathematics, particularly mathematical WP. Having attended the workshops and cluster PLCs, the research participants identified and presented components of the solutions as follows:

- to show how teaching and learning of mathematical WP occur within the Afromontane context;
- to show the importance of using indigenous games to teach and learn mathematical WP;
- to show the importance of concrete teaching of mathematical WP to the learners;
- to show the importance of creating learning experiences for learners to learn mathematical WP in class; and
- to show the importance of using English as LOLT in the process of teaching and learning mathematical WP.
- In the next section, I present universal activities that form part of the components of solutions, the aim was to enhance teaching and learning of mathematical WP not only the activities presented to Afromontane learners, but also to other learners globally population (Matlala 2015:18-23; Young 2015:2-5).

5.3.1 Teaching mathematical WP within the Afromontane context

The DBE (2011:4) in the CAPS document claims active and critical approaches as the best practices that could be utilized to teach and learn mathematical WP within the context of learners. In addition, McCain and Bryant (2015:4) recommend collaborative and hands-on strategies as the best approaches that could be used to teach and learn mathematical WP within the learners' context, rather than rote and uncritical learning, where learners are forced to learn within certain given boundaries. In the same way, Dunley-Owen (2015:3) recommends open learning as one of the strategic plans that could be employed in the teaching of mathematical WP, because it allows learners to create their own context-based ideas about mathematics and take responsibility for their own learning. Equally important, Torkey (2012:6-11) encourages mathematics teachers to cite work on mathematical WP related to things they see and touch.

The team met in the Grade 4B class where the issue around the table was to find possible and effective ways of teaching and learning mathematical WP within the context of the learners. To attain this objective, team members highlighted that they should work in collaboration. Mrs Dikeledi volunteered to present a lesson on the issue on the table. Grade 4 learners, one of the neighbouring teachers, and a former Grade 4 mathematics teacher contributed to the lesson.

Mrs Dikeledi: *Class, today in my lesson I am going to show you how possible could we teach and learn mathematical WP within your context as learners.*

Class: *Yes, Ma'am.*

Lemao: *Mme, re ya tseba hore in context re lokela ho sheba le ho nahana ka ntho tse reptileng. (Ma 'am, we all know that within our context we have look and think about physics objects around us.) (A learner contributing)*

Mrs Dikeledi: *Yes, good, my boy.*

Malefa: *Mehlala ya dintho tse re potileng ke ditafole, ditulo, dikoloi, matlo le tse ding (Examples of things around us are tables, chairs, cars, houses and others) (a learner making a contribution)*

Mrs Dikeledi: *Very good, my girl. Let me proceed with my lesson,*

Example:

Ntswaki has ten sweets. She shares her sweets equally amongst three of her friends.

Question

How many sweets were shared amongst her three friends?



Figure 5.13: Sweets activity




This activity intends to show that how possible could learners learn mathematical WP by using concrete objects like sweets.

Mrs Dintwe: *Can I come in, Mrs Dikeledi? To show how sharing is done to the class.*
(A mathematics teacher from one of the neighbouring schools)




Mrs Dikeledi: *Oh! Me Dintwe, my colleague, please come forward, you are welcome.*

Mrs Dintwe: *Class, let me illustrate to you how sharing of these sweets is done.*

Mrs Dintwe demonstrates the sharing process to the class in the form of a lesson.

First friend =  +  +  = *three sweets*

Second friend =  +  +  = *three sweets*

Third friend =  +  +  = *three friends*

So, out of ten sweets, each friend will get three sweets. Then, Ntswaki will be left with one sweet. Now, to share the remaining sweet amongst Ntswaki's three friends, Mr Lefa will show us how the sharing process is done, Mr Lefa, over to you.

Mr Lefa: Thanks, Mrs Dintwe, the sharing process will be done in the following manner. (A former Grade 4 mathematics teacher.)

Mr Lefa demonstrated to the class how the last part of sharing is done.



Mr Lefa: Class, let us look at the picture. This picture suggests that Ntswaki managed to share the remaining sweet in thirds, so that each of her three friends may have an equal share of one third. The total number of one thirds of the whole sweet shared amongst her three friends can also be done in the following manner

$= \text{one third of a whole sweet} + \text{one third of a whole sweet} + \text{one third of a whole sweet} = \text{one sweet}$

Mampe: Ma 'am, let me tell the class how much each of her three friends would get. One each from her three friends will get a share of three sweets and one third of the whole sweet. (Another learner contributing)

Mrs Dikeledi: Shine, Mampe, you got it right. Thank you, colleagues, for showing collaborative support. Now, to show your understanding I want you to respond to the following activity in your respective groups.

Activity

Ntate Motaung collected eight eggs on Monday, four on Tuesday, and five on Wednesday. On Friday, he took them to market. Two eggs were broken on the way. How many eggs did he have to sell?



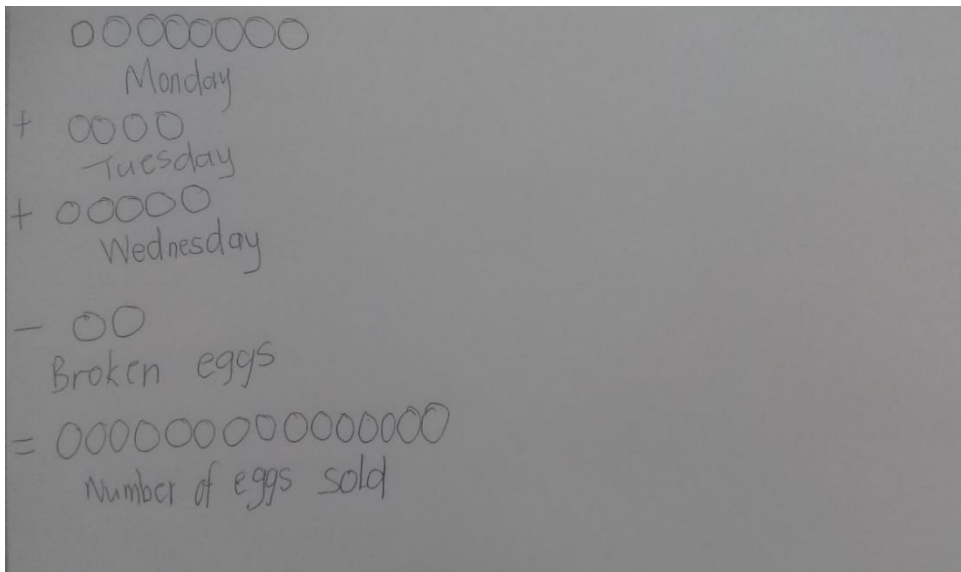


Figure 5.14: Group C's responses

The figure presents the responses by learners from Group C.

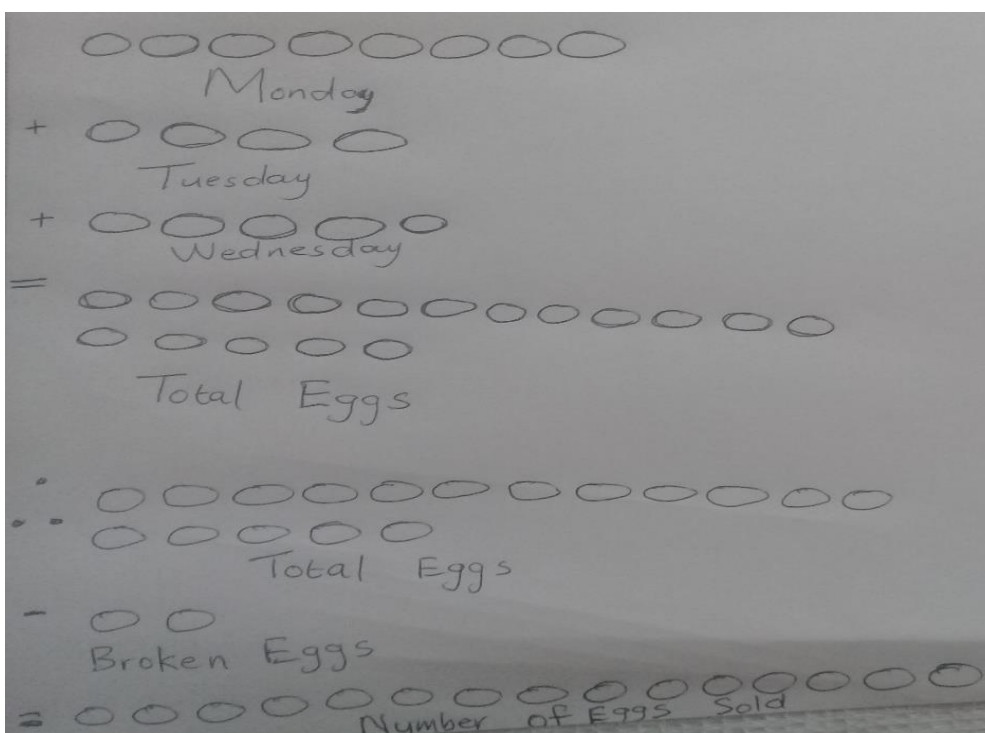


Figure 5.15: Group D's responses

This figure presents the responses made by learners from group D.

I assume that a lesson presented by Mrs Dikeledi met its objectives, because she cited sweets as an example for the activity. In my knowledge, sweets, stones, trees, tables, eggs form part of universal activities (Matlala 2015:18-24). The use of sweets and eggs appear to be concrete objects that fall within the Afromontane context (cf. Figures

5.13, 5.14 & 5.15). Positive contributions that were made by teachers and learners in the lesson indicated that they were working together as a team to meet the objective of the lesson (cf. contributions made by teachers and learners from the texts). For this reason, I noted that these collaborative efforts made by teachers and learners were in line with the principle of PAR (cf. 4.2.2.3), and also in line with the recommended practices alluded in the opening paragraph. It was clear that part of the lesson presented by Mr Lefa was intended to develop mathematical interpretation skills of learners. For example, the text,

one third

indicates that one third was written in words and it could be converted into a symbolic language as $\frac{1}{3}$. This interpretation skill was in line with linguistic capital (cf. 2.2.2.3), where the objective is to develop the intellectual and social skills of learners to communicate mathematical WP effectively and efficiently. I also view the exchange of ideas by teachers and learners during the lesson as an inventive idea that worked towards building the team, in line with the epistemological stance (cf. 2.2.4) where knowledge is claimed to be good when shared by people. By looking at the discursive interaction between learners and teachers, one potential finding is that teachers and learners were working together as a team; no discomfort could be identified.

In line with the above, scholars like Matsuura *et al.* (2013:3, 10) and Zuber-Skerritt (2015:13-14) share the same sentiments, namely to state that the empirical data presented in this Section 5.3.1 concur with the those in Section 3.3.1, namely that learners could learn mathematical WP better and with understanding within their contexts.

In conclusion, the team was exposed to different ways which indicated collaboration amongst them. This circulation of power produced different forms of performance among learners, teachers and the entire team. Positive contributions or inputs made everyone in the team aware of multiple forms of knowledge that could assist learners in learning mathematical WP better.

5.3.2 Employing indigenous games to teach mathematical WP to Afromontane learners

One of the crucial specific aims stipulated in the CAPS document by the DBE (2011:8), is that mathematical WP should be taught within the cultural, environmental and economical context of the learners. In addition, Jarmila and Charles (2001:28) and the Ministry of Education (2014:4-6), maintain that learners could learn mathematical WP better through indigenous games, if ever teachers create conducive learning spaces to demonstrate and identify mathematical skills related to the games. Wijaya, Van den Heuvel-Panhuizen and Doorman (2015:45) further advance that the games used should be easily accessible and make sense when connected with mathematical skills, particularly skills in mathematical WP. In the same way, UNESCO (2015b:11) encourages teachers to equip learners with the relevant indigenous knowledge and skills so that they may connect and facilitate developments of teaching mathematical WP within their contexts by using indigenous games.

In an attempt to identify the relevant indigenous game to teach and learn mathematical WP, few indigenous games were presented around the discussion table by team members. Some of the indigenous games identified were *morabaraba* (a board game), *kgati* (a rope-skipping game) and *diketo* (a coordination game). For the purpose of the study, *kgati* was identified as a relevant and indigenous game to map a way forward. The first part of the lesson was presented in the form of a scenario, and the second part in the form of a table, where learners were requested to complete it in their respective groups. Mr Sepoti (another Grade 4 mathematics teacher), with the assistance of the team, presented the lesson.

Lesson

Mr Sepoti: *Good day, learners*

Class: *Good day, Ntate Sepoti.*

Mr Sepoti: *My dear learners, today, I am going to be your new mathematics teacher for a while because the team around us here requested me to make a presentation on indigenous games and mathematical WP, and my presentation will be in the form of a scenario.*

Class: *Yes. Sir.*

Botle: *Nna ke tseba diindigenous games hore ke eng. (I know what indigenous games are)* (A learner making contributions)

Mr Sepoti: *Thank you, my girl.*




Tharollo: *Mehlala wa tsona ke diketo, morabaraba, kgati le tse ding.* (Examples of indigenous games are coordination game, a board game, a rope –jumping game and others) (A learner contributing)

Mr Sepoti: *I am happy to see that you all know the indigenous games. You are making my job much easier. Now, let us look at how kgati as an indigenous game could be integrated with mathematical WP and make sense.*

The scenario:



Figure 5.16: Kgati (A rope-jumping game)

The above figure illustrates three schoolchildren playing *kgati* as an indigenous game. The game is normally played by the minimum of three players with two players swing the rope to form a loop and swing it low across the surface of the ground while the third jumps over it when it reaches the lowest point. When one looks closer at the game, one learns that different geometric shapes such as half-circles or semi-circles; acute and obtuse angles are formed. When the loop touches across the surface of the ground, it forms a semi-circle facing upwards  , and when the loop is woven up, it forms another loop facing downwards  . When one joins the two loops, a full circle is formed  .

From the scenario highlighted above, I requested Mr Kodu to present the first part on the table below to get a clear picture how one would complete the rest.

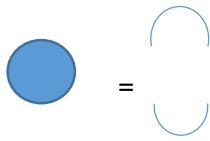
Geometric pattern	Numeric pattern	WP created
	$1 = \frac{1}{2} + \frac{1}{2}$	One full swing is half a loop of the rope facing upwards plus half a loop of the rope facing downwards

Table 5.1: Activity of kgati as an indigenous game

This activity intends to show how indigenous games could possibly be intertwined with teaching and learning of mathematical WP to make sense. It further portrays the ability of learners to interpret and convert practical knowledge into abstract knowledge.

Mr Sepoti: *Over to you, Sir.*

Mr Kodu: *Thank you, Sir.*

Then, after a pause, Mr Kodu presented the first part of the table as follows:

The table consists of four columns, namely 1st column, 2nd column, 3rd column and 4th column. The 1st column presents the nose of full swings made by the rope in the game; the 2nd column presents geometric shapes formulated from observing the number of swings in the first column, the 3rd column presents numeric patterns formulated by observing different shapes from the second column, Then, the 4th column presents mathematical WP formulated from converting symbolic patterns into words.

Mr Sepoti: *Thank you for the explanation, Sir.*

Mr Kodu: *Yes, Sir.*

Mr Sepoti: *Class, is your turn now. You may start completing the table.*

Class: *Yes, Ntate.*

Next, the learners were divided into two groups, Group I and Group H, and they were encouraged to participate in their respective groups. The responses were as follows:

Figure 5.17 presents the responses by the learners from Group I.

Nos of full swings	Geometric pattern	Numeric pattern	WP created
1	○	$1 = \frac{1}{2} + \frac{1}{2}$	One full swing is half loop of the rope facing upwards plus half loop of rope facing downwards.
2	○ ○	$2 = 2(\frac{1}{2}) + 2(\frac{1}{2})$	Two full swings is two by half loop of the rope facing upwards plus two by half loop of rope facing downwards.
3	○ ○ ○	$3 = 3(\frac{1}{2}) + 3(\frac{1}{2})$	Three full swings is three by half loop of the rope facing upwards plus three by half loop of rope facing downwards.
4	○ ○ ○ ○	$4 = 4(\frac{1}{2}) + 4(\frac{1}{2})$	Four full swings is four by half loop of the rope facing upwards plus four by half loop of rope facing downwards.

Figure 5.17: The responses by learners from Group I

Figure 5.18 presents the responses by the learners from Group H.

Nos of full swings	Geometric pattern	Numeric pattern	WP created
1 full swing	○	$1 = \frac{1}{2} + \frac{1}{2}$	One full swing is half loop of the rope facing upwards plus half loop of the rope facing downwards.
2 full swings	○ ○	$2 = 2(\frac{1}{2} + \frac{1}{2})$	Two full swings is two by half loop of the rope facing upwards plus half loop of the rope facing downwards in brackets.
3 full swings	○ ○ ○	$3 = 3(\frac{1}{2} + \frac{1}{2})$	Three full swings is three by half loop of the rope facing upwards plus half loop of the rope facing downwards in brackets.
4 full swings	○ ○ ○ ○	$4 = 4(\frac{1}{2} + \frac{1}{2})$	Four full swings is four by half loop of the rope facing upwards plus half loop of the rope facing downwards in brackets.

Figure 5.18: The responses by learners from Group H

Mr Sepoti: Yes, I just want to thank Mr Kodu and the entire team for the opportunity.

Mr Kodu: You are welcome, Sir, thank you.

The next part is guided by data analysis.

The lesson met its objective by using *kgati* as an indigenous game in the teaching and learning of mathematical WP. This claim is supported by teachers and learners who worked together as a team (cf. the scenario presented by Mr Sepoti, the second part

presented by Mr Kodu and the groups' responses). For this reason, I noted this lesson as a joint venture working in line with the principle of PAR (cf. 4.2.2.3), where people contribute their unique skills. This joint venture concurs with the views stipulated in the paragraph above that if teachers create conducive learning spaces for their learners to learn mathematical WP on their own, learners would be able to demonstrate and identify mathematical skills related to the games, as well as connect and facilitate developments of teaching mathematical WP within their contexts by using these games.

This joint venture was in line with the navigational wealth (cf. 2.2.2.2), because learners were given a platform to complete Table 5.1 above on their own, and the responses were extremely well (cf. Figures 5.17 & 5.18). This joint venture is further justified by the epistemological stance (cf. 2.2.4), which acknowledges sharing of knowledge as a useful vehicle of thoughts by which learners could learn new skills from others on how they could go through the problem solving challenges. Furthermore, this joint venture was inclusive, in the sense that a platform was created for the team to participate freely in the lesson (cf. the scenario presented by Mr Sepoti, and the second part presented by Mr Kodu and the groups' responses).

In the light of the empirical data presented in Section 5.3.2 above, I learnt that the ideas presented by Roth and Radford (2011:5-6) and Headden and McKay (2015:4) from this section concur with the ideas in Section 3.3.2, namely that, by creating learning spaces, learners would be able to demonstrate and identify mathematical skills related to the games, and connect and facilitate developments of teaching mathematical WP within their contexts by using these games.

Employing indigenous games to teach and learn mathematical WP advances the idea that a learner can demonstrate mathematical skills through indigenous games, as well as identify, integrate and facilitate progresses of teaching mathematical WP within their contexts by using these games.

5.3.3 Concrete teaching of mathematical WP to the Afromontane learners

According to Blomeke, Suhl and Kaiser (2011:157-161), teaching and learning of mathematical WP become interesting to learners when teachers are well conversant with the content of the concept. UNESCO (2005:10-21) agrees that it becomes

interesting to observe teachers creating learning spaces for learners to learn mathematical WP through the manipulatives. In addition, Kelly (2006:187-191) advances an idea that learners could learn mathematical WP better when classroom activities are concretised in such a way that they cater for various cognitive levels of thinking. This idea is further confirmed by the DBE (2011:10), in the CAPS document, where it encourages teachers to plan for diversity when teaching mathematics, particularly mathematical WP. In the same way, Jantan (2010:3-5) agrees that diversity planning should serve as a vehicle of thoughts to address the anticipated problem-solving misconceptions that might occur during and after the lessons.

When the team met in the Grade 4B class to discuss possible ways of teaching mathematical WP in a concrete way, it was suggested that this could be attained through the presentation of lessons. Mr Kodu, as a Grade 4 mathematics teacher, and Mr Letuba, a neighbouring Grade 4 mathematics teacher, were both requested by the team to demonstrate how concrete teaching could possibly assist learners in learning mathematical WP better and with understanding. The lesson was presented as follows:

Mr Kodu: *Class, today I am going to present to you a mathematical WP lesson using concrete objects like cars, tables, chairs ...*

Leifo: *Ntate Kodu, ere ke qetele hle, le majwe, dibotlolo, dikolo le tse ding (Sir, let me finish, please, stones, bottles, schools and others (a learner interrupting with the aim of providing more examples).*

Mr Kodu: *Mpatuwa! Come up with your own examples, please!*

Mpatuwa: *Teacher, nna ke tseba borotho le tee (Teacher, I know bread and tea) (a learner responding)*

Mr Kodu: *Thank you very much. Now, let us work together in the next presentation.*

Example:

Morena and three of his friends are driving donkey carts. Each cart is pulled by two donkeys. Each cart is loaded with eight bags of wood.

Questions

A) How many drivers are there altogether?

B) If we have eight donkeys, how many two donkeys less will we have?

Now, the next picture will help us to get the answers correct.

Learners and other team members looked at the picture. The picture was demonstrated as follows:

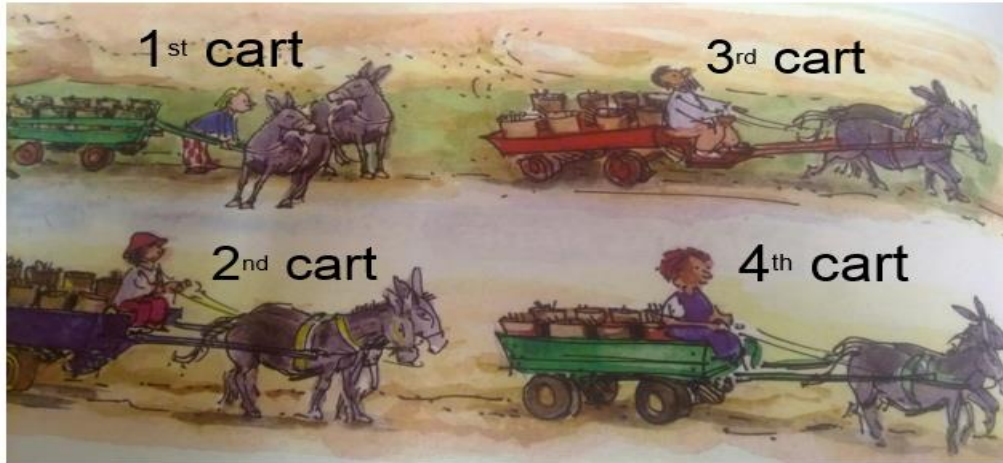


Figure 5.19: Donkey cart activity

This activity intends to show how teachers can use donkey carts as concrete objects to teach mathematical WP to learners.

Mr Letuba: *I want to advise our learners as team members to keep on watching at the picture when the lesson is in progress, because the whole presentation will be on the picture.*

Ntlo: *Sir! Sir! Nka araba ya pele* (Sir! Sir! I can answer the first one) (a learner showing an interest)

Mr Letuba: *Go on, my child.*

Ntlo: *Titjhere ere ruta hore rena le dravara tse four.* (From our picture we learn that we have four drivers), *and I can show you how to get a solution.*

Ntlo demonstrated the answer as follows:

$$\begin{array}{ccccccc}
 \text{A)} & 1^{\text{st}} \text{ cart} & & 2^{\text{nd}} \text{ cart} & & 3^{\text{rd}} \text{ cart} & & 4^{\text{th}} \text{ cart} \\
 & \begin{array}{c} \img alt="Small image of the 3rd cart driver" data-bbox="201 771 294 841" \\ \end{array} & + & \begin{array}{c} \img alt="Small image of the 2nd cart driver" data-bbox="367 771 460 841" \\ \end{array} & + & \begin{array}{c} \img alt="Small image of the 3rd cart driver" data-bbox="562 771 655 841" \\ \end{array} & + & \begin{array}{c} \img alt="Small image of the 4th cart driver" data-bbox="724 776 817 846" \\ \end{array} & =
 \end{array}$$



= four donkey cart drivers.

Mr Kodu: *Thank you, my boy.*

Lenong: *Sir, can I do the next one?* (Another learner making a request)

Mr Kodu: *With pleasure, my girl.*

Lenong presented the second answer as follows:

Lenong: *Nka araba like this* (I can answer like this)

B)



So, *ho setse ditonki tse six kaofela.* (So, we have six donkeys left altogether.)

Mr Kodu: *Thank you for the good presentation, my girl.*

Mr Kodu: *Thanks, learners and colleagues, for your support. Now, learners will do the next part of our lesson in their respective groups. But learners who specifically will present this one, will be from Group E and Group F.*

Activity:

Mr Sewapa counted the birds on the telephone pole every morning.

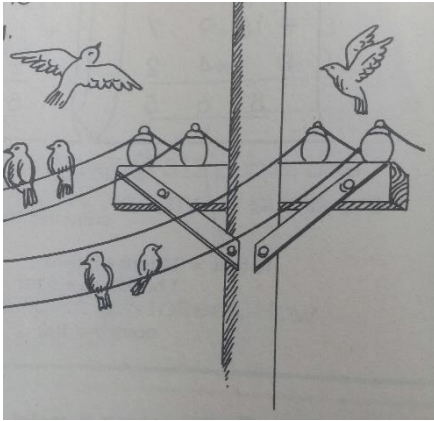


Figure 5.20: Birds activity

This is what he found:

Monday – two birds

Tuesday – two birds

Wednesday – four birds

Thursday – three birds

Friday – one bird

How many birds did he count altogether?

Figure 5.21 presents the responses made by the learners from Group E.

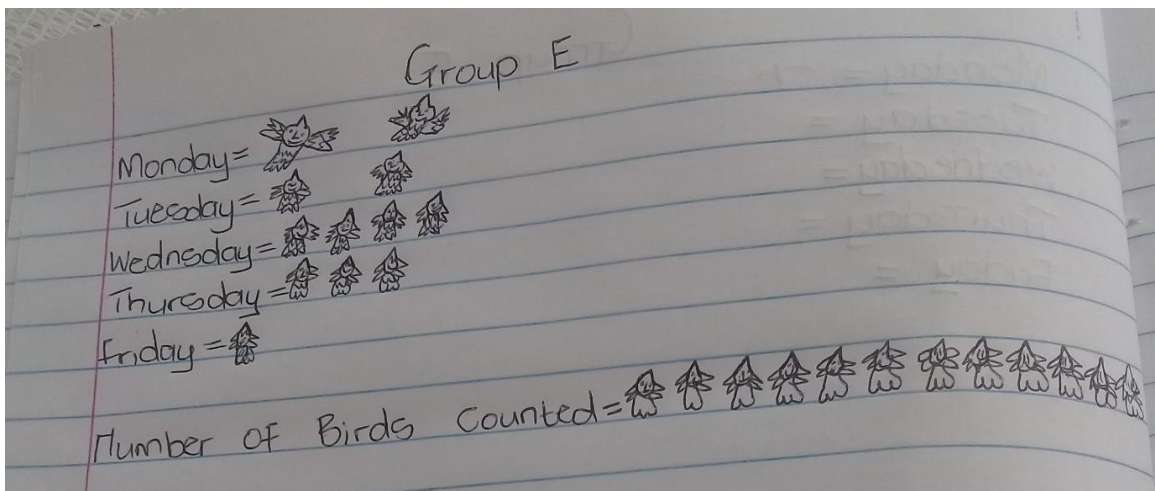


Figure 5.21: Group E's responses

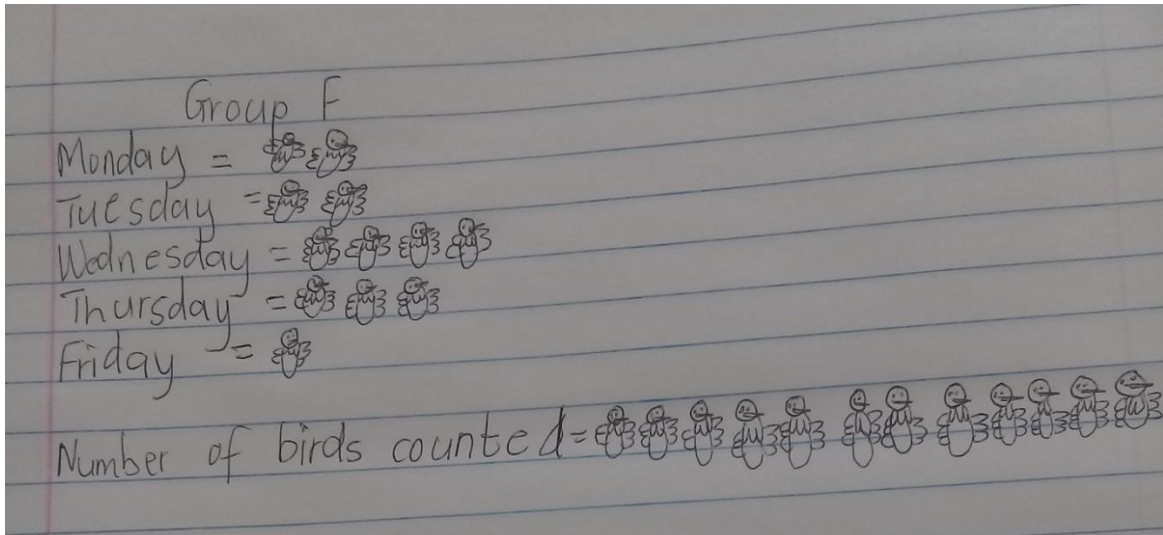


Figure 5.22: Group F's responses

This figure presents the responses by learners from Group F.

The next part of this section is presented by using analyses of the responses made by learners during the lesson, and these learners' responses after the lesson to the activity provided by the teacher. The first part is led by the analyses of the learners' responses during the lesson, and the second part is led by the learners' responses after the lesson. The first part is presented as follows:

Analyses of the responses made by learners during the lesson.

Analysis of the responses made by Ntlo (First learner)

“ 1st cart 2nd cart 3rd cart 4th cart

+ + + + =

= four the total number of donkey cart drivers altogether”

This text shows that Ntlo managed to show his counting skill. The learner had managed to pick up from the question that he had to introduce a positive sign (+) in

order to tackle the question appropriately. After Ntlo had realised that a positive could assist him in getting the total number of donkey-cart drivers, he had to observe the picture and start by adding the drivers of the donkey carts one by one, namely from the first donkey cart to the fourth donkey cart, in order to get a total of four donkey-cart drivers. (For example: first donkey-cart driver plus second donkey-cart driver plus third donkey-cart driver plus fourth donkey-cart driver equals four donkey-cart drivers.) The fact that the teacher provided a platform for learners to contribute in the lesson, shows that these teachers were working closely with their learners. This practice is in line with the principle of PAR (cf. 4.2.2.3). The fact that teachers were working jointly with other teachers to present the same lesson (cf. during the presentation of a lesson, and the sound working relations demonstrated by Mr Letuba and Mr Kodu), could serve to show the learners that when one works closely with other people, one gets new ideas that could assist one in attaining one's hopes and dreams (cf. 2.2.2.1).

Analysis of the responses made by Lenong (second learner)



This text shows that Lenong managed to demonstrate her counting skills. The learner was informed by the text 'less' that she had to introduce a negative sign (-) in order to tackle the question appropriately. Lenong had to observe the picture, and subtracted two donkeys from the total number of eight donkeys in order to get a difference of six donkeys (for example, eight donkeys minus two donkeys equals six donkeys). The fact that Lenong managed to translate the phrase 'less' is an indication that she had a good background of translating mathematical word sentences into mathematical symbols (-), in line with our linguistic capital (cf. 2.2.2.3).

Analyses of the responses made by learners from the two respective groups after the lesson

Analysis of Group E and Group F learners' responses

From my observation, I noted that the two groups responded to the given activity in a similar way (cf. Figures 5.20 & 5.21). Learners from Group E and Group F found that they had to translate the phrase, '*altogether*' into a mathematical symbol (+) in order to answer the question appropriately. This translation process was in line with the linguistic capital (cf. 2.2.2.3), namely to look at how learners utilise their linguistic skills to interpret mathematical word sentences into mathematical symbols. However, by observing the responses of these learners further, I noted that after they had picked up that the plus sign (+) was a relevant operational sign to be used in order to get the sum correct, they had to add the number of birds counted from Monday to Friday together in order to get the total number of birds counted for the whole week, i.e. two birds + two birds + four birds + three birds + one bird equals twelve birds. This holistic approach was in line with the principle of PAR (cf. 4.2.2.3). Learners could learn from the holistic approach that they had to work together to achieve their hopes and dreams (cf. 2.2.2.1).

Dunley-Owen (2015:4) and Thompson (1994:2-10) share the same sentiments with Sections 3.3.3 and 5.3.3, namely to say that elementary learners learn mathematical WP better and with understanding through concrete teaching. Amazingly, during breaks in my observation times, I met one educator who did not form part of my research participants, and he indicated to me that concrete teaching would never happen as long as we did not have materials serve as back-ups.

In conclusion, I noted that elementary learners learn mathematical WP better through positive and physical engagements, where they are given learning spaces to do things on their own and at their own pace.

5.3.4 Creating learning practices to teach mathematical WP to Afromontane learners

Shwarchuk, Sowinski and Lefevre (2013:65-66) claim planning and teaching of mathematical WP activities that are within the context of Afromontane learners as a best practice. This version is supported by Dunley-Owen (2015:5-7), who also claims

that it would assist learners to be logic in their reasoning and being creative when learning about the phenomenon of interest. Similarly, the DBE (2011:8) declares that by so doing, learners would take ownership of the lesson, see the beauty of mathematics, and gradually gain confidence regarding learning mathematics positively, particularly mathematical WP. Philipp (2010a:11; 27-28) agrees that if they are self-confident or self-reliant in solving sums on mathematical WP, they will be ready to identify interpret and link them with real-world situations.

The team met in the Grade 4 A mathematics class in an attempt to discuss possible ways in which teachers could create learning practices for learners to learn mathematical WP. It was noted from the discussions that the best way was to request Grade 4 mathematics teachers to present a lesson whereby the team could check how far or how possible could teachers create the learning practices in the classroom settings. Mr Kodu volunteered to present the lesson.

Mr Kodu: *Learners, I am going to present my lesson on the chalkboard, this lesson will be brief and precise. Please, take note that at the end of this lesson an individual person will be asked to present something on the board.*

The lesson was presented as follows:

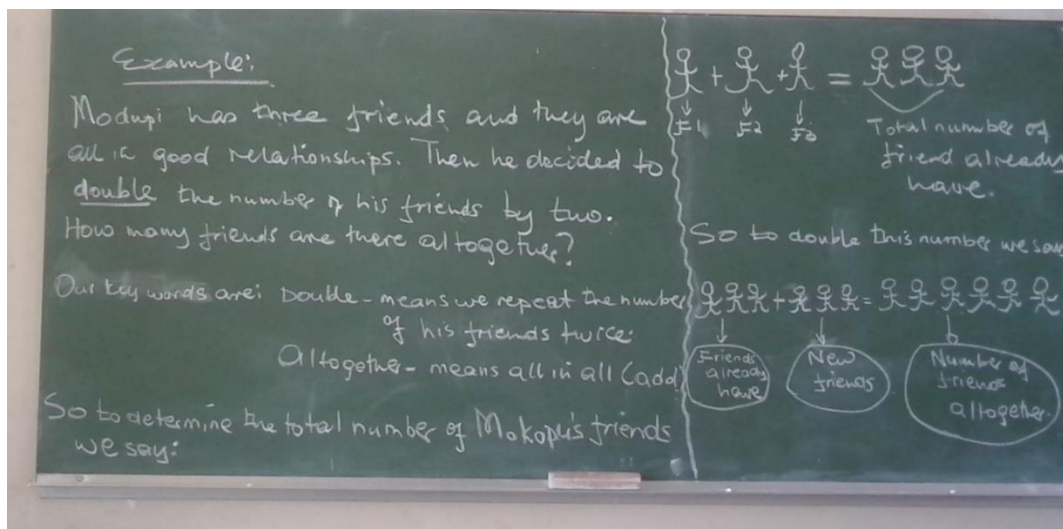


Figure 5.23: Mr Kodu's presentation

This figure shows how mathematics teachers could possibly create learning practices for learners to learn mathematical WP in the class setting.

Now, I am done with my presentation. Is there anyone who wants to ask questions?

Class: *No one, Sir.*

Mr Kodu: *Lekwenya. is everything clear to you?*

Lekwenya: *Yes, Sir. (A learner responding)*

Mrs Motete: *Re a thaba ho bona bana ba rona ba utwisisa diWP ka tsela ena (We are glad to see our children understanding mathematical WP in this manner) (A parent appreciating a lesson presented).*

Mr Kodu: *Thanks, M 'am, for the positive contributions. Now, class it is your turn to respond to the activity.*

Class: *Yes, Sir.*

Mr Kodu: *Here is the activity.*

Activity:

If Nondo has eight apples and Mokopu has three apples. What is the difference?

Mr Kodu: *I want my class to take note that this is a chalkboard activity, whereby learners will be given opportunities of going to the board to write down their answers.*

Mpho: *titjhere, titjhere ere ke e etse hle (teacher, teacher, please give me a chance)*
(a learner asking)

Mr Kodu: *No Mpho, Mohanwe was the first one to raise his hand, now, let us see how Mohanwe could respond to the question (A learner went to the chalkboard to write down his responses)*

Mohanwe responded as follows:

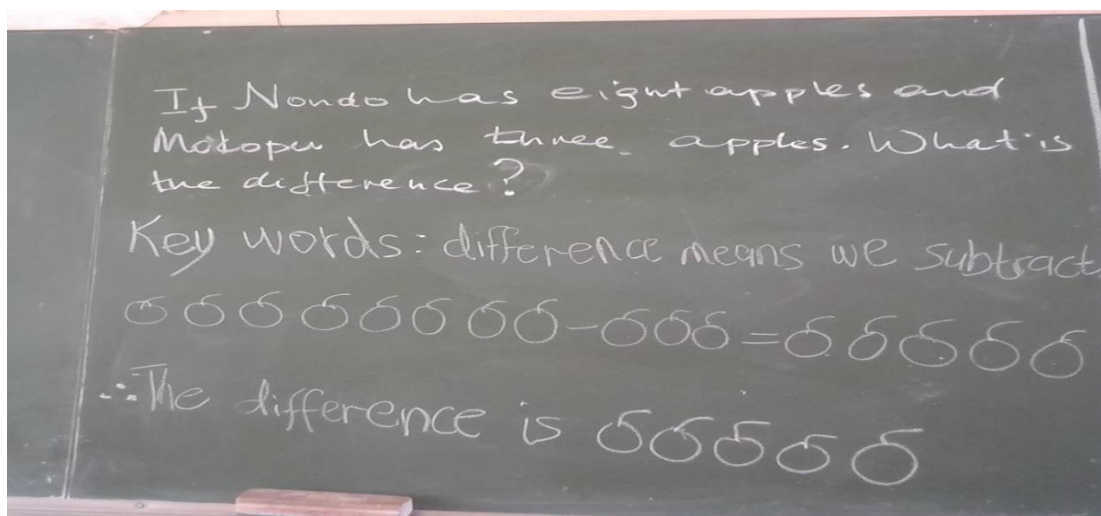


Figure 5. 24: Mohanwe's responses

This figure presents the response by Mohanwe from the Grade 4 B mathematics class.

Mr Nkodu: *At this moment, I can see the hand moving around, oh yes! It is a hand from my colleague Mrs Ntuke. Class, Mrs Ntuke is going to take you through the next part of the lesson.* (Mr Kodu handed over part of the lesson to Mrs Ntuke, one of the mathematics teachers from the neighbouring schools.)

Mrs Ntuke: *Shine, Mohanwe, shine! Your response was extremely well*

Mohanwe: *Ke a leboha, Ma'am. (Thank you, Ma 'am)* (A learner acknowledging thanks)

Class: *Ma'am! Ma'am! Ma'am! ----* (learners were shouting with their hands up eager to participate)

Mrs Ntuke: *Hoooo, wait please! Hoooo! Please wait wait. Shhh ----. Now, listen class, our next presenter will be Thandi because her hand was already up. Thandi, come forward.*

Class: *ahhh ...*

Mrs Seledu: *bana tholang hle (children, please stop making noise) (a parent from the school governance)*

Mrs Ntuke: *Ok, thank you, Mme. Go on Thandi.*

Thandi responded as follows:

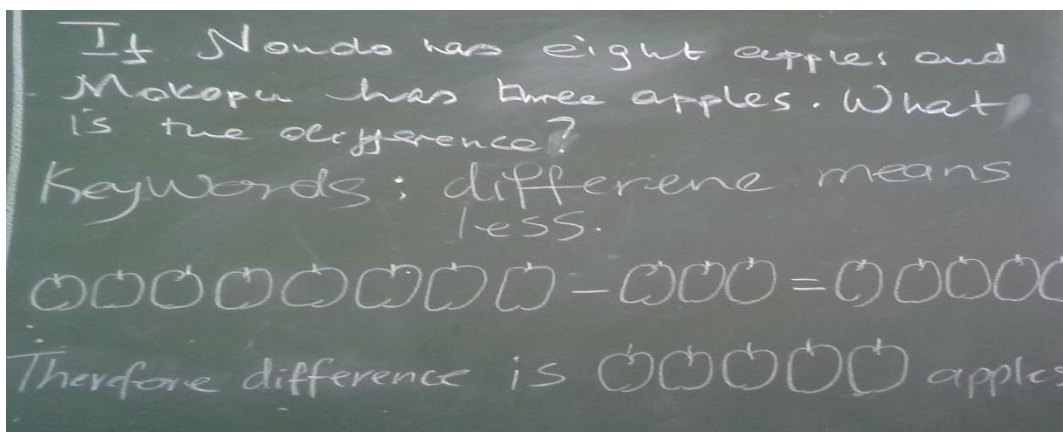


Figure 5.25: Thandi's responses

This figure presents the response by Thandi from the Grade 4B mathematics class.

Thandi: *I am done, Ma'am, thank you---*

Mr Lebeso: *Ke a thaba ho bona bana ba rona ba ithita diWP ba lefree (It is encouraging to see our children learning mathematical WP as free as they could)* (A parent commenting about a lesson presented by the teacher)

Mrs Ntuke handed the platform back to Mr Kodu to wrap up.

Mr Kodu: *thank you, Mme, colleagues and everyone.*

In the next part of this section I analyse the lesson presented by the teacher and the learners' responses who volunteered in the class. The first part was led by the analysis of the lesson presented by the teacher in the class, followed by one indicating the responses made by the two learners in the class.

Figure 5.22 advises that Mr Kodu presented his lesson very well by using pictures and key words such as '*double*' and '*altogether*' taken from the mathematical word sentence. These key words were listed and defined in simpler terms to better the understanding of learners in the Grade 4 mathematics class. This translation was in line with our linguistic capital (cf. 2.2.2.3). The figure further shows the use of pictures as being imperative because elementary learners seem to have learnt and understood mathematical WP better by using pictures (Dunley-Owen 2015:6).

In line with the above analysis, Figure 5.23 and Figure 5.24 advise that the responses made by Mohanwe and Thandi be aligned with the example cited by Mr Kodu during his presentation. When learners were asked to determine a difference between the number of apples that Nondo and Mokopu had, I noted that both picked up the term

difference,

from the given mathematical word sentence as a key word. The phrase '*difference*' suggests that they had to subtract the number of apples Mokopu had from the ones Nondo had.

Both did their calculations more or less in the same way: Both subtracted the number of apples that Mokopu had from the total number of apples that Nondo had to get a difference of five apples; that is, eight apples minus three apples equals five apples. In my understanding, these learners have managed to use their navigational capital (cf. 2.2.2.2) to go through the given activity without any doubt. However, the use of the phrase,

Aahhh,

further suggests that the learning atmosphere was free and conducive to learning; in fact, all learners were eager to participate in the lesson (cf. 4.2.2.3).

Based on the analysis made above, I note that Goos (2015:3-6) and Liljedahl (2015:4) present the same idea with the empirical data presented in this section (cf. 5.3.4). I also noted that both sentiments concur with the one in Section 3.3.4, namely that elementary learners, particularly in the Grade 4 mathematics class, learn mathematical WP better when they are given the opportunity to do things on their own.

Teaching and learning of mathematical WP by creating learning practices advance that learners learn mathematical WP better when they are provided with learning practices in the classroom setting.

5.3.5 Employing English as a language to teach mathematical WP to Afromontane learners

Shilamba (2012:26) declares the use of LOLT as the best way to teach and learn mathematical WP. Modupeola (2013:91-92) agrees that it is used as a practice by the second-language users to develop their linguistic skills in order to avoid miscalculations when solving sums on mathematical WP. In addition, Mati (2015:2) claims that it is seen to be working effectively in multilingual classrooms where learners have to communicate sums on mathematical WP with other learners from different ethnic groups. Similarly, the DBE (2011:8), in the CAPS document, qualifies these opinions by asserting that it helps them to make sense of mathematical WP. In agreement with the above views, Colindres (2015:2) advances that teachers need to encourage their learners to speak English more often in order to develop their proficiency in the language so that they may interpret sums on mathematical WP comprehensively.

After a long discussion meeting held in the Grade 4 class about the issue of the use of English as a language to teach mathematical WP, the team suggested that the best way was to present a lesson by using English in order to find out how learners could be assisted to communicate mathematical WP effectively. Mr Mpe (mathematics Head of Department) and Mme Motoho (a local businessperson) were requested by the team to work together to facilitate the presentation.

Mr Mpe: *Class, today our lesson will be on how we could use English as a language to teach and learn about mathematical WP.*

Class: *Yes, Sir.*

Mr Mpe: *Now, my lesson goes like this.*

Lesson:

Mr Katse's age is 54 years old twice as much as of his son's age. How old is his son?

Mr Mpe: *before I continue with my lesson, I want remind our children that in the previous lessons we have dealt with number sentences, where we have learnt that we can have a number missing, which has to be found to make the sentence true, for example: $2 \times \square = 4$, an empty box from the example, suggests that there is a certain number missing that has to be multiplied together by two in order to get four as a product. So, we all know that we have to write down aside the set of natural numbers, e.g. $\mathbf{N} = \{1, 2, 3, 4, 5, \dots\}$. Now, from this set of natural numbers we can have our clue board that will drive us to the solution. Remember, a clue board is when we reconcile or join multiplication calculations for the same natural number multiplier that may be written as a limit for a certain number sentence, and a number sentence is a sentence that uses numbers instead of words. Let us see how it works.*

Number sentence

$$2 \times \square = 4$$

clue board

$$2 \times 1 = 2$$

$$2 \times 2 = 4$$

Now, from our clue board we learn that 1 and 2 multiply the number 2 that represents a multiplier repeatedly to form a pattern needed to a limit of a number sentence, $2 \times 2 = 4$. 2 (the multiplicand) in the number sentence represents \square , then if that is a case, we may have our number sentence be written completely as $2 \times \boxed{2} = 4$. Now, in my knowledge, this information will help us to get our answer. Remember; we are working towards determining the age of Mr Katse's son.

If we are given that Mr Katse's age = 54

The son's age = twice as much as Mr Katse's age (i.e. $2 \times \square$)

Then, we shall resort to the set of $\mathbf{N} = \{1, 2, 3, 4, 5, \dots\}$, the number sentence and the clue board as our clues to our solution. Let us see how?

Number sentence**Clue board**

The son's age = $2 \times \square = 54$

$$2 \times 1 = 2$$

$$2 \times 2 = 4$$

Mme Motoho: *Can I come in to assist doing the last part, Sir?*

Mr Mpe: *Oh! Yes, Mme, please come forward.*

Mme Motoho: *Good morning, class.*

Class: *Good morning, Ma'am.*

Then, Mme Motoho presented the last part as follows:

Mme Motoho: *I hope that everyone was listening when Mr Mpe was taking you through the journey of explaining a number sentence and a clue board. The journey was good isn't? My job is very easy because I have to take you through the last part of the lesson. Now, listen carefully. When we look at our number sentence, we have the following formula that will drive us to the solution. The formula is as follows: The son's age = $2 \times \square = 54$, now this formula informs us that we must replace the missing number, which is represented by a placeholder or a box \square with numbers from the set of natural numbers to make sense out it. For example:*

$$2 \times 1 = 2$$

$2 \times 3 = 6$, this pattern will go up until we reach a limit of $2 \times 27 = 54$. Let see how it goes.

Number sentence**Clue board**

The son's age = $2 \times \square = 54$

$$2 \times 1 = 2$$

$$2 \times 2 = 4$$

: :

: :

$$2 \times 25 = 50$$

$$2 \times 26 = 52$$

$$2 \times 27 = 54 \text{ (the limit needed)}$$

So, our number sentence will be $2 \times \square = 54$

27

Then, the number in the box will represent the son's age, which is 27. Mr Katse's son will be 27 years old.

Thank you, Mr Mpe.

Mr Mpe: Thank you, Ma'am. Now, in the next step, you will be provided with the activity to present, and you will be asked to present it on the board in English, but this will be done on voluntarily basis.

Class: Mmm---, English! why English?

Mr Mpe: Yes, Class, because you are doing mathematics in English.

Class: Yes, Sir.

Activity

Solve this mathematical WP

Bags of wood cost R 15, 00 each. How much are three bags of wood?

The next part is led by the responses made by learners on voluntarily.

Nthabiseng: Ntate Mpe, please I can try (A learner asking)

Mr Mpe: Yes, come forward, my girl.

Nthabiseng responded in the following manner:

Nthabiseng: Class, I am the teacher now, so must listen, here is my answer.

The three bags of wood = $15 \times 3 = R45$

While Nthabiseng was busy with the sum, I noted the hands of other learners waving around in the air. I thought that Nthabiseng was not doing well, but when I asked other learners what the of waving hands was all about, I was told that learners were anxious participate in the lesson.

Mr Mpe: Shine, my girl, you got it right.

Molantwa: Ntate Mpe, I can explain better in English than Nthabi please (another learner asking)

Mr Mpe: Molantwa, come forward, it is your turn.

Molantwa responded as follows:

Molantwa: *Class, I am a good mathematics teacher. Now, listen to me.*

Our correct answer: 3 bags of wood = 15+15+15 = 45

Three bags of wood cost R 45, 00.

The next part of this section is guided by the analysis of the lesson presented by Mr Mpe, together with Mme Motoho, followed by the responses made by learners.

The lesson presented by Mr Mpe and Mme Motoho advises sharing of knowledge as imperative regarding the teaching and learning mathematical WP. This sharing of knowledge was in line with our epistemological ideology (cf. 2.2.4), where knowledge is valuable when it is shared by the people together. However, the phrase

'voluntarily'

suggests that the instruction presented in English to the learners were loud and clear (cf. Nthabiseng and Molantwa's responses). This serves as evidence that the learners had accumulated sufficient linguistic skills in the previous lessons (cf. 2.2.2.3). The fact that Mme Motoho assisted Mr Mpe with the presentation of the lesson also serves as evidence that they were working together (cf. Mr Mpe and Mme Motoho' lesson). The practice was in line with the principle of PAR (cf. 4.2.2.3).

The responses by Nthabiseng and Molantwa further suggest that the activity was designed in a manner that would assist in developing the linguistic skills of learners, particularly the speaking skill. This claim is substantiated by the phrase,

'I can try'

articulated by Nthabiseng while the lesson was in progress, claiming that she could present part of the lesson better in English if she were given the opportunity to do so, and indeed she presented part of the lesson appropriately (cf. the response by Nthabiseng in English on the activity provided by the teacher). Again, the response by Molantwa leads one to believe that he was bold enough to go and stand in front of the class to present his response in English,

'I can explain better in English'

further suggests that his reasoning skills in terms of explaining a given sum on mathematical WP have developed extremely well. To show that his reasoning skills

had developed tremendously, he managed to present a sum from a different approach. For example, in order to determine the price of three bags of wood, he added fifteen by three; that is, $15+15+15 = 45$, and further correctly concluded that the price of three bags of wood was R45,00. In my view, one needs children like Molantwa who are bold enough to present their case in front of other learners without any fear or prejudice, because by so doing, the aspirations of other learners would be revived (cf. 2.2.2.1).

Colindres (2015:81-82) and Koning and Rothland (2012:291-292) present the same idea with the empirical data presented in this section (cf. 5.3.5) and the theoretical data from Section 3.3.5, namely that learners should be exposed to English at school, at home or in their close environment, which will make teaching and learning of mathematical WP much easier or better. Surprisingly, during my observation, I learnt that some teachers still had serious challenges regarding interpreting mathematical WP in English.

The use of English in the teaching and learning of mathematical WP discloses that learners can learn mathematical WP better in English whenever they are given platforms to do so in their respective classrooms.

5.4 CONDUCTIVE CONDITIONS FOR DESIGNING A CONTEXT-BASED STRATEGY

In Section 5.3, ample solutions were identified in the teaching and learning of mathematical WP and five were found to be relevant to the theoretical framework. In the same way, the relevant conducive conditions for those solutions were also identified. These conducive conditions aimed at enhancing teaching and learning of mathematical WP within the context of the learners and employing indigenous games as a strategy to learn about them. Conducive conditions could also assist teachers in creating learning spaces for learners to learn mathematical WP in the abstract way and assist in the use of English in the teaching and learning of mathematical WP.

5.4.1 Conditions that enhance teaching and learning of mathematical WP within the context of Afromontane learners by using indigenous games

The Gambian Department of State for Education (2004:9-13), in the policy document under its guiding principles, stipulates that the curriculum should be designed in such

a way that it develops conducive conditions from various levels where the cultural diversity, indigenous knowledge and languages of learners are observed in different ways. This is confirmed by the DBE (2011:8), claiming that the conditions underpinning curriculum should be in such way that they support and expose learners to learning mathematical WP in a social, environmental, cultural and economic context. In addition, Emerson, Fear, Fox and Sanders (2012:7-13) agree that it is through the commitment of teachers, learners and parents that these best practices can possibly happen.

It became an evident when team members met in the Grade 4B class discussing that conducive conditions still needed to be created for learners to learn mathematical WP effectively. The plan of the day was to request Mr Lebaka to chair the meeting. Everyone in the meeting was encouraged to participate as a team member.

When Mr Nkgekge was given a platform to make his contributions, he stated,

Hare nyolleng maemo a diWP problems ka ho sebedisa indigenous games boholoba nako (Let's improve the conditions in which we teach mathematical WP by using indigenous games timeously)

Mrs Thoko contributed as follows,

Botjhere hare fetoleng maemo a bana ba rona ka ho ruta WP ka dipapadi tsa botjhaba (Teachers, let us try to change the prevailing situations by using indigenous games when teaching mathematical WP)

When Mrs Dikeledi was given time to contribute, she articulated the following,

Conditions can definitely change when we work together as a team.

Mr Mooko, as the school principal, when asked to make his contributions, articulated the following,

Team efforts and team spirit should be our game as a team.

The extract

improve the conditions,

implies that it is through the efforts of the entire team that conducive conditions could be created. Therefore, learners can learn mathematical WP within their context. It

further suggests that indigenous games can play an important role in making this happen. Furthermore, the next text

'change the prevailing situations by using indigenous games'

advises that it is through the integration and the efforts made by parents and teachers that indigenous games could be meaningful when teaching mathematical WP. This is affirmed by Young (2015:5), who claims that by learning mathematical WP in that way it would not be forgotten easily. Mr Nkgekge and Mrs Thoko agreed that learning mathematical WP within the context of the learners and integrating them with the indigenous games would lead to them learning with determination (Wehmeyer *et al.* 2012:136). Learning with determination is aligned with the familial capital (cf. 2.2.2.4) of the CCW framework, on condition that it caters for learners to develop their indigenous skills and the knowledge they have obtained from their siblings, parents and other family members. These indigenous skills and knowledge should operate on the condition that they assist learners in linking mathematical WP with indigenous games, namely to learn that the conditions under which mathematical WP operate at school could be similar to conditions at home (Shwarchuk *et al.* 2014:64-66).

Team efforts and team spirit both could put us somewhere only if we are willing to work together.

The text further suggests and supports words articulated by the latter speaker, which clearly emphasises a point that it is through teamwork and the efforts that could be made by the team (learners, parents and teachers) that learners could do better in the learning processes of mathematical WP. Articulated words such as *working together*, *team efforts* and *team spirit* from the previously mentioned text are in line with the principles of PAR (cf.4.2.2.3), which indicates that PAR creates space for people to work together towards attaining a common goal. In the context under study, conducive conditions sustaining the issue of attaining a common goal is to assist learners in working together to integrate mathematical WP with the indigenous games (Gustafson & ILLuebbey 2013:53)

From the above discussions, it transpired that the empirical data presented from this section concur with the theoretical Sections 3.4.1 and 3.4.2. Bhat both agree that conditions conducive for teaching and learning mathematical WP within Afromontane

learners' contexts should be created so that the indigenous games and mathematical WP are integrated well.

Conditions that enhance teaching and learning of mathematical WP within the context of Afromontane learners advance the ideas that the efforts made by teachers, parents and learners can create conducive conditions for learners to learn mathematical WP from within their context, and by using indigenous games as strategies to assist them.

5.4.2 Conducive conditions that support abstract teaching and learning of mathematical WP to create learning spaces to Afromontane learners

The DBE (2011:13), in the CAPS document, encourages teachers with the appropriate skills and knowledge to create conditions conducive to the teaching and learning of mathematical WP. According to Suurtamm *et al.* (2015:4), these conducive conditions could be created by introducing learners to the concrete objects before they could even go to the abstract level of thinking. This is affirmed by Jean-Paul and Jean-Claude (2015:8-9), who claim that the fourth-graders at this level of learning learn mathematical WP better through the manipulatives. This idea was advanced by the South African Institute for Distance Education (2007:4), claiming that it could be even more effective if a learning space were created for Afromontane learners to learn how to manoeuvre the challenges of learning mathematical WP in abstract ways. This is further confirmed by the Department of Correctional Services (2015:28), which claims that wherever teaching and learning of mathematics, particularly mathematical WP takes place, provision should be made for a safe and secure environment.

Abstract teaching and creation of the learning space for learners to learn mathematical WP effectively were the issues on the table during the meeting proceedings held by the team in the Grade 4B class. Mt Tsebe (parent) was requested by the team to chair the proceedings of the meeting where everybody was requested to participate.

When Mr Nketu was requested to make his contributions, he responded as follows,

Prospective and knowledgeable teachers do their planning on time in order to create conducive environment whereby a learning space is provided for learners to learn mathematical WP abstractly.

Mr Kodu added,

Schools, societies and Education Department need to work together in order to assist teachers to create conducive conditions of learning mathematical WP in case where overcrowding of classes, shortage of textbooks and insecure building hinder the effective teaching and learning

Mr Tops contributed the following,

It is every one's responsibility to ensure that conducive conditions and strategies are created for learners to learn WP in the better way

Mr Lebaka added,

Teacher-learner-parental involvements in the teaching and learning of mathematical WP where the conducive environment is created or done together as a joint venture, learners would do their utmost best in the learning process of the phenomenon of interest.

The next section is guided by an analysis of the words spoken by co-researchers in the research proceedings.

By referring to the following words articulated by Mr Nketu,

prospective and knowledgeable teachers do their planning on time in order to create conducive environment,

the text suggests that clever and well-informed teachers do their planning on time to assist learners with new skills and approaches of dealing with the unforeseen and unconditional problem-solving challenges (e.g. conversion of word sentences into mathematical symbols) that might hinder their progress. This is supported by Mr Kodu with the following words:

schools, societies and Education Department need to work together in order to assist teachers to create conducive.

This text further supports the words articulated by Mr Nketu above, with the view that it advises teachers that they could not assist learners with new skills and knowledge to go through the problem-solving challenges if they do not work jointly with parents. The text further suggests that the efforts by the entire team (teachers, learners, parents and the departmental officials) would make teaching and learning of mathematical WP possible, even if conditions do not allow that. This attempt to equip

learners with the skills of going through the problem-solving challenges is aligned with the navigational capital (cf. 2.2.2.2) of CCW as framework, where the idea is to perceive learners as people who have acquired those skills from their elders. Then they could be assisted by teachers and parents working together to implement these skills effectively and efficiently in the teaching and learning of the phenomenon of interest. This is also supported by the principles of PAR (cf. 4.2.2.2–4.2.2.3) where the idea is to encourage parents and teachers to work together in order to create conducive learning environment for learners to learn mathematical WP. The DBE 2011:8) is of the same view, namely that by doing so, learners would see the beauty of mathematics, particularly mathematical WP.

The following words articulated by Mr Tops,

conducive conditions and strategies are created for learners to learn mathematical WP in the better way,

suggest an initiative and prerogative measures of developing and equipping the skills of learners as a gain in the teaching and learning of mathematical WP. These initiative and prerogative(classless) measures are described as teacher-parental interaction or intervention strategy work under the egalitarian(classless) conditions where everyone is free to air his or her views without any fear or prejudice and also learn from others (Ahmad, Krogh & Gjøtterud 2014:5). In the same way, Mr Lebaka stated,

Teacher-learner-parental involvements in the teaching and learning of mathematical WP where the conducive environment is created or done together as a joint venture.

The tone of the words articulated by Mr Lebaka is similar to the ones articulated by the latter speakers, namely to have learners learning together in the conducive environment created by teachers. Liljedah (2015:5-9) claims that learning mishaps could be avoided when teachers, parents, learners and Departmental officials work jointly as a team.

The empirical data presented from this section concur with Sections 3.4.3 and 3.4.4 from the literature review section, stating that learners could be able to learn abstract teaching of mathematical WP only if they are allowed or given an opportunity to link them with concrete objects in order to give sense.

In conclusion, from the above texts it is clear that it is through the joint efforts the teachers, parents and other relevant stakeholders that learners could learn new skills that would assist them to manoeuvre through the problem-solving challenges.

5.4.3 Conducive conditions that support the teaching and learning of mathematical WP to Afromontane learners

Cockroft (2015:79) claims that elementary learners could learn and understand mathematical WP better, on condition that they mix English with their mother tongue. The DBE (2011:8) acknowledges that code switching may be used on condition that, or in case teachers want to emphasise and clarify new and difficult concepts in the teaching and learning of mathematical WP. The Colorado Department of Education (2015:6) declares that code switching plays a prominent role in minimising misunderstandings that might occur between the teacher and learners during lessons.

From the meeting chaired by Mrs Leeto (parent) in the school hall, the co-researchers found it necessary to look into the possible conducive conditions that could enhance teaching and learning of mathematical WP by using English as a language of instruction. Team members were requested to participate actively.

When Mokopu was given a platform as a learner to make his contributions, he stated,

English e molemo ha re code switcha maemong a thata a ho utwisisa diWP (Code switching is useful where we use English to understand mathematical WP in difficult situations)

Mrs Modikwe (parent) in turn stated,

Ha e sebediswe maemong a boima a ho hlalosa diwords (Let it be implemented in the complex conditions whereby learners need clarity on the aspects related to mathematical WP)

Mr Lebaka responded,

Let it be used as a remedy to explain and make emphasis on the parts of the mathematical WP that need some interpretations not on regular basis because LOLT is recommended as the language of learning and teaching by the Education Department.

From the above texts, it is clear that code switching plays a prominent role in the teaching and learning of mathematical WP. The words articulated by Mokopu and other two co-researchers confirm that. When Mokopu was given time to contribute to the meeting, he stated,

it helps us to understand WP in a difficult situation.

The text suggests that code switching gives learners something to lean on in times of difficulty or under conditions where they need this in order to understand some of the difficult mathematical WP aspects presented by the teacher in the lesson. This was confirmed by Mrs Modikwe, who also articulated the following words when making her contributions during the meeting,

in the conditions whereby learners need clarity on certain aspects.

The text suggests ideas similar to the afore-mentioned text, namely that code switching could be used in cases where learners seem to get lost during the presentation of mathematical WP. For this apparent reason, we also found Mr Lebaka, the subject advisor, adding similar words to those articulated by the two latter co-researchers in the meeting. When he was given an opportunity to contribute, he stated:

let it be used as a remedy to explain and make emphasis.

This text further suggests that code switching could be employed by teachers as a strategy by teachers to explain and make emphasis on the mathematical WP aspects that need clarity. Furthermore, it suggests that it could only be used in line with the guidelines provided by or stipulated in the CAPS document (DBE 2011:8-9). According to the Colorado Department of Education (2015:11), these guidelines stipulated in the CAPS document assist learners and teachers in code switching.

In the light of the above, I found that the analysis was aligned with the linguistic capital (cf. 2.2.2.3) of the CCW framework, namely that learners were given time to contribute to the meeting. The team acknowledged the fact that the intellectual and social skills attained through previous communication experiences have to be considered of significant importance in the teaching and learning process of mathematical WP. It would also assist them in navigating the problem-solving challenges that might occur

on their way to attaining their hopes, dreams, aspirational capital (cf.2.2.2.1) and navigational capital (cf. 2.2.2.2).

The empirical data presented from this section and those presented in the literature review in Section 3.4.5 concur with the idea that fourth-graders, at the level of their understanding, still need to be taught by means of code switching. However, amazingly, during the research proceedings, it transpired that most of mathematics teachers employed their mother tongue as a language of learning and teaching (LOLT) and used a bit of English.

In conclusion, I noted that various stakeholders still maintain that code switching remains a strategy that could be employed to assist learners when learning mathematical WP in English.

5.5 THREATS AND RISKS TO DESIGNING A CONTEXT-BASED STRATEGY

In Section 5.4, several conditions conducive to designing a context-based strategy were identified. This section intends to discuss the anticipated threats and risks that could hamper the process of designing a context-based strategy for teaching and learning of mathematical WP. The anticipated threats and risks might occur in instances where one finds that teaching and learning of mathematical WP transpire when learners learn mathematical WP within their contexts, employing indigenous games as their strategy. These anticipated threats and risks might also occur where the learning spaces are created by teachers for learners to solve sums on problem solving in the abstract ways on their own. Lastly, there was the risk of teaching mathematical WP using code switching, while one is supposed to use English as LOLT.

5.5.1 Threats and risks towards teaching and learning of mathematical WP within the context of Afromontane learners by employing indigenous games

The DBE (2011:5), in the CAPS document, acknowledges the use of indigenous systems as of vital importance in the teaching and learning of mathematics, particularly mathematical WP. However, Sepeng (2015:25) argues that the type of mathematical

WP taught in the school curriculum is not within the context of the learners, because the curriculum does not address the socio-cultural situations faced by learners from poor family backgrounds. Hence, Gay (2013:52-54) declares the usage of the indigenous games as risky because it is not prescribed in the school curriculum. This claim is confirmed by Prague (2001:27-28), who indicates that the use of non-prescribed indigenous games in formal assessment such as tests and examinations is a waste of time, because it is not considered appropriate and precise.

However, in the meeting held by the research participants in the school hall, the issue on the table was to find a way to deal with the threats and risks that might occur when teachers teach mathematical WP within the context of learners.

When Mrs Dikeledi was given time to make her contributions, she articulated the following words:

Using the indigenous games in teaching and learning process of mathematical WP might tempt learners to dwell much on them, because were prescribed in the CAPS document but not practically used in the classroom situation

Mrs Tshepiso stated the following:

Ho leka ho ruta dipalo boemong ba bana ntle le karikulamo ke a tshaba hobane ba tla feila (teaching mathematical WP within the context of learners but outside the curriculum box, I am afraid because learners will fail)

Mr Lebaka contributed with the following words:

Threats and risks sometimes could produce better results.

The next section is guided by the analysis of the three texts presented above.

By referring to the following words by Mrs Dikeledi,

to dwell much on them, because were prescribed in the CAPS document,

the text discourages learners and teachers from dwelling too much on the usage of the indigenous games for, as prescribed in the CAPS document, they could be used in the teaching and learning of mathematical WP, but it is not yet ready to be implemented in the curriculum. Mrs Tshepiso affirmed this,

but outside the curriculum box, I am afraid because learners will fail.

The text implies that teaching and learning of mathematical WP within the context of indigenous games, not yet prescribed in the Departmental Education policy, is a risk. The following words by Mr Lebaka,

threats and risks sometimes could produce better results,

further suggest that teachers and parents might take the risk of using indigenous games to teach mathematical WP within the context of Afromontane learners. However, when taking the risk, they should always be aware that it could either yield better results or not. The three texts analysed above agreed that it was not compulsory to use indigenous games to teach mathematical WP, but if one does it, one does it at one's own risk.

The analysis of the three texts above is aligned with the resistance capital (cf. 2.2.2.6) of the CCW framework, which specifies that knowledge and skills of learners could sometimes develop them to discriminate against each other when used incorrectly in racial and ethnic groups. In our context, we view the issue of teaching and learning mathematical WP in the context of Afromontane learners, also employing indigenous games as a strategy to teach mathematical WP in the context of learners, as a debatable issue, in the sense that learners have various contexts. This also varies in terms of implementing their indigenous skills and knowledge when utilising those games. In fact, one might find it difficult to have learners in the same class with different backgrounds playing indigenous games together. This might drive learners to a certain measure of oppositional behaviour that might drive learners to discriminate against one another, in the sense that one may end up finding learners from the same class opposing other learners about their ethnical backgrounds, indicating that some are better than others. This may result in racial discriminatory acts where they would end up fighting. This would be against one of the principles of PAR (cf. 4.2.2.1), which encourage learners to work together in order to achieve their goals. Hence, Matela (2015:24) discourages the oppressive ideologies that prevailed in the past regime where learners were denied opportunities to have their voices heard in the classroom setting.

From the above discussions, it transpired that the theoretical data presented in Sections 3.5.1 and 3.5.2 concur with the empirical data presented in this section, namely that teaching and learning of mathematical WP by means of indigenous games could become a threat, because indigenous games are not prescribed in the CAPS document as the solution. Yet people view them as good, because they could be used to assist learners in learning mathematical WP better.

In conclusion, it emerges that teaching and learning of mathematical WP by using indigenous games is not only the best way of learning mathematical WP, but teachers and learners can use other, better strategies to learn mathematical WP.

5.5.2 Threats and risks towards abstract teaching of mathematical WP by creating learning spaces to Afromontane learners

According to Rushton and Larkin (2001:28-31), learners who are advised to learn mathematical WP in abstract ways, in learning spaces created by teachers in their absence, might fall into the trap of learning in the traditional way. Bhattacharjee (2015:66-70) describes the traditional way of learning as the way in which learners learn mathematical WP through rules and procedures (algorithmic way of learning) and where knowledge is sluggish. This is confirmed by Bailey (2002:1-7), who claims that by so doing, they could end up being confused. On the contrary, Young (2015:3) suggests that in order to avoid becoming confused, teachers should always encourage learners to stick to learning mathematical WP with the use of concrete objects.

In the meeting held by the co-researchers in Grade 4B, it became evident that threats and risks might occur when teachers only create learning spaces for learners to learn mathematical WP on their own. For this reason, the team created a platform for the research participants to air their views about the issue.

When Mrs Dikeledi was an opportunity to contribute, she responded:

Teachers are overloaded and working under pressure, and they do not have sufficient time to create learning spaces for learners to learn mathematical WP on their own, for the reason that they always rush to complete their pacesetters.

Mr Tops, the HOD, stated:

Teachers don't have ample time to teach and watch learners learning at the same time; therefore, I urge parents to work with them.

Mr Lebaka stated the following,

extra time, extra work and loyal parenting of watching the children's work regularly could assist a lot

The next section is guided by the analysis of the words spoken by the afore-said co-researchers.

The following words articulated by Mrs Dikeledi,

they don't have sufficient time to create learning spaces,

suggests two major challenges teachers are faced with; the first one being that they are overloaded with work; and secondly, that they do not have enough time to create learning spaces, at the same time having sufficient time to look after the children when reading or engaging themselves in solving mathematical WP activities. These two major challenges become a threat and risk at the same time, because they cannot take the risk of creating learning spaces for learners to learn mathematical WP while they are overloaded with work. The following words articulated by Mr Tops the HOD,

Teachers do not have an ample time to teach and watch learners learning at the same time,

further affirms a point that teachers would not be able to create learning spaces for learners to learn mathematical WP and watch their learning at the same time because of time constraints. It further urges parents to assist teachers in that regard. On the same note, Mr Lebaka stated,

extra time, extra work and loyal parenting of watching the children's work regularly could assist a lot,

further suggesting ways or strategies that could be used as a remedy for teachers, at the same time as solutions, trying to hide the point that teachers could be threatened by an overload of work. This dialogue is in line with the ontological stance (cf.2.2.5) of the CCW framework, namely that the reality in this regard was that teachers were overloaded. On the other hand, one might perceive the same argument as not being

in line with the aspirational wealth (cf. 2.2.2.1) of the CCW framework, namely that if teachers claim not to have time to create learning spaces for learners to learn mathematical WP, at the same time not being ready to guide or supervise learners on their attempts to learn, this might hamper the hopes and dreams of these learners. This is also against one of the principles of PAR (cf. 4.2.2.3), which encourages teachers and parents to work together, creating a platform for learners in order to contribute their unique skills and knowledge in the teaching and learning processes of mathematical WP. This is affirmed by Hmelo-Silver (2013:28), who claims that the creation of learning spaces provides learners with the opportunities to engage themselves in constructive processing of conceptual ideas of the teaching and learning of the phenomenon of mathematical WP.

From the above discussions, it is clear that the theoretical data from Section 3.5.3 and Section 3.5.4 agree with the empirical data presented from this section with the view there are threats and risks of creating learning spaces for learners to learn mathematical WP in abstract ways.

In conclusion, the creation of learning spaces for learners to learn mathematical WP on their own could create serious problems, because learning might not take place appropriately.

5.5.3 Threats and risks of using English to teach mathematical WP to Afromontane learners

Hoffer (2002:12-13) declares the use of English as a threat in the elementary classes if 90% of the lesson are presented in English. In addition, Mahofa (2014:46) claims that if it is often used in the classroom, learners might expect it to happen in their examinations where the language used is English. Hoffer (2002:3) indicates that, according to the research conducted by other scholars, most of the learners who rely mainly on code switching were always found to be in trouble, because when it is not done, they become lost and end up being confused. According to Shilamba (2012:3-4), when that happens, they fail to convert mathematical WP statement into symbols.

It became evident when the team held a meeting in the Grade 4A class that there are threats and risks of employing code switching as a learning strategy that would enable

learners to learn mathematical WP in a better way. In addressing this challenge, team members contributed as follows.

When asked, Mr Lesia stated:

Bana ba rutwe haholo ka puo eo ba utlwisisang (lets our children be frequently taught in the language they understand better).

According to Mrs Dikeledi,

Code switching is important because it helps us to clarify or make emphasis on the WP aspects more often.

Mr Lebaka, on the other hand, contributed as follows,

Code switching is permitted to be used by the Department of Basic Education in the CAPS document, but it should be used correctly.

The next section is guided by the analysis of the words spoken by the co-researchers from the above-mentioned textual presentations.

By referring to the following words by Mr Lesia,

taught in the language they understand better,

the text suggests ignoring the fact that code switching works as a strategy that could be used to assist learners to understand mathematical WP aspects that are not clear. It further suggests that teachers should be allowed to teach mathematical WP in the language that is understood by the learners.

Mrs Dikeledi, stated,

code switching is important because it helps us to clarify or make emphasis on the mathematical WP aspects which really need clarity,

suggesting that it is good to code switch, but on the condition that a teacher utilises it with the aim of clarifying difficult or new words learners are not conversant with.

Mr Lebaka, responded,

but it should be used correctly,

suggesting that code switching should be used as permitted by the Department of Education, but it becomes a threat when it is not used correctly, like when it is used not to clarify or emphasise part of the lesson presented by the teacher in the class, but as if it is a language of instruction to teach and learn mathematical WP. Therefore, if code switching is overindulged and excessively done, it will be against the linguistic capital (cf. 2.2.2.3) of the CCW framework, namely that the intellectual and social skills of the learners attained through communication experiences in multiple languages will not be exercised thoroughly. This is also not aligned with the principle of PAR (cf. 4.2.2.3), which creates space for all participants to contribute their unique skills and knowledge in the project.

It becomes clear that the theoretical data from Section 3.5.5 concur with the empirical data presented from this section, namely that code switching could be utilised up to a certain limit in the teaching and learning of mathematical WP.

In conclusion, all the relevant stakeholders agreed that code switching could be implemented as a communication tool to initiate and invite negotiation of meaning between teachers and learners when mathematical WP lessons are in progress (Mahofa 2014:40).

5.6 INDICATORS OF SUCCESS FOR DESIGNING A CONTEXT-BASED STRATEGY

The success of this study is guided by the meetings by the co-researchers, the lesson presented by teachers, the responses by learners, the reflections by mathematics teachers and the analysis of the words articulated by different co-researchers from the research team. These series of presentations suggested that indicators of success in the teaching and learning of mathematical WP could be assigned in different ways (cf. 5.3.1-5.3.5). Therefore, the drive of this section would be to display how mathematical WP could possibly be taught successfully within the context of Afromontane learners by using indigenous games as a learning strategy. The next drive would also be to look into the success achieved by teachers when they create learning spaces for Afromontane learners to learn the phenomenon of interest in abstract ways. The last drive would be to look into how code switching could be employed the best as a

learning strategy to enhance teaching and learning of mathematical WP in the classroom setting. Finally a summary will be given.

5.6.1 Success of teaching and learning mathematical WP in the Afromontane context by using indigenous games

Sánchez (2010:23-26) declares the creation of conducive learning spaces by teachers as a good plan, because it would assist learners in learning mathematical WP within their context. In addition, Hmelo-Silver (2013:33) claims that the creation of conducive spaces would not only allow them to learn mathematical WP within their context, but also to learn how they could be integrated with the indigenous games.

Success of teaching and learning mathematical WP within the learners' context by using indigenous games was the issue around the table. The team created a platform for all members to participate. Mr Motopi (local businessperson) was requested to lead the discussions.

When Mrs Makweetu (parent) was given time to contribute, she stated the following:

Matitjhere a rona ana le bokgoni ba ho ruta diword ka ho sebedisa dipapadi tsa botjhaba (Our teachers are capable of teaching mathematical WP in the context of our children, and they could even go to an extend of using indigenous games to teach them).

Mr Mpeu (former mathematics teacher) responded,

WP in the context of learners can give sense when they are taught with the use of concrete objects.

Mr Lebaka (subject advisor) stated,

mathematical WP is integrated with the indigenous games our learners are familiar with.

Mrs Lekodilo (parent):

everything is possible only if we share our ideas or knowledge.

The text

using indigenous games to teach,

recommends that one of the best ways to teach and learn mathematical WP is by using indigenous games. The next text,

the use of concrete objects,

advances concrete objects as the best way that could be used for supplementing indigenous games as other strategies in the teaching and learning process of mathematical WP.

In addition, the term *integrated* recommends the integration of mathematical WP with indigenous games as perfect, but further suggests total perfection could come by using different types of concrete objects in the environmental setting of learners. This is supported by Merttens (2012:34), who claims concrete teaching and learning as the best way to learn mathematical WP, especially to learners in the elementary grades. The text,

share our ideas or knowledge,

further suggests that people could achieve more if they are in a better position to share their ideas or knowledge. This is in line with the principle of PAR (cf. 4.2.2.3), which stipulates that some space should be created for people to contribute their unique skills and knowledge when dealing with mathematical WP. It is also aligned with the epistemological stance (cf. 2.2.4) in the case where the objective was to encourage people to work in a joint venture to share knowledge about the success of integrating mathematical WP with indigenous games.

The above analysis shows that the empirical data concur with Section 3.6.1 and Section 3.6.2 of the literature review, namely that teaching and learning of mathematical WP within the context of Afromontane learners become a success when done with concrete indigenous games.

In conclusion, one could learn that the success of learners in the elementary grades is attained by learning mathematical WP better with manipulatives from their contexts.

5.6.2 Success of abstract teaching of mathematical WP by creating learning spaces to Afromontane learners

Dunley-Owen (2015:5-7) declares teaching of mathematical WP by creating learning spaces for learners to learn mathematical WP in abstract ways as a societal gain, because it would produce critical thinkers such as builders, architects, surveyors, etc. This is affirmed by Ladele (2013:14), who claims that this could possibly happen if learning spaces could be created by teachers for learners to learn mathematical WP on their own, but under the supervision of their teachers. Contrary to this, Hoong *et al.* (2015:4-5) advance an idea that, before learners would be able to work out mathematical WP in abstract ways, they should first be introduced to concrete ways of learning. Dunley-Owen (2015:8) agrees that if learners learn through manipulatives, they grasp mathematical WP easily and they would not easily forget what they have learnt in class.

During the meeting held in the school hall by the co-researchers where the issue on the table was to find out how one could possibly abstract teaching and learning to bring success in the process of teaching and learning of mathematical WP, team members participated as follows.

When Mrs Kobi was requested to contribute, she said,

Dipalo di bobebe ha di rutwa ka dintho tse tshwarehang (mathematical WP could be easily learnt through the use of manipulatives).

Mrs Lento stated,

Bana ba ka utwisisa dipalo betere ka ho rutwa ka dintho tse tshwarehang (Learners could learn mathematical WP better when they are integrated with the use of concrete objects),

and Mr Lebaka responded,

Yes, I want to agree with the two speakers, especially learners from the elementary grades, but they should also be encouraged to think abstractly as well.

The next part is led by the analysis of the contributions of the first three speakers, followed by a brief dialogue between Mrs Dikeledi and Mr Lebaka, which also led them to a brief presentation by the teacher.

By referring to the following words by Mrs Kobi,

learnt through the use of manipulatives,

the text suggests that the only way that fourth-graders could learn mathematical WP is through the use of the concrete objects. This was further confirmed by the following words by Mrs Lento,

WP is better when they are integrated with the use of concrete objects.

The text suggests the same idea as the one suggested by the latter co-researcher (Mrs Kobi) that the use of manipulatives in the teaching and learning of mathematical WP could make learners learn mathematical WP better. Mr Lebaka, who stated the following,

especially learners from the elementary grades, but they should also be encouraged to think abstractly as well,

also agreed that learners at the Grade 4 level of learning could learn mathematical WP better through the use of manipulatives. He even stressed the point that abstract learning should not be put aside, as it helps learners to think critically. This idea is not aligned to our ontological stance (cf. 2.2.5) where we view the nature of reality together as a team. The fact that learners could only learn mathematical WP better when they are taught in a concrete way might be viewed by other people as unreal, because reality is not one-sided. This is confirmed by Rodrigues and Jan (2012:138), who claim that reality could not only be achieved by thinking, but also by learning abstract thinking. It may prevent students from learning abstract forms, which, according to these teachers are very important.

When Mrs Dikeledi was given the opportunity as a mathematics teacher to contribute, she stated,

Teaching and learning mathematical WP by creating learning space for learners to learn WP is not a serious problem.

Mr Lebaka: *Could you quickly show parents what you mean by that!*

Mrs Dikeledi: *Yes, let me show our parents.*

Mrs Dikeledi demonstrated her presentation on the projector as follows:



Figure 5.26: A flock of sheep activity

Figure 5.26 was intended to check whether learners had accumulated sufficient knowledge of integrating mathematical WP with their environmental settings through concrete objects using the appropriate operational signs.

Parents and Mr Lebaka, the picture that you all see on the screen is a flock of sheep activity (cf. Figure 5.26 above). In this picture I am trying to show my learners that mathematical WP related activities could be easily dealt with when they are shown in the concrete (visible way) way, in the form of pictures and then finally in the abstract way (invisible way). The aim of this activity is to check whether my learners have accumulated sufficient knowledge of integrating mathematical WP with their environmental settings through the concrete objects that would ultimately assist them to solve mathematical WP in the abstract way. In the next section, I would be presenting an activity and thereafter asking two learners to respond.

Activity

If a father has 18 sheep left from his flock and decides to share them all to his 6 children in the family. How many sheep will each child get?

Mrs Dikeledi: I am going to ask Teboho and Lerato to respond to the question.

Teboho: Let me try, Ma'am, and I hope that I will get it correct.

Mrs Dikeledi: Yes, come on, my boy.

Teboho: My answer will be --- ehh! Let me see.

If the father has 18 sheep, then will be shared as follows:

First child=



Second child=



Third child=



Fourth child =



Fifth child =



Sixth child =



Mrs Dikeledi: *Lerato, can you conclude, my girl?*

Lerato: Yes, Ma'am, *let me think.*

Therefore, each child will get a share of three sheep.

Reflective analysis

Figure 5.25 presents an activity using a flock of sheep flock in a concrete way and within the context of the learners (Hott, Isabell & Montani 2014:2). The teacher introduced CPA as a method that could be employed to assist learners in learning mathematical WP in an abstract way (Hoong *et al.* 2015:4-5). Merttens (2012:34-35) describes CPA as a method that could be used by teachers in the elementary grades to develop the real understanding in children, and the actual meaning stands as follows:

C-concrete (visible way of thinking)

P-pictorial (thinking through pictures)

A-abstract (invisible way of thinking)

However, the responses by Teboho and Lerato above indicate that the teacher managed to attain the objectives alluded in the opening paragraph. The learning space created by the teacher was conducive in the sense that learners were given the platform to contribute knowledge in the lesson (Willacy & Calder 2017:6-7). Moreover, the articulated words by the three co-researchers above played a prominent role of motivating everyone in the team (cf. Mrs Kobi, Mr Lento and Mr Lebaka above). Therefore, for these apparent reasons, the team found it necessary to conclude that the fourth-graders could learn mathematical WP abstractly if teachers integrate their lesson plans with concrete substances such as stones, horses, trees, schools, etc.

The data above concur with the social capital (cf. 2.2.2.5) of the CCW framework, namely that the lesson presented by the teacher provided learners with an opportunity to communicate mentally with people and the community resources as well. The use of sheep as one of the community resources assisted Mrs Dikeledi in attaining the objective of integrating mathematical WP with the environmental setting of the children. This is also aligned with the epistemological idea (cf. 2.2.4) of our framework where we saw the teacher allowing herself to share knowledge with the learners in the presentation. In a similar way, we also saw the same teacher engaging other co-researchers in the presentation in the form of a dialogue (cf. Mrs Dikeledi and Mr Lebaka's dialogue above), in order to share knowledge on the successes of creating learning spaces to teach mathematical WP in an abstract way (cf. 4.2.2.3). Boaler,

Williams and Confer (2015:4) claim the idea to be more effective only if it is done under the supervision of teachers to maintain order.

The data analysis above show that the empirical data presented from this section concur with Section 3.6.3 and Section 3.6.4 of the literature review. Both agree that with a conducive learning space created by teachers, learners can use manipulatives to learn mathematical WP effectively on their own.

In conclusion, we have learnt that teaching and learning of mathematical WP in an abstract way becomes meaningful when concrete objects are used.

5.6.3 English as a successful communication tool to teach mathematical WP to Afromontane learners

Boaler *et al.* (2015:1-2) discourage mathematics teachers to use difficult mathematical concepts when presenting their lessons without doing code switching. The idea is confirmed by The National Center on Cultural and Linguistic Responsiveness (2016:22-23), which describes the usage of difficult mathematical WP aspects in the lessons as a waste of time, because learners would not learn with understanding, but by memorising. Hence, Pollard (2002:14) encourages teachers firstly to identify and prepare the difficult mathematical WP aspects that need code switching before going to the class.

- In the meeting held to find out how code switching can be used to bring success to the learning and teaching process of mathematical WP, team members made their contributions as follows:

When Mrs Kobi was requested to contribute, she stated,

Bana ba rona ha ba thusitswe ka codeswitch ba ya pasa (When our children were being helped to learn mathematical WP through code switching pass)

Sekolopata stated,

Boteacher ha ba re thusa ka code switch re a utwisisa mme re a pasa diWP (When our teachers assist us to learn through code switching, we pass mathematical WP)

Mr Lebaka responded,

Yes, code switching assists learners to understand concepts on mathematical WP, but please let us not take much of our time doing code switching.

The next part is led by the analysis of the words articulated by Mrs Kobi, Sekolopata and Mr Lebaka.

By referring to the following statement by Mrs Kobi,

being helped to learn mathematical WP through code switching pass,

the text suggests that if learners are assisted using code switching as a communication strategy, they would definitely pass mathematical WP. This was affirmed by Sekolopata with the words,

us to learn through code switching, we pass mathematical WP.

The text suggests assistance from teachers playing a significant role in assisting learners to do well when learning mathematical WP. This is further confirmed by Mr Lebaka who stated,

Yes, code switching assist learners to understand at this level (Grade 4) of learning.

The text suggests that teachers should continue to code switch when assisting learners with mathematical WP, but they should also consider that when assisting them, they should not spend too much of their time doing code switching in their respective lessons. The texts were aligned with the linguistic capital (cf. 2.2.2.3) of the CCW framework. Both stated that with the use of intellectual and social skills learners attained through communication experiences, they would be able to utilise them appropriately, only if given the time to do so in teaching and learning process of mathematical WP. The idea was also aligned with the PAR objective (cf. 4.2.2.2), namely that learners be assisted by their teachers using code switching as a communication strategy to communicate their problem-solving challenges, rather than being taken as objects in the teaching and learning processes of mathematical WP. This was confirmed by Zuber-Skerritt (2015:12), who claims that whenever learners are assisted using code switching, they would indeed have been motivated and energised to achieve their goals.

Mrs Dikeledi stated,

When preparing my new lessons as a mathematics teacher, I used to identify difficult words and code switch them using semantic method.

Mr Lebaka: *What is a semantic-method teacher?*

Mrs Dikeledi: *Semantic method means the use of the unfamiliar words (difficult to understand) together with their meanings in the form of code switching*

For example: decrease = theoha

increase = nyoloha

Mr Lebaka: *Where did you get this semantic method?*

Mrs Dikeledi: *From the article I read, namely The National Center on Cultural and Linguistic Responsiveness of 2016.*

Mr Lebaka: *Please, go on, Ma'am!*

Mrs Dikeledi: *Think you, Sir.*

Mr Lebaka: *Ok!*

Mrs Dikeledi: *Parents, this semantic method consists of three steps. Allow me at this stage to list and describe each step.*

Three Semantic steps

1. Oral work

This is a step where all the learners in a class have to do oral work from the list of semantic words presented by the teacher.

2. Rough work writing

This is a step where an individual learner has to take out an activity book and write down the list of all the semantic words and then present them back to the entire class to show his or her understanding.

3. Assessment

This is a step where a teacher assesses learners.

Lesson

Topic: Use of subtraction to solve problems

Activity:

Bathole Moketa Trading designs and sells empty boxes. This table shows how many boxes were sold each working day for two weeks.

Week No	Monday	Tuesday	Wednesday	Thursday	Friday
1	5	12	4	8	7
2	2	16	13	3	14

Table 5.2: Number of boxes designed and sold in the Batho le Moketa Trading

This table intends to assess the ability of learners using the number of boxes designed and sold by Bathole Moketa Trading as a vehicle to check whether they have accumulated sufficient skills of solving WP using code switching as a learning strategy.

Questions

1. In Week 1, how many more boxes were sold on Friday than on Wednesday?
2. What is the difference between the numbers of boxes sold on Thursdays in the two weeks?

1. Semantic words : difference = phapang o e fumanang ka ho tlosa

: Many more = ka ho fetisisa kapa ho tlola

2. Three semantic steps in practice

2.1 Oral work

Learners, before we continue with our lesson today, I want us to do oral work of the semantic words above. (Learners are all engaged in the oral work activity)

2.2 Rough work writing

Dear Learners, we are done with the first part of our lesson. Now I want to ask every one of you to take out his or her scribbler to write down the semantic words I have just presented to you. Thereafter, I will ask Mpho, Molemo and Nthabiseng to go to the chalkboard to present their work.

Mpho's responses

1. Difference means phapang

2. Many more means ho tlola

Molemo's responses

a) Difference = phapang

b) Many more= ka ho fetisisa

Nthabiseng's responses

a) Difference is phapang

b) Many more is ho tlola

2.3 Assessment

Learners, we are done with the first and second parts of our work. We are now on our final part of our work. Now, I want Molefe and Tumisang to help us in answering our activity.

Answers from the learners

Molefe's answers

a) Number of boxes sold on Friday in week 1 = □□□□□□□□

Number of boxes sold on Wednesday in week 1=□□□□□ so, the answer is: No of boxes sold on Friday week 1: □□□□□□□□- No of boxes sold on Wednesday week 1:□□□□□ = □□□□ more boxes were sold on Friday.

b) No of boxes sold on Thursday in week 1= □□□□□□□□

No of boxes sold on Thursday in week 2 =□□□□

So, the difference is =

No of boxes sold on Thursday in week 1: =□□□□□□□□□ - No of boxes sold on Thursday in week 2: □□□□ = □□□□□ was a difference.

Tumisang's answers

a) Boxes sold on Friday in week 1 = □□□□□□□□

Boxes sold on Wednesday in week 1= □□□□□ so, to get the boxes sold more on Friday than on Wednesday, I say:

Boxes sold on Friday: □□□□□□□□□-boxes sold on Wednesday: □□□□□=□□□□ more

b) Boxes sold on Thursday week 1= □□□□□□□□

Boxes sold on Thursday week 2 = □□□so, the difference is:

Boxes sold on Thursday week 1: □□□□□□□-boxes sold on Thursday week 2:

□□□=□□□□□ was a difference

Reflective analysis of the lesson presented

The lesson presented by the teacher was in the context of the learners, because the teacher used boxes that were designed by a local businessperson as a vehicle to check whether learners had accumulated sufficient skills to use code switching as a learning strategy in the teaching and learning of mathematical WP. The questions presented by the teacher were aligned with the semantic method where the semantic words and three steps were observed. In the oral presentation, all learners were given time to engage in the oral work (cf. 2.1 above) in the rough-work writing step. Learners were also engaged in writing, while other learners were requested to present their responses to the rest of the class. These responses were promising, because learners had them correct (cf. 2.2).

Finally, in the assessment step, learners were also found to be performing extremely well using similar and different approaches to respond to the two questions cf. 2.3). The learning platform was created for them to present their answers to the class, in line with one of the objectives of PAR (cf. 4.2.2.3), which stipulates that PAR creates spaces for co-researchers to present their unique skills and ideas in the teaching and learning of word sums. This also is affirmed by the social capital (cf. 2.2.2.5) of the CCW framework, where it allows people to communicate with other people or community resources to attain their goals. For the purpose of this study, it was found that learners are given opportunities to share their knowledge with other learners in the form of presentations. Johansson (2013:8) advanced an idea that to have opportunities to use two or more languages, one becomes bold to communicate the ideas freely.

From the above empirical analysis, it transpired that Section 3.6.5 from the literature review concurs with the empirical data from this section. Both mention code switching as a good strategy that could be used by teachers to emphasis and clarify important aspects in the teaching and learning of mathematical WP.

In conclusion, it became clear that code switching plays a prominent role in the teaching and learning of mathematical WP, because it helps the teacher and the learner to code switch into the language they both understand in order to minimise mathematical WP misconceptions.

5.7 SUMMARY

This chapter commenced with an introductory section where an overview of the route to be undertaken was presented. It entailed a section whereby a need to formulate a context-based strategy for teaching and learning of the phenomenon of interest was addressed. Furthermore, the five objectives aligned with the empirical data generated from the research field by the co-researchers were presented, discussed and analysed through the application of CDA as a tool, in line with the CCW as a theoretical framework of our study and PAR as a research approach. In addition, cross-referencing between Chapters 3 and 5 was done in order to determine whether the empirical data presented in Chapter 5 refuted or agreed with the ones from the literature review. Finally, a conclusion was drawn from each of the five objectives, leading to the final chapter where the research findings and recommendations are presented.

CHAPTER 6: FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND THE PRESENTATION OF THE STRATEGY

6.1 INTRODUCTION

This study aimed to design a context-based strategy to enhance the teaching and learning of mathematical WP to Afromontane learners. This chapter focuses on the background of the study, reflecting on how the problem envisaged by the Afromontane learners could be addressed. This reflection was coupled with five objectives of the study, ensuring that an enhancement process in the teaching and learning of mathematical WP takes place properly. The findings and recommendations will be presented by comparing the literature review, coupled with the empirical data generated from the research field. A presentation based on how a context-based strategy could be designed to enhance teaching and learning of mathematical WP to the Afromontane learners is given. Finally, a conclusion is drawn.

6.2 BACKGROUND TO THE STUDY

The study aims to design a context-based strategy to enhance teaching and learning of mathematical WP to Afromontane learners. Afromontane learners geographically refer to mountainous learners located in rural areas (Da Silva 2015:viii). Thus, in the context of this study, Afromontane learners form part of the social construct of learners that live in these mountainous places, drawing from the wealth of their cultural and indigenous knowledge. However, the wealth of knowledge that has sustained Afromontane learners is often marginalised in the teaching and learning of mathematics, particularly with regard to mathematical WP (Lucero 2010:127). In addition, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ III) of 2011 states that the task-given instructions by the teacher should link mathematics with cultural knowledge. The Mathematics Curriculum Assessment Policy Standard (CAPS) defines mathematics as a human activity aiming to build relations in physical and social phenomena and between mathematical objects themselves (Department of Basic Education 2011:8). Thus, this definition creates a platform for Afromontane learners' ways of knowing and teaching mathematical WP in

Grade 4, grounded in their social and physical context. Mloi (2014:486) argues that learners do not perform well in mathematics problem solving, because the wealth of knowledge they bring to the classroom is marginalised, substantiating my claim as a novice researcher. For this reason, I advanced the idea that there should be a context-based strategy designed to enhance the teaching and learning of mathematical WP of Afromontane learners, and the strategy should be contextualised within the Afromontane context. It is expected that learners would be able to interpret, analyse and convert words into mathematical symbols, and apply mathematical operations correctly, which will be achieved through context-based pathways of teaching and learning.

6.2.1 Problem statement

The main aim of this study was to design a strategy that would enhance teaching and learning of mathematical WP to Afromontane learners. The motive behind designing this strategy was to ensure that the indigenous skills and cultural wealth of the Afromontane learners are recognised and put into practice in the teaching and learning process of mathematical WP. The DBE (2014:18) reveals that fourth-graders in South Africa lack skills of converting mathematical WP into number sentences, because they do not learn them within their context. Various literature reviewed also shows that learners in African countries and globally experience similar challenges (SACMEQIII 2010:5; TIMSS 2015:53). In view of these critical challenges, it is clear that there is a need to design a context-based strategy that will enhance the teaching and learning of mathematical WP of Afromontane learners. Based on the afore-mentioned reasons, it is hoped that this strategy would assist in bridging the prevailing gap.

6.2.2 Research question

How can a context-based strategy be designed that will enhance teaching and learning of mathematical WP of Afromontane learners?

6.2.3 The aim of the study

To design a context-based strategy that will enhance the teaching and learning of mathematical WP of Afromontane learners.

6.2.4 The objectives of the study

The objectives of the study are as follows:

- to identify the challenges in the teaching and learning of mathematical WP of Afromontane learners;
- to investigate solutions for challenges experienced in the teaching and learning of mathematical WP of Afromontane Grade 4 learners;
- to analyse the condition conducive to the implementation of a context-based strategy for the purpose of sustainability beyond the duration of the study;
- to investigate the threats and the risks for implementation of a context-based strategy in the teaching and learning of mathematical WP; and
- to identify indicators of success for the implementation of a context-based strategy in the teaching and learning of mathematical WP.

6.3 FINDINGS AND RECOMMENDATIONS

The findings and the recommendations for this study are guided by the research outcomes, which were found to be unresolved. Therefore, to narrow this gap, the findings and the recommendations are presented as follows:

6.3.1 Finding 1

6.3.1.1 Inadequate skills to teach mathematical WP within the context of the learners forced some teachers to use rote teaching (algorithmic approach)

The literature review (cf. Section 3.21) and the empirical data generated from the research field (cf. Section 5.2.1) revealed that teachers still employ traditional ways (algorithmic ways) of teaching mathematical WP and, as a result, they fail to teach mathematical WP within the context of their learners.

6.3.2 Recommendation 1: Conditions and the anticipated threats

6.3.2.1 Collaborative teaching and learning with the hands-on strategies

Teaching and learning of mathematical WP within the context of the learners need collaborative or cooperative learning, where learners are given platforms to learn

mathematical WP on their own and at their own pace in a free environment. Data presented from the literature review (cf. Section 3.3.1) and the empirical section (cf. Section 5.3.1) affirm that teaching and learning of mathematical WP within the learner context could easily happen when mathematical WP lessons are interwoven with the learner environment. In Chapter 3, the universal activity about horseracing is used as an example (cf. Figure 3.1). All learners can learn about horseracing, regardless of their background or learning setups. The literature review in Chapter 3 considers the learning conditions conducive when learners are given platforms to learn mathematical WP on their own within a classroom setting (cf. Section 3.4.1). As indicated in Chapter 5, during my observations when empirical data were generated from the field, I noted that teachers created learning conditions conducive to their learners (cf. Section 5.4.1).

In the light of the above, anticipated threats would be watching teachers engaging with learners during the process of learning mathematical WP, not within their context, but neglecting indigenous games as one of the best strategies to enhance teaching and learning of mathematical WP. In addition, some took a risk, using these without official documentation guiding them (cf. Sections 3.5.1–3.5.2; 5.5.1). However, in addressing threats and risks that might hinder good practices in the teaching and learning of mathematical WP, I advise teachers and the SMT working in collaboration with the parents to establish a Threats Assessment Team (TAT). This team should comprise one member each from the South African Police Services (SAPS), the School-Based Support Team (SBST), the SMT and the School Governance component to address risks and threats.

6.3.3 Finding 2

6.3.3.1 Insufficient skills integrating and implementing indigenous games with mathematical WP

The literature review (cf. Section 3.2.2) and the empirical data (cf. Section 5.2.2) presented showed that teachers lack the skills to integrate and implement their lessons with indigenous games and as a result, learners cannot convert indigenous games into mathematical WP.

6.3.4 Recommendation 2: conditions and anticipated threats

6.3.4.1 The use of indigenous games to bridge the gap between traditional and western practices

Teaching and learning of mathematical WP using indigenous games as learning materials play a significant role in bridging the prevailing gap between traditional and western ideologies. This was affirmed by the literature review (cf. Section 3.3.2) and the empirical data (cf. Section 5.3.2), which presented and recommended indigenous games as one of the best strategies that could be used to bridge the gap between traditional and western practices. With the use of Figure 3.2 cited as an example, the use of a coordination game in Section 5.3.2, as well as the positive responses by the learners from Group A and Group B, respectively, drives one to recommend indigenous games as strategy that could be employed in the teaching and learning of mathematical WP.

However, with regard to the conditions and anticipated threats, this section (6.3.2.1) addresses the same issues.

6.3.5 Finding 3

6.3.5.1 Abstract teaching and learning of mathematical WP still remains a challenge

The literature review (cf. Section 3.2.3) and the empirical data (cf. Section 5.2.3) presented the ideas that teachers recommended abstract teaching and learning of mathematical WP as of vital importance, but they lacked the pedagogical skills to implement these effectively and efficiently.

6.3.6 Recommendation 3: Conditions and anticipated threats

6.3.6.1 Teaching and learning of mathematical WP by using concrete objects

Abstract teaching and learning of mathematical WP become meaningful if the conceptual objects are converted into concrete objects. The literature review (cf. Section 3.3.3), together with the empirical data, presented the same message, stating that teaching and learning of mathematical WP in an abstract way make sense through the use of concrete objects. Figure 3.3 provided an example of the use of the manipulatives, while Figure 5.8 affirmed the fact that learners could learn

mathematical WP better by using manipulatives. For these apparent reasons, I recommend the use of indigenous games as one of the best strategies that could be used in the teaching and learning of mathematical WP.

However, with regard to conducive conditions, teachers should create learning spaces for learners to study mathematical WP on their own, at the same time learning from others how to share knowledge or skills when doing problem solving. Free participation and creative thinking by learners lead one to believe that teaching should be learner-centred rather than teacher-centred (cf. Sections 3.4.3; 3.4.4; 5.4.2).

In the light of the above, the anticipated threats for the study were found to be in line with the traditional way of teaching and learning mathematical WP. During my observations, I noted that in some mathematics classes, teachers were still engaged in the traditional way of teaching; that is, shouting and holding sticks to impart mathematical WP knowledge to learners, while learners observed and listened in fear. Indeed, in a learning environment like that, one should expect the learning atmosphere to be apprehensive (cf. Sections 3.5.1–3.5.2; 5.5.1).

In addressing these threats and risks, as a novice researcher, I would advise the SMT to work in collaboration with parents to establish the afore-mentioned Threats Assessment Team (TAT). The TAT should draw up a programme indicating how, when and where these threats could be addressed, and provide feedback to the victims, wherever possible,

6.3.7 Finding 4

6.3.7.1 Creating a learning environment remains a challenge in the teaching and learning of mathematical WP

The literature review (cf. Section 3.2.4) and the empirical data (cf. Section 5.2.4) revealed that teachers faced challenges regarding the issue of creating learning spaces for learners to learn mathematical WP at their own pace. One of the major concerns was limited time allocated for teaching and assessing of learners. Some appeared to divorce themselves deliberately from creating the learning spaces, because they seemed to avoid situations where they would fail to catch up with their pacesetters.

6.3.8 Recommendation 4: Conditions and anticipated threats

6.3.8.1 Connecting conceptual world with the real world

Creating learning spaces could become meaningful if learners were given a platform to connect the real world (actual world) with the conceptual world (fantasy or mental world), using manipulatives give sense to the learning process of mathematical WP sense. Figures 3.4 and 5.8, cited as examples from the previous chapters, confirmed that teaching and learning of mathematical WP could become easier to learn if a platform were created for learners to use the skills acquired in the past to connect the real world with the conceptual world. As a mathematics teacher, I also noted that elementary learners could learn mathematical WP much easier when a lesson is connected with the indigenous games and other relevant concrete objects within their context.

The anticipated threat raised by teachers during the research proceedings was that they only had limited time to create a platform for their learners to connect the two worlds in the classroom settings. In addressing this threat, I would advise our teachers to work with parents to prepare and present extra classes to address the threat.

However, with regard to the conditions and anticipated threats, this section (cf. Section 6.3.7.1) addressed the related issues.

6.4 PRESENTATION OF A CONTEXT-BASED STRATEGY FOR TEACHING AND LEARNING OF MATHEMATICAL WP TO AFROMONTANE LEARNERS

The purpose of this chapter was done to define the need to design the strategy, the definition of the strategy which covers the introductory part in the form of the scenario, followed by a picture and a brief analysis of mathematical WP skills that could be accumulated by learners. The integration and application of the strategy that led to the conclusion were also highlighted.

6.4.1 The need to design a context-based strategy

This strategy is based on bridging the prevailing gap between African and Western ideologies regarding teaching and learning of mathematical WP (Khupe &Keane

2017:26-27). Nkoane (2006:51-52) claims that the outsourcing of African indigenous skills and games is the main cause. This claim is supported by Kaya and Seleti (2013:35-36), who indicate that the Western systems colonise and demoralise the African indigenous knowledge systems with the aim to promote their Western ideologies. However, in the context of promoting African indigenous knowledge for a sustainable livelihood, Moloji (2015:23-24) propagates the incorporation of indigenous games such as *morabaraba*, *kgati*, etc., to assist learners in identifying mathematical concepts rooted in these games. This concurs with Mosimege (2016:458), who maintains that playing these indigenous games should not be viewed from the narrow perspective of play, enjoyment and recreation, but rather to ensure that problem-solving skills are taught effectively. Learners also show full participation during the lesson presentations. The use of indigenous game in teaching problem-solving skills contextualises the subject matter for learners to access it easily.

Yosso (2005:79) argues that the navigational skills, social capital and linguistic capital learners possess are critical for understanding abstract problem-solving skills offered in mathematics classes. For example, navigational skills are evident even at a very young age, when children are able to navigate the maps of their environments, such as map to the bathroom, or the path to the playground. It is evident that the social home environments can be used effectively to teach problem-solving skills. The theory of community cultural wealth is enriched by the home environment. Consequently, home environments demonstrate the wealth of these capitals. This shows that learners learn various forms of content on problem-solving skills from everything that happens to them and in their immediate environments. In the Eastern Free State, we have learners who are geographically located in mountainous places and who have a wealth of knowledge that has sustained them for a long time. However, it is evident that this wealth is often marginalised in the teaching and learning of mathematical WP (Nyaka, *Guard News* 26 September 2018:1; ARU, *Ke eo taba QwaQwa Campus Newsletter* 9 October 2015:4).

On the basis of this consideration, I decided to design a context-based strategy to enhance the teaching and learning of mathematical WP to Afromontane learners. My claim is substantiated by Da Silva (2015:viii), who declares that these learners form part of the social construct of people who live and subsist in these mountainous places,

and they should work with their teachers to analyse and reveal related mathematical concepts embedded in the wealth of their cultural and indigenous knowledge.

6.4.2 Defining a context-based strategy

As a novice researcher, I learnt from the previous studies conducted by other researchers that African countries like South Africa have less instructional time during the day than countries like Singapore, Japan, France and Australia (Leone, Wilson & Mulcahy 2010:1). Lately, The South African Numeracy Chair [SANC] (2013:1-4) has commenced with a project called “Afterschool Mathematics Club” to encourage parents to join their programmes so that they may assist their children with mathematics, particularly mathematical WP. This project is intended to create conducive learning spaces for schoolchildren to learn mathematical WP free from curriculum and assessment-driven teaching practices, after school hours. This project presents a variety of ways in which mathematics can be taught to elementary learners. One of the strategies is to encourage teachers to assist their learners in learning mathematics through indigenous games. This claim is affirmed by recent studies conducted by Moloji (2013:124-126), and Nkopodi and Mosimege (2009:377-378), namely that, through indigenous games, learners can learn mathematical concepts better and with understanding.

Therefore, my claim as a novice researcher and Grade 4 mathematics teacher to design a context-based strategy was driven by the fact that I observed fourth graders struggling to learn mathematics better, particularly mathematical WP (Kaya & Seleti 2013:31-36). Having noted their struggle, I introduced *diketo* (a coordination game) and indicated how the game could be utilised as a context-based strategy to develop the learners’ number vocabulary, number concept, and calculations so that they could see the role play by mathematics in real-life situations (DBE 2011:8-9). In my attempt to design the strategy, I also presented a scenario to give my readers a picture of how the game is played. Herewith the scenario:

I must indicate that much of the focus was not on the scenario as such, but on the idea to assist me in identifying the keywords so that I may design a context-based strategy to enhance teaching and learning of mathematical WP. For the purpose of this study, I identified words such as *mokh’u*, players, hole and *diketo* as my keywords. Readers must take note that the following descriptions were made from my context.

Words	Descriptions
1. <i>mokhu</i>	the main stone used by the players to control the game
2. <i>diketo</i>	the small stones placed by players in the hole
3. players	contestants or competitors in the game who keep the game running.
4. hole	a flat surface on the ground identify by players to place <i>diketo</i> into.

Table 6.1: Words and descriptions

This table presents the descriptions of words that can assist learners in integrating *diketo* with mathematical WP during the game.

The following figure illustrates how the game is played.



Figure 6.1: Diketo as an indigenous game (Adapted from: traditional games in Kenya –Kora <https://www.youtube.com>)

Figure 6.1 presents three children playing *diketo* as an indigenous game. It further shows how the game is played and what materials are needed to get it running.

By observing the figure, one can learn variety of mathematical skills, for example: one can learn how to count, develop his vocabulary, learn conversions and calculations skills. For example:

- **Learning to count**

Figure 6.1 presents a certain number of players who are playing *diketo* as an indigenous game. These players can be counted as Player 1, Player 2 and Player 3. In our context, this counting can be converted to Player 1, Player 2 and Player 3 in mathematical WP.

- **Learning to develop a vocabulary**

Learners can learn to develop their vocabularies by learning from the following list and description of words.

Players means participants taking parts in the indigenous game

Mokh'u means the main stone in the indigenous game

Diketo means the small stones use by players to get the game running

Hole means a flat surface on the ground designed by players to place the small stones (cf: Table 6.1; Figure 6.1).

- **Learning to convert**

Our learners can learn conversion of mathematical symbols or numbers into mathematical WP from the following descriptions.

Player 1 can be converted into Player one

Player 2 can be written as Player two

Player 3 can be written as Player three

- **Learning to calculate**

By observing the picture in Figure 6.1, one learner can learn how to determine (count) the total number of small stones (*diketo*) before the game starts, and at the same time identify an appropriate operational sign needed, the addition sign (+). Next, to determine the total number the small stones in the hole before the game started, a learner can do the following:

Observe the picture, look into the hole and check the number of small stones left and counted them. Again, observe the number of small stones scooped by all players in the game.

Let us assume that both Player 1 and Player 3 have scooped nothing from the hole. In that case, a learner can state the following:

The total number of small stones left in the hole is equal to seven; the number of small stones scooped by Player 1 is equal to zero; the number of the small stones scooped by Player 2 is equal to one; and the number of small stones scooped by Player 3 is equal to zero.

To determine the total number of the small stones before the game started, a learner can say:

Seven small stones plus zero small stones plus one small stone plus zero small stones are equal to eight small stones. ($7 \text{ small stones} + 0 \text{ small stones} + 1 \text{ small stone} + 0 \text{ small stones} = 8 \text{ small stones}$).

If a learner wants to determine the total number of small stones left in the hole, then he/she has to observe Figure 6.1 above, and check the total number of the small stones left in the hole and the total number of small stones held by each player. For this an appropriate operational sign is needed, and the appropriate sign is the subtraction sign (-). From there, she can utter the following mathematical statement in words:

Total number of the small stones before the game started is equal to eight small stones, total number of the small stones scooped by player one is zero, total number of small stones scooped by Player 2 is one and total number of small stones scooped by player three is zero.

In order to determine the total number of the small stones left in the hole, from this analysis, she can say:

Total number of the small stones before the game started subtract the total number of small stones scooped by player one subtract the total number of the small stones scooped by player two subtract the total number of the small stones scooped by player three is equal to seven small stones. ($8 \text{ small stones} - 0 \text{ small stones} - 1 \text{ small stone} - 0 \text{ small stones} = 7 \text{ small stones}$).

Now, if she wants to determine which player out of three players has managed to scoop more small stones from the hole than others, she has to observe the figure and compare the number of stones hold by each player; then also think of an appropriate sign or signs to match. The appropriate signs are greater than ($>$) or less than ($<$) and equal sign ($=$). These signs might be used to illustrate matching of small stones carried by each player in the following manner.

- **Player 2 scooped more small stones than Player 1**

This implies that when comparing the number of small stones scooped by Player 2 and Player 1, one notes that Player 2 scooped more small stones than Player 1 did (Player 2 $>$ Player 1).

- **Player 3 scooped fewer small stones than Player 2: Player 3 $<$ Player 2**

This implies that when comparing the number of small stones scooped by Player 3 and Player 2, one notes that Player 3 scooped fewer small stones than Player 2 (Player 3 $<$ Player 2)

- **Player 1 and Player 3 scooped the same number of small stones: Player 1 = Player 3**

This implies that when comparing the number of small stones scooped by Player 1 and Player 3, the total number of small stones scooped by both players are the same (Player 1 = Player 3).

From the discussions, one can learn that mathematical symbols or numbers were converted into mathematical WPs. In the next table, conversions are presented in the form of a summary.

Mathematical symbols (symbolic form)	Mathematical WP (word form)
Player 1	Player 1
Player 2	Player 2
Player 3	Player 3
=	Equal sign
+	Addition sign
>	Greater-than sign
<	Less-than sign

Table 6.2: A summary of mathematical conversions

The table intends to show a conversion summary of the analysis made of Figure 6.1 above. This table is divided into two parts, namely the symbolic part and the part on the word form, where the symbols have been converted into words. The next part is guided by example of an activity reflecting back to Figure 6.1 as to how *diketo* could be used as a context-based strategy to enhance teaching and learning of mathematical WP. This activity was informed by the example in Table 6.1 indicating how the mathematical symbols could be converted into mathematical word problems or vice versa.

The next part is led by example of an activity relating to the integration of *diketo* and mathematical WP.

Activity:

Player 1 has scooped three small stones from the hole; Player 2 has scooped two small stones from the hole; and Player 3 has scooped two small stones from the hole. How many small stones have been scooped from the hole by the players altogether?

Solution

Before our learners can rush to a solution, they have to identify a mathematical key word from the question. The key word is 'altogether'. Reflecting back to the conversion table above, the learner has to understand that he has to convert a key word 'altogether' into a mathematical symbol, which could be done as follows:

'Altogether' means that one has to 'add', and addition is represented by (+) in a symbolic form; therefore, to determine the total number of small stones which have been scooped from the hole by the players, we have to do the following:

The total number of small stones scooped by Player 1 equals three, total number of small stones scooped by Player 2 equal two and the total number of small stones scooped by player three is equal to two.

Thus, we write our sum as follows:

The small stones scooped by player one plus the small stones scooped by player two plus the small stones scooped by player three is equal to the sum of seven small stones altogether (3 small stones + 2 small stones + 2 small stones = 7 small stones).

The next part is led by reasons why *diketo* was chosen as a context-based strategy to enhance teaching and learning of mathematical WP.

The next part is led by the reasons why *diketo* was chosen as a context-based strategy to enhance teaching and learning of mathematical WP.

- equipment is user friendly

The reason why I decided to employ *diketo* as a context-based strategy to enhance teaching and learning of mathematical WP was that the game is accessible; it creates a platform for learners to play it anytime they want, and it is played without paying any money. The learning equipment or materials are accessible and user friendly; whenever learners want to play it, they simply have to group themselves, dig a small hole, go round to look for the small stones to play with, and play it (cf. Figure 6.1 above).

- game is contextualised

The game is played in a free or relaxed environment, where learners are free to integrate it with mathematical WP. Learners look around for a free, a relaxed playground, or a floor to play on it. They play the game on their own and with their own pace (cf. Figure 6.1 above).

- game is concretised

Learners use concrete objects to play the game, for example, they use stones and floors to play the game (cf. Figure 6.1 above).

- game is vocabulary orientated or aligned

Before learners are engaged in a game, they have to know what *diketo* is, how many players are needed for the game, and what types of stones are needed to play the game. They normally select different stones for the game and name them, for example, *mokh'u* and *diketo* (cf. Figure 6.1; Section 6.4.2).

6.4.3.1 The application of diketo as a context-based strategy to enhance teaching and learning of mathematical WP

It became evident through the literature review that success comes by creating a safe and welcoming environment for the elementary learners to apply their skills and connect new content knowledge with prior knowledge in the teaching and learning process of mathematical WP. It was also noted that through the use of manipulatives, they could learn mathematical WP better and with understanding (cf. Section 3.6.1–3.6.2).

The empirical data presented in Chapter 5 showed similar experiences that elementary learners learn mathematical WP better through concrete teaching and through concrete teaching, they could be able to integrate the concepts on mathematical WP with concrete objects within their context (cf. Section 5.6.1–5.6.2). However, by referring back to Figure 6.1 above, it was evident that whenever *diketo* players want to win their games, they have to be sensitive and think critically when throwing *mokh'u* (the main playing stone) up and down, and scooping *diketo* (the small playing stones) from the hole to get the game running (cf. Figure 6.1 above).

In line of the above views, I noted that one could design a related activity to the indigenous game under discussions.

For example: activity

- (a) How many small stones were in the hole before the game started?

Before responding to the question, learners had to observe all the pictures appearing in Figure 6.1 above, and figure out which operational signs were relevant and needed to solve the problem, as well as look thoroughly at the small stones scooped by an

individual player from the hole, and add the remaining small stones in the hole with the total number of small stones scooped by the three players from the hole.

Solution

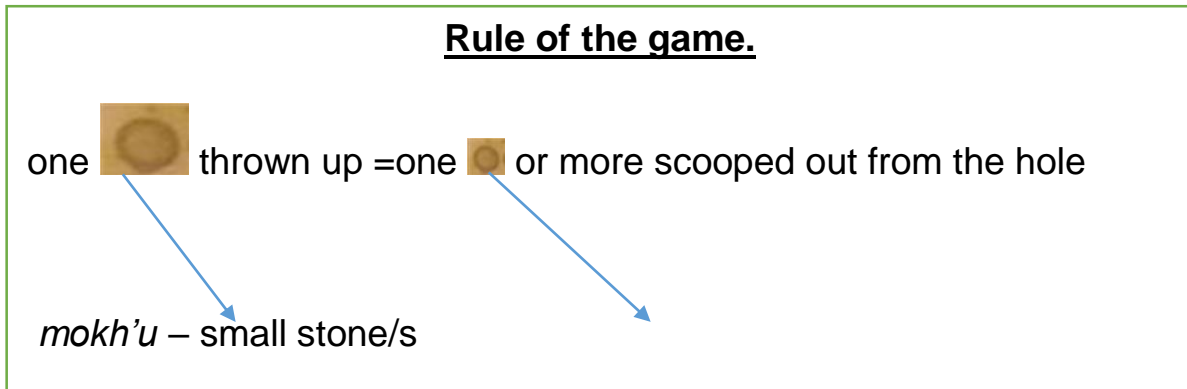


Table 6.3: A summary of rules for *diketo* game

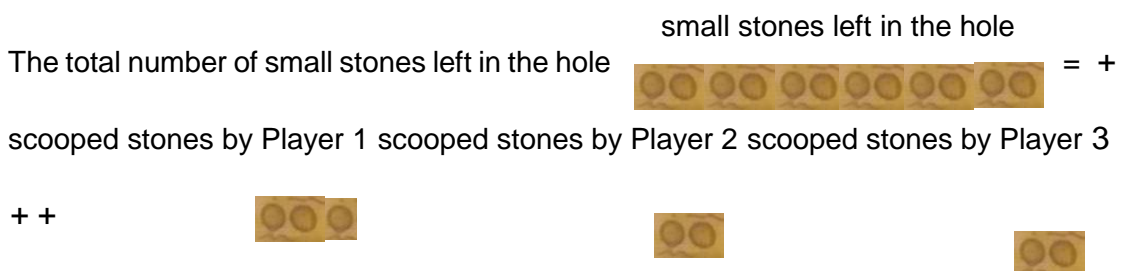
This table intends to show us that whenever a player throws *mokh'u* up into the air for the first time, the first throw is equal to one or more scoops of the small stones from the hole by the player.

The next part is led by the solution of the activity provided above.

The total number of small stones before the games started is equal to the total number of *diketo* left in the hole during the game, plus the number of *diketo* scooped by player one from the hole, plus the total number of *diketo* scooped by player two from the hole, plus the total the number of *diketo* scooped by player three from the hole. For the sake of clarity, one has to say:

The total number of the small stones before the game = the total number of the small stones remaining in the hole + total number of the small stones scooped by Player 1 from the hole + total number of small stones scooped by Player 2 from the hole + total number of small stones scooped by Player 3 from the hole.

In the next part I tried to show my readers how we could possibly sum up the solution by concretising it. To concretise our solution we have to say:



In addition, one can learn from Kihe (2017:775), who cites Polya’s 1985 model on problem-solving techniques with four steps, namely understand the problem; devise a plan; carry out the plan; and reflect back. In a similar way, Sánchez (2010:26) advanced five steps as interactive classroom strategy, namely defining the problem, searching for relevant cues, comparing, visualising and summing up.

However, as a novice researcher, I also noted that the following five steps could have a huge impact in the teaching and learning process of mathematical WP.

The table below provides the highlights of the steps, followed by the full descriptions how the steps could be implemented in the teaching and learning of mathematical WP.


	I-	Identify a problem
	C-	Circle unfamiliar words
	C-	Concretise and interpret
	C-	Contextualise
	O-	Operationalise and solve

Table 6 4: *Diketo as a problem-solving technique*

This table shows the five steps on problem solving suggested by the researcher in the teaching and learning process of mathematical WP.

The next part is guided by the descriptions of the five steps as suggested by the researcher aligned with the intakes presented by Kihe and Sánchez from the above discussions.

1. Identify a problem

Define a problem/find an actual problem to address

2. Circle unfamiliar words

Identify new words with your learners, which you think your learners are not well conversant with, or allow your learners to utilise words from one’s vocabulary to give a problem sense.

3. Concretise and interpret

Draw a picture in your mind aligned to your problem and try to interpret it according to your understanding.

4. Contextualise

Align your thinking around concrete objects that you know around you and your place.

5. Operationalise and solve

Think of an appropriate operational sign/s that you can fit into your mathematical sentence to give it sense and solve the equation.

6.4.3 The integration and application of the strategy

The manifestation of *diketo* as a context-based strategy in the teaching and learning of mathematical WP will be two-fold, namely the application as well as the result. The aim is to show how this strategy could be utilised in order to enhance teaching and learning of WP in the formal and informal settings.

6.4.3.2 The integration of *diketo* with mathematical WP

This figure serves as a practical example intended to show us how learners could possibly strike a balance between teaching and learning of mathematical WP at home and school, between the conceptual world and the real word.

Example:



Figure 6.2: A balance scale (Adapted from: <https://www.youtube.com>)

According to Sam (2017:58-63), if one has to strike a balance between two entities by using the balance scale named 'Pan-Balance-Approach', one has to be steady in terms of striking a balance rightfully. In the context of the study, the correct way of striking a balance is to integrate mathematical WP lessons with the environmental settings of learners (Anthony 2015:38). In addition, I view the correct of striking a balance as to encourage our teachers to integrate their mathematical WP lessons with *diketo* as an indigenous game, because we have learned that learners can learn a variety of mathematical skills from this indigenous game (cf. Tables 6.1, 6.2 & 6.3).

Equally important, Jitendra (n.d.:18-19), the National Association for the Education of Young Children [NAEYC] and the National Council of Teachers of Mathematics [NCTM] (2010:4-5) also indicate that the issue of striking a balance between mathematical WP and *diketo* should be seen operating in the conceptual world (imaginary world), and the real world (actual world), between formal schooling and informal schooling. For example,



Figure 6.3: Diketo as an indigenous game: reflection activity

This activity serves an echo of Figure 6.1. Its objective is to indicate how learners can strike a balance between formal setting (school) and informal setting (home) during

the learning process of mathematical WP. It further intends to assess and develop the ability of learners with counting skills.

The next section is guided by the example of activity that could be given to learners in the form of a homework to suggest a balance between formal and informal settings.

Homework

Instruction

By referring back to Figure 6.3 above, at this stage, learners can be requested to go home and do the activity with their parents, siblings or any community members.

Questions

1. Double the total number of players in the game.
2. Double the total number of the small stones left in the hole and halve them.
3. What is the difference between the total number of small stones scooped by player 1 and player 2 from the hole 2?

6.5 SUMMARY

This chapter provided a summary of the problem statement, research question and the aim and the objectives of the study, namely to teach mathematics to Afromontane learners. The findings and recommendations were discussed. The context-based strategy was presented, and the application and integration of the strategy with mathematical WP were made known. Finally, a conclusion was reached.

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The District Director
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Dear Ms Mabaso

NOTIFICATION TO CONDUCT RESEARCH PROJECT IN YOUR DISTRICT BY K T SIBAYA

1. The above mentioned candidate was granted permission to conduct research in your district as follows:

Topic: A context-based strategy for teaching and learning of word problems for Afromontane learners

List of schools involved: Majara and Tabola Intermediate schools in Thabo Mofutsanyana District.

Target Population: 2 Grade 4 – 6 Mathematics teachers and 1 HOD responsible for Grade 4 – 6 Mathematics.

2. **Period:** From date of signature of this letter to 30 September 2018. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year nor during normal school hours.
3. **Research benefits:** Learners' performance in Mathematics will improve because they will realise that their indigenous knowledge and cultural wealth they possess from home form part of mathematical skills and mathematical concepts they learn from schools. This indigenous ideology does not deviate from the CAPS document because it frames teaching of mathematics using indigenous skills as a provocative role that could be played by teachers and parents to assist children to learn mathematics better. This is also aligned to our research methodology, Participatory Action Research (PAR) which allows parents, teachers and other relevant stakeholders to work together to develop the confidence of learners learning maths by using indigenous games and skills they possess from home.
4. Logistical procedures were met, in particular ethical considerations for conducting research in the Free State Department of Education.
5. The Strategic Planning, Policy and Research Directorate will make the necessary arrangements for the researcher to present the findings and recommendations to the relevant officials in your district

Yours sincerely


DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 19/02/2018

RESEARCH APPLICATION SIBAYA KT NOTIFICATION EDITED 09 FEB 2018. TM DISTRICT
Strategic Planning, Research & Policy Directorate
Private Bag X20565, Bloemfontein, 9300 - Old CNA Building, Room 318, 3rd Floor, Charlotte Mexeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 Fax: (086) 6678 678

Dear Mr Khanyae Sibaya

Ethics Clearance: A context-based strategy for teaching and learning of word problems for Afromontane learners

Principal Investigator: Mr Khanyae Sibaya

Department: School of Education Studies (Bloemfontein Campus)

APPLICATION APPROVED

With reference to your application for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2016/1290**

This ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours faithfully



Prof. MM Mokhele
Chairperson: Ethics Committee

Education Ethics Committee
Office of the Dean: Education
T: +27 (0)51 401 9683 | F: +27 (0)86 546 1113 | E: NkoaneMM@ufs.ac.za
Winkie Direko Building | P.O. Box/Posbus 339 | Bloemfontein 9300 | South Africa
www.ufs.ac.za



P.O.Box 13549
Witsieshoek
9870
02 February 2018

Research Participant
Makhaloaneng Village
9870

Dear research participant

RE: PARTICIPATION OF THE RESEARCH PARTICIPANT IN THE RESEARCH PROCEEDINGS

I am doing a research with the University Of Free State Qwaqwa Campus .The aim of the study is to enhance teaching and learning of mathematics word problems for the Afromontane learners. I refer Afromontane learners as the learners who are located in the rural and mountainous places. And these learners form part of the social construct of learners that live and subsist on the mountainous rural places and also who use their indigenous knowledge and cultural wealth to sustain their livelihood. For these apparent reasons, I found it necessary to include you as one of the research participants in the research proceedings with a view that with your indigenous knowledge and cultural wealth you have will assist in enhancing teaching and learning of word problems within the context of these learners. The research study will be conducted in the afternoon not during the school hours to disturb normal tuition.

In the light to the above, I also want to assure you as a participant that your will be protected in these research proceedings, that is your privacy or dignity will not be infringed. And I also want to assure that you will be free to withdraw from these research proceedings at any time without any intimidations. For further details, don't hesitate to call me from the following cell phone no: 072 18 55425, my e-mail address: sibayakt@gmail.com.

Thank you in anticipation.

Khanyae

Letsatsi

NB: The next part of the request is guided by the consent form that you could fill as a parent to agree that your child will participate in the research proceedings.

A CONSENT FORM

This serves as a confirmation that a research participant takes a decision to take part in the research proceedings.

A.RESEARCH PARTICIPANT

Names :

Address :

.....

Contacts

Signature :

Date :

P.O. Box 13549
Witsieshoek
9870
02 February 2018

Parent/Guardian
Makhaloaneng Village
9870

Dear Parent/ Guardian

RE: LEARNER PARTICIPATION IN THE RESEARCH PROCEEDINGS

I am doing a research with the University Of Free State Qwaqwa Campus .The aim of the study is to enhance teaching and learning of mathematics word problems for the Afromontane learners. I refer Afromontane learners as the learners who are located in the rural and mountainous places. And these learners form part of the social construct of learners that live and subsist on the mountainous rural places and also who use their indigenous knowledge and cultural wealth to sustain their livelihood. For these apparent reasons, I found it necessary to include your child in the research proceedings with a view that he/she has a necessary indigenous knowledge and cultural wealth to make this study a success and also to learn how those indigenous knowledge and cultural wealth could be integrated with word problems in order to learn them better within their context. These research proceedings will not take place during school hours but after school in the two local intermediate schools.

In the light to the above, I also want to assure you as a parent or a guardian that your that child will be protected in these research proceedings, that is his/her privacy or dignity will not be infringed. And I also want to assure that he/she will be free to withdraw from these research proceedings at any time without any intimidations. For further details, don't hesitate to call me from the following cell phone no: 072 18 55425, my e-mail address: sibayakt@gmail.com.

Thank you in anticipation.

Khanyae

Letsatsi

NB: The next part of the request is guided by the consent form that you could fill when feeling that your child will participate in the research proceedings.

A CONSENT FORM

This serves as a confirmation that a parent/guardian takes a decision to allow his/her child to take part in the research proceedings.

A.PARENT/GUARDIAN

Names :

Address :

.....

Contacts

Signature :

Date :

B.LEARNER

Names :

Address :

.....

Grade :

Signature :

Date :

P.O.Box 13549

Witsieshoek

9870

02 February 2018

Majara Intermediate School

P.O.Box 13492

Witsieshoek

9870

Dear Principal

PERMISSION TO CONDUCT RESEARCH STUDY IN YOUR SCHOOL

I am doing a research with the University Of Free State Qwaqwa Campus .The aim of the study is to enhance teaching and learning of mathematics word problems for the Afromontane learners. I refer Afromontane learners as the learners who are located in the rural and mountainous places. And these learners form part of the social construct of learners that live and subsist on the mountainous rural places and also who use their indigenous knowledge and cultural wealth to sustain their livelihood. For these apparent reasons, I found it necessary to include learners from your school with a view that they have these indigenous knowledge and cultural wealth. The School Management Team (SMT), the School Governing Body (SGB) and teachers will also be requested to participate in the study. The research proceedings will not take place during school hours but after school.

In the light to the above, I promise that everyone who will be participating in the research proceedings will not infringe their privacy and dignity that is everyone will be treated equally and with respect. For further details do not hesitate to call me at 072 1855 425, my email address is sibayakt@gmail.com

I hope that my request will receive your undivided attention.

Yours faithfully

Sibaya Khanyae Tom

Khanyae

Date