Supporting foundation phase teachers at rural schools to improve teaching skills in mathematics: A PALAR approach

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DECLARATION

I, the undersigned, hereby declare that the work contained in this dissertation/thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

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ABSTRACT

South Africa has had a good number of curricula implemented in the last decade. These curricula and specifically the mathematics curricula were ideally written for the mainstream learner. Unfortunately, for learners that experience barriers to learning and learners in rural areas, with very few resources, these curricula set out to be a challenge from the onset (Langhan et al. 2012; Simelane in Gina, 2018). Since 1994, there has not been a formal nationally approved curriculum to address the specific needs for learners who experience barriers to learning (Donohue & Bornman, 2014; Kempen & Steyn, 2016). Learners with low to even moderate-intensity barriers to learning generally attend mainstream schools in rural areas and often these schools have to adjust mainstream mathematics curricula to try and accommodate these learners (Kempen & Steyn, 2016). This research focuses on improving the mathematics teaching skills of Foundation Phase (FP) teachers at rural schools in the uMzinyathi District of KwaZulu Natal, in South Africa to accommodate learners who experience barriers to learning.

The study is epistemologically embedded in the critical transformative learning and social constructivist theory, where the teachers' perspectives on how to improve their teaching skills, will collaboratively be investigated in an Action Learning Group (ALG).

The research design employed is Participatory Action Learning and Action Research (PALAR). The PALAR design approach of research seems to be the best suited for this particular research, seeing that the topic under investigation involves engagement within the community. The research consists of three reiterated cycles where data was generated through reflective journals, transcriptions from the ALG meetings and a fishbone diagram.

The study endeavoured to contribute unique knowledge towards theory and practice in the following ways: The teachers as members of the ALG theorised on strategies to improve the teaching skills of FP teachers in mathematics – in collaboration with me, who acted as the research facilitator for the study. These perspectives aim to influence the practice of teachers at rural schools. The Differentiated Curriculum and Assessment Policy Statement (DCAPS) (DBE, 2018) was implemented and the following adaptations were made to enhance its practicality. The teacher's manual was translated into isiZulu, and a more descriptive introduction, as well as photos of natural and recycled learning and teaching support material (LTSM) was inserted. The contributions of this study may prove to be valuable to improve teaching skills in mathematics in rural areas of South Africa.

Keywords: Participatory Action Learning Action Research, Rural Schools, Mathematics, Teacher support, Barriers to learning, Curriculum development.

OPSOMMING

Suid-Afrika het die afgelope dekade ŉ groot aantal kurrikulums geïmplementeer. Hierdie kurrikulums, en spesifiek die wiskunde-kurrikulums, is ideaal vir die hoofstroomleerder geskryf. Vir leerders wat struikelblokke ten opsigte van leer ervaar en leerders in landelike gebiede, met baie min hulpbronne, was hierdie kurrikulums ongelukkig uit die staanspoor ŉ uitdaging (Langhan et al. 2012; Simelane in Gina, 2018). Sedert 1994 is daar nie ŉ formele nasionaal goedgekeurde kurrikulum wat fokus op die spesifieke behoeftes van leerders wat struikelblokke ten opsigte van leer ervaar nie (Donohue & Bornman, 2014; Kempen & Steyn, 2016). Leerders met lae tot selfs matige struikelblokke vir leer, woon oor die algemeen hoofstroomskole in landelike gebiede by en dikwels moet hierdie skole hoofstroomwiskundekurrikulums aanpas in ŉ poging om hierdie leerders te akkommodeer (Kempen & Steyn, 2016). Hierdie navorsing fokus op die verbetering van die wiskunde-onderrigvaardighede van Grondslagfase- (GF) onderwysers by landelike skole in die uMzinyathi Distrik van KwaZulu Natal in Suid-Afrika, om leerders te akkommodeer wat struikelblokke ten opsigte van leer ervaar.

Die studie is epistemologies ingebed in die kritiese transformatiewe leer en sosiaal-konstruktivistiese teorie, waar die onderwysers se perspektiewe oor hoe om hul onderrigvaardighede te verbeter, saam in ŉ aksieleergroep (ALG) ondersoek sal word.

Die navorsingsontwerp wat gebruik word, is deelnemende aksieleer en aksienavorsing (DALAN). Die DALAN-metode van navorsing blyk die beste geskik te wees vir hierdie spesifieke navorsing, aangesien die onderwerp wat ondersoek word, betrokkenheid binne die gemeenskap behels. Die navorsing bestaan uit drie itererend siklusse waar data gegenereer is deur reflektiewe joernale, transkripsies van die ALG-vergaderings en ŉ visgraatdiagram.

Die studie het gepoog om unieke kennis by te dra tot die teorie en praktyk op die volgende maniere: Die onderwysers, as lede van die ALG, het geteoretiseer oor strategieë om die onderrigvaardighede van GF-onderwysers in wiskunde te verbeter, in samewerking met die navorsingsfasiliteerder vir die studie. Hierdie perspektiewe het ten doel om die praktyk van onderwysers by plattelandse skole te beïnvloed. Die Gedifferensieerde Kurrikulum- en Assesseringsbeleidsverklaring (GKABV) (DBE, 2018) is geïmplementeer en sekere aanpassings is gemaak om die praktiese toepassing daarvan te verbeter – die onderwysershandleiding is in Zoeloe vertaal, en ŉ meer beskrywende inleiding, sowel as foto's van natuurlike en herwonne leer- en onderrigondersteuningsmateriaal (LOOM), is ingevoeg. Die bydraes van hierdie studie kan waardevol wees om onderrigvaardighede in wiskunde in landelike gebiede van Suid-Afrika te verbeter.

Sleutelwoorde: Deelnemende aksieleer, Aksienavorsing, Plattelandse skole, Wiskunde, Onderwyserondersteuning, Struikelblokke vir leer, Kurrikulumontwikkeling.

ESINGAKUCABANGA

INingizimu Afrika inamakharikhulamu amaningi aseke asetshenziswa kule minyaka elishumi edlule. Lawa makharikhulamu, ikakhulukazi eweziBalo, abe elungele futhi ebhalelwe abafundi abafunda ezikoleni ezejwayelekile. Ngebhadi, kubafundi abanezinkinga zokufunda kanye nabafundi basezindaweni zasemakhaya, abanezinsizakufunda ezincane kakhulu, le kharikhulamu ivele ibadalele inkinga nje zisuka amadaka phansi. (Langhan et al. 2012: Simelane and Gina, 2018). Kusuka ngowezi-1994, akukaze kube nekharikhulamu kazwelonke esemthethweni aphasisiwe yokubhekana nezingqinamba kanye nezidingo zabafundi abanezinkinga zikufunda (Donohue & Bornman, 2014 Kempen & Steyn, 2016). Abafundi abanezingqinamba ezincane noma eziphakathi nendawo zokufunda ngokuvamile bavele bafunde ezikoleni ezejwayelekile, ezikoleni zasemakhaya bese-ke othisha bezama ukuhlela kabusha iikharikhulamu yesifundo seziBalo esetshenziswa ezikoleni ezejwayelekile ukuze ilungele nalaba bafundi (Kempen & Steyn, 2016). Lolu cwaningo lugxile ekuthuthukiseni ubuchule namakhono okufundisa iziBalo ebantwaneni be-Foundation Phase (FP) kothisha basezikoleni ezisemakhaya esiFundeni saseMzinyathi endaweni eKwaZulu Natali, eNingizimu Afrika ukuze kucatshangelwe abafundi abanezinkinga zokufunda.

Lolu cwaningo lugxiliswe kwi-(*epistemology*) okungukuthi ezindleleni esithola ngazo ulwazi kanye nasekuqapheleni izinguquko ezenzeka lapho abantwana befunda nasendleleni yokufunda ngokwenza okuthile ngamaqembu bexubene, lapho uthisha eyobe enenhloso yokuthuthukisa amokhono okufundisa, ngokuwadibanisa nokuwahlola lapho befunda ngokwenza izinto besemaqenjini *Action Learning Group* (ALG).

Lolu cwaningo luqeqesha abantwana ngendlela yokwenza. (*Participatory* Action *Learning and Action Research* (PALAR) Indlela yocwaningo ye-PALAR ibonakala ingengcono nefaneleke kunazo zonke kulolu cwaningo, njengoba isihloko esicwaninga ngaso sidinga ukubambisana nomphakathi. Ucwaningo lwakhiwe ngezikhawu ezintathu ebezilokhu ziphindaphindwa lapho ulwazi belutholakala ngokuphindela emuva kumajenali, namarekhodi avela emihlanganweni ye-ALG neye dayagremu ebukeka samathambo kafishi.

Ukufunda ngalokhu kuyindlela yokuzama ukusiza ngolwazi olungajwayelekile ukuze siphonse esivivaneni sokucabanga nokwenza ngalezi zindlela ezilandelayo: Othisha njengamalunga e-ALG bafundiswe ukucabanga ngamaqhinga okuthuthukisa amakhono okufundisa abebanga le-(FP) iziBalo – sibambisene nabo kanye nami engasebenza njengomholi wocwaningo (facilitator). Le ndlela yokubuka ihlose ukusiza othisha basemakhaya endleni abenza ngayo. Ikharikhulamu ecabangela izidingo zabantwana ngokwehluka kwabo (*Differentiated Curriculum*) (DBE, 2018) kanye noSomqulu weNdlela eMisiwe yokuHlola abantwana (*Assessment Policy Statement)* (DCAPS) wethulwa ukuba uqale ukusebenza kwase kuchibiyelwa ukuze kubhekwe ukuthi uwusizo futhi uyasebenza nakulaba bantwana. Inkombandlela kathisha (*The teacher's manual*) yabe isihunyushelwa esiZulwini, kwafakwa nesingeniso esichazwe kabanzi, kanye nezithombe zokususelwe emvelweni kanye nokugungasetshenziswa obese kuzolahlwa (recycled) kodwa kusize ekulekeleleni ekufunda nokufundisa ukuze kwakhe izinsiza ezizolekelela. (LTSM). Lolu cwaningo lungaba nomthelela omuhle futhi onenani ekuthuthukiseni amakhono okufundisa iziBalo ezikoleni zasemakhaya zaseNingizimu Afrika.

Amagama angokhiye: Ukufunda ngokwenza uhlanganyela nabanye, Izikole Zasemakhaya, iziBalo, Ukusekela othisha, Izingqinamba ekufundeni, Ukuthuthukisa iKharikhulamu .

ACRONYMS

3Rs	Relationship, reflect, recognised
7Cs	Communication, commitment, competence, compromise, critical self-reflection, collaboration and coaching
ADHD	Attention Deficit Hyperactivity Disorder
AL	Action Learning
ALG	Action Learning Group
ANC	African National Congress
AR	Action Research
ASD	Autism Spectrum Disorders
B.Ed	Bachelor of Education
BRICS	Brazil, Russia, India, China and South Africa
CAPS	Curriculum and Assessment Policy Statements
CDE	Centre for Development and Enterprise
CPA	Concrete Pictorial Abstract
CTLT	Critical transformative learning theory
DBE	Department of Basic Education
DBST	District-Based Support Team
DCAPS	Differentiated Curriculum and Assessment Policy Statement
DoCG&TA	Department of Cooperative Governance and Traditional Affairs
DoE	Department of Education
EWP 6	Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System (DoE, 2001)
EFAL	English First Additional Language
FP	Foundation Phase
GoI	Government of India
HIV/AIDS	Human immunodeficiency virus / Acquired immunodeficiency syndrome
EHL	English Home Language
HOD	Head of Department
IMF	International Monitoring Funding
ISP	Individual Support Plan
KZN	KwaZulu-Natal
LoLT	Language of teaching and learning

LSEN	Learners with Special Educational Needs
LTSM	Learning and Teaching Support Material
NCS	National Curriculum Statements
NCS	National Curriculum Statements
NEEDU	National Education Evaluation and Development Unit
NWU	North-West University
OBE	Outcomes-based education
PALAR	Participatory Action Learning and Action Research
PAR	Participatory Action Research
POPIA	Protection of Personal Information Act
QMS	Quality Management System
RNCS	Revised National Curriculum Statement
RNCS	Revised National Curriculum Statement
RSA	Republic of South Africa
SAG	South African Government
SANASE	South African National Association for Special Education
SBST	School-Based Support Team
SGB	School Governing Body
SIAS	Screening, Identifying, Assessment and Support
SLP	Short learning programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
Unicef	United Nations International Children's Emergency Fund
USB	Universal serial bus
ZPD	Zone of Proximal Development

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CHAPTER 1
ORIENTATION TO THE STUDY

1.1 INTRODUCTION

By applying the Participatory Action Learning and Action Research (PALAR) qualitative design approach, this research will aim to improve Foundation Phase (FP) teachers' teaching of mathematics in a rural context. In this Chapter I will introduce the background and rationale as well as the problem statement of the research. The research questions and concepts clarification will be explained before I dwell on the theoretical framework and methodology of the research. The data generation and analysis will be dealt with and some measurements on trustworthiness and ethics will be discussed as a backdrop for the research.

1.2 BACKGROUND AND RATIONALE

Since the Salamanca Conference and Declaration on Special Needs Education (UNESCO, 1994), the approach to education regarding learners who experience barriers to learning, has changed substantially worldwide. "Education for All" now appeared on the radar of all the United Nations Educational, Scientific and Cultural Organisation (UNESCO) -affiliated countries. As a result of the Salamanca Declaration and previous conferences, inclusive education became a policy in countries all over the world (Sunardi et al., 2016). Buli-Holmberg (2016) concurred that the most efficient education system for educating learners who experience barriers to learning adopts an inclusive approach. In 2001 South Africa adopted an inclusion policy and *The Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System* (DoE, 2001) (hereafter referred to as EWP 6) was published, in which guidelines were stipulated for the implementation of inclusive education in the South African environment. This necessitated changes to the curriculum, accompanied by suitable curricular adaptations aimed at supporting learners who experience barriers to learning.

South Africa has implemented a good number of curricula in the last decades. This includes *Curriculum 2005* (DoE, 1997); *National Curriculum Statements* (NCS) (DBE, 2002); the *Revised National Curriculum Statement* (RNCS) (DBE, 2004) and the current *Curriculum and Assessment Policy Statements* (CAPS) (DBE, 2011a) (hereafter referred to as curriculum and/or CAPS) (Magagula, 2015; Neethling, 2015). These curricula were predominately written for the mainstream learner (Kempen & Steyn, 2016). Unfortunately, for learners that experience barriers to learning and learners in rural areas, with very few resources, these curricula were a challenge from the outset (cf. 2.10) (Langhan et al., 2012; Simelane in Gina, 2018). The CAPS (DBE, 2011a) was developed for all schools in South Africa. These included mainstream schools, full-service schools, rural and special schools. Even though CAPS (DBE, 2011a) itself is relatively rigid, the way it is presented to the learner can be flexible to enable learning, especially for learners who experience barriers to learning (DBE, 2010; DBE, 2011a).

Despite the policy changes, inclusive education has not yet been fully implemented in South Africa (Hay et al., 2020; Louw & Wium, 2015; Smit et al., 2020). Inclusive education requires a shift away from the *medical model* (Biesta & Van Braak, 2020) that referred to a change that needs to take place within the learner and the terminology of "learners with special needs" (LSEN). A systematic change needs to take place, where these learners will be referred to as "learners that experience barriers to learning and development" (hereafter referred to as learners that experience barriers to learning), with a more eco-systemic model of identifying barriers both within the learner (intrinsic) (cf. 3.4.2) and those arising from external influences (extrinsic) (cf. 3.4.1) (Hay et al., 2021). A curriculum such as CAPS (DBE, 2011a) must be compiled in a manner that accommodates these learners in the class where they are currently attending (DBE, 2001; DBE, 2011a). The EWP 6 (DoE, 2001) proposes that the system be changed to accommodate the learner, instead of the individual changing to suit the system.

Since 1994, South Africa has never had a curriculum to adequately address the specific needs of learners who experience barriers to learning (Donohue & Bornman, 2014, Kempen & Steyn, 2016). This phenomenon is, however, not unique to South Africa (Sunardi et al., 2016). Wolhuter (2020) suggested that it would be appropriate to compare South Africa's education mathematics curriculum to that of Brazil, Russia, India and China (BRICS countries), and also that South Africa can benefit from these comparisons (cf. 2.3). This will be done in order to establish the need for adaptation to the current CAPS (DBE, 2011a).

In the absence of a standardised curriculum for these learners, the South African National Association for Special Education (SANASE) compiled a learning programme that was more appropriate for these learners, but it was never promulgated (SANASE, 2002). Following the latter, a standardised CAPS-aligned (DBE, 2011a) learning programme was developed by the Department of Basic Education (DBE). The *Differentiated Curriculum and Assessment Policy Statement* (DCAPS) (DBE, 2018) is currently still a draft document. Before this, teachers' practices in respect of learners who experience barriers to learning were often characterised by time-wasting activities, the wrong transmission of content, limited content coverage, teaching the same content to different grades, and low expectations of learners (Langhan et al., 2012).

White Paper 6 (DoE, 2001) stipulates the task to support learners who experience barriers to learning as the primary responsibility of the teacher. The *Screening, Identifying, Assessment and*

Support (SIAS) document (DBE, 2014) details the "process of identifying individual learner needs concerning the home and school context, to establish the level and extent of additional support that is needed" and the "process to enable access to and provide such support at different levels" (p. 22). The SIAS process is trying to curb the unnecessary placement of learners in special schools, by identifying the best learning sites to support these learners (cf. 3.7.6). The SIAS policy (DBE, 2014) further describes the process in which the teachers need to be supported after the learner was placed. The above-mentioned support should be provided by the School-Based Support Team (SBST). The SBST, in turn, receives support from the District-Based Support Team (DBST). In the absence of the SBST, the DBST must support the parents, teachers, and the school (cf.2.9) (Hay, 2018; Hay et al*.*, 2021). Dalton et al*.* (2012) emphasises the importance of support to learners and provides guidelines on the central role of parents and teachers in implementing strategies to support learners to overcome barriers to learning. Although this is stipulated in the above-mentioned documents, this is not always happening at the grassroots level (Kempen & Steyn, 2016; Payne-van Staden & Van der Merwe, 2021).

Teachers feel that they do not receive sustainable and efficient support from the SBST and DBST (Kempen & Steyn, 2016). Teachers think that learners who experience barriers to learning, delay the progress of the whole class (Murungi, 2015). If teachers do not understand the learners' disabilities, it is understandable that they would find it difficult to modify and adapt the curriculum to address these unique learning needs (Hay et al*.*, 2022).

This is then also the situation at rural schools which are far from district offices and large cities. Without support and resources, it is a mammoth barrier to overcome. In the EWP 6 (DoE, 2001) it is stipulated that such support to teachers should include the provision of training, mentoring, monitoring, and consultation, to identify and address barriers to learning and accommodate the diverse range of learning needs (Louw & Wium, 2015). It is because of the lack of support in rural areas that teachers often decide to form a support group where they will support one another through collaboration (Neethling, 2015).

Schools in certain rural communities, like in the uMzinyathi district, where the research took place, are situated in a very poor socio-economic area (Bosman, 2022). Stofile et al*.* (2011) describe poverty as a major external barrier to the education of learners. Du Plessis and Mestry (2019) further state that provincial governments cannot supply rural schools with adequate support in terms of physical and human resources. Disadvantaged communities often lack professional help and support from government structures (Kauffman & Landrum, 2013; Louw & Wium, 2015; Payne-van Staden & Van der Merwe, 2021). In general, rural and semi-rural schools are remote and often underdeveloped, with the result that disadvantaged schools lack proper sanitation, water, roads, electricity as well as technology (Beckman & Gallo, 2015). However, the EWP 6 (DoE, 2001) emphasises that parent support and involvement are important to ensure successful education. Parents with limited resources and knowledge, and insufficient involvement in their children's schooling, are unable to provide the necessary support to their children (Bosman, 2022). Parents on their own are rich resources and they know so much about their children and surviving in the rural communities. However, these parents are not always present and involved in the learners schooling that is way action must be taken in the community to equip educators with the skills to deal with these challenges.

The government is trying its best to address teacher development, but the focus is often on urban schools, with the result that teachers at rural schools are being neglected (Du Plessis & Mestry 2019; Jojo, 2019). Moloi (2012), on the other hand, argues that current educators need to receive compulsory refresher training. To enable teachers in the rural areas to attend teacher training may involve long traveling time, which will result in teachers being absent from classrooms (Du Plessis & Mestry, 2019). Transport difficulties may also contribute to the fact that the teachers are not properly supported through visits from the supervisor from the district to render support to teachers, and it limits their access to support from the community and private sector. Support for these teachers thus has to come from amongst themselves. With the limited support and resources, there is also the fact that learners with a variety of barriers to learning are taught in one class, because of the absence of special and full-service schools in the specific area.

Kempen and Steyn (2016) report that, even though inclusion is promoted in South Africa, the lack of quality education for learners who experience barriers to learning could result in the exclusion of these learners. Reasons for this might include the lack of appropriate curriculum accessibility and the insufficient support given to teachers (Kempen & Steyn, 2016). This also applies to the teaching of mathematics.

In South African schools the teaching and learning of mathematics are not yet at the standard that the education policies and curricula intended. This is evident from research done by DBE, universities, and independent research agencies (DBE, 2019). Mathematics requires higher order thinking and cognitive functioning. Learners who experience barriers to learning – depending on their barriers – may find it difficult to cope with the demand and this cognitive functioning required (Sunardi et al., 2016). According to the DBE Annual performance plan, 2020/2021 (DBE, 2020) "… studies indicated that large proportions of South African children reach Grade 5 without achieving basic numeracy proficiency. This outcome at Grade 5 reflects the quality challenges that persist in the Foundation Phase." (p. 28).

To enable learners to reach their full potential, the curriculum needs to be adapted and the class size must be small enough for the teachers to attend to each learner's individual needs (Sunardi et al., 2016). It seems that teachers in rural areas are not receiving sufficient support from the provincial departments to adapt the curriculum, especially in mathematics. Teachers are not trained in addressing the needs of learners who experience barriers to learning (Kempen & Steyn, 2016). To make the educational system more functional, Jojo (2019) suggested that professional development needs to be more targeted and long-term, to address the systemic changes that are necessary for sustainable change. To ensure sustainability in mathematics, a stable curriculum policy, and the required resourcing and infrastructure at the schools are of high importance (Jojo, 2019). This support ideally needs to come from the DBE (Moloi, 2012). When considering the rural environment, it is very difficult for the department to address the specific needs of the teachers and the learners who experience barriers to learning (Du Plessis & Mestry, 2019; Jojo, 2019; Lessing & De Witt, 2011).

It is evident from the literature that educators need support to enable them to be more competent in teaching mathematics (Jojo, 2019; Kempen & Steyn, 2016; Lawrence, 2008; Motshekga, 2013).

1.3 PROBLEM STATEMENT

A systematic review of the literature provided a background to the problem under investigation in this study, the title of which has been stated as *Supporting foundation phase teachers at rural schools to improve teaching skills in mathematics: A PALAR approach*.

What emanated from the literature is that teachers find it difficult to adapt the curriculum in a manner to accommodate the specific needs of a diverse learner population, especially those experiencing barriers to learning in mathematics (Jojo, 2019; Kempen & Steyn, 2016; Langhan et al., 2012; Moosa, 2014). This study focuses on improving the teaching of mathematics in rural schools through a collaborative professional development initiative.

Considering the above-mentioned literature, it seems clear that support for educators is needed and that it may not be efficiently facilitated in rural schools. This may be because teachers feel that they do not receive sustainable and efficient support from the SBST and DBST (Hay et al., 2021; Kempen & Steyn, 2016). The lack of support appears to hurt the effective and sustainable implementation of inclusive education, particularly in rural schools (Hay et al., 2021; Neethling, 2015). Teachers experience difficulty in delivering the curriculum, as well as interpreting it. In response to the above-mentioned problem, this study intends to offer an alternative.

Through a participatory design of collaborative professional development, teachers in the FP working in rural contexts, will be given the opportunity to improve their teaching of mathematics. To focus the research, the problem observed needs to be stated as a research question.

1.4 RESEARCH QUESTION

1.4.1 Main research question

Hofstee (2018) suggested that the problem identified be formulated as a research question to gain a better understanding of the topic to be researched. In this study the lack of an appropriate curriculum and the understanding thereof, as well as the poor teacher support to support learners who experience barriers to learning, culminate in a research question that is formulated as follows:

How can Foundation Phase teachers in rural contexts improve their teaching of mathematics?

The following sub-questions emanate from the above research question.

1.4.2 Sub-questions

The following sub-questions guided the study:

- What challenges and barriers do FP mathematics teachers in rural school's experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?
- What strategies can we develop to improve FP teachers' teaching of mathematics to minimise these challenges?
- What guidelines can be derived from their learning to improve the teaching of mathematics in the FP in rural contexts?

1.4.3 Objective

The objective of this research primarily was to investigate and develop strategies to improve the teaching of mathematics in FP for learners who experience barriers to learning in a rural context.

To enable us to reach this objective, six FP teachers and I, as the research facilitator, formed an Action Learning Group (ALG) to work collaboratively as co-researchers to first investigate what challenges and barriers teachers in rural school's experience regarding FP mathematics teaching. An ALG, is a group of five to seven people with similar interests, that investigate and solve a common problem (Scott, 2022). In the process of our investigation, we focused on specific curriculum challenges. We further had to determine how educators are currently dealing with learners with mathematical barriers in rural schools.

All this data was incorporated into a fishbone diagram (Ciocoiu, 2010; Wong, 2011; Shinde et al., 2018; Arp, 2020) from which we could determine what the teachers are currently experiencing in mathematics and then consider possible strategies that we can develop to improve FP teachers' teaching of mathematics to minimise these challenges. We collaboratively decided on piloting the DCAPS (DBE, 2018) in our classes.

We had to plan, act, reflect and implement the DCAPS (DBE, 2018) to make the necessary adaptations to the teacher's manual, in order to contextualise it for the rural environment. We used a PALAR design to work collaboratively on amending the headings and introduction, translating it into isiZulu and simplifying the language to the teacher's manual. Photos of learning and teaching material, from natural and recycled material, were incorporated into the teacher's manual to optimise its usability.

The research process simultaneously provided an opportunity for personal and professional development for the co-researchers as well as the secondary participants in this research. The guidelines derived from the learning to improve the teaching of mathematics led to the overall objective of this research project, to develop strategies to improve the teaching of mathematics in FP to learners who experience barriers to learning in a rural context.

1.5 CONCEPTS CLARIFICATION

1.5.1 Barriers to learning

"Barriers to learning" refer to challenges that the learner may experience (DBE, 2014). These barriers may be within the learner (intrinsic) (cf. 3.4.2) or within the education system as a whole (extrinsic) (cf. 3.4.1). These challenges prevent learners from developing to their full potential (Lansberg et al., 2011) or may prevent access to learning and development (DBE, 2014).

1.5.2 Rural schools

The definition of "rural schools" for present purposes will be that of remote schools away from amenities such as shops, tarred roads, and streetlights (Carelse, 2018). Rural schools will for the purpose of this study refer to the public mainstream schools in the rural community of the uMzinyathi district that accommodate learners who experience barriers to learning.

1.5.3 Foundation Phase

Foundation Phase (FP) refers to the learners of the age of five to nine. It is the first phase where the school curriculum is applicable in Grades R, 1, 2, and 3. Learners are allowed to fail one grade in this phase. Educators teaching in this phase lay the foundation of formal schooling for these learners (Neethling, 2015).

1.5.4 Mathematics

Mathematics is a language that makes use of symbols and notations to describe numerical, basic geometric and graphical relationships. It is a 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 to enhance logical and critical thinking, accuracy and problem-solving techniques that will contribute to decision-making (DBE, 2017:5).

This study revolves around mathematics as part of the CAPS (DBE, 2011a) that is presented to FP learners in rural schools.

1.6 THEORETICAL AND CONCEPTUAL FRAMEWORK GUIDING THIS RESEARCH

The two theories that will guide the thinking in this study are the *critical transformative learning theory* (Mezirow, 2011) and the *social constructivist theory* (Vygotsky, 1978).

This study will firstly be grounded in a critical transformative learning theory. The aim of critical transformative learning theory is not just to understand the problem but to change it for the better (Rehman & Alharthi, 2016). This type of inquiry is concerned with understanding how individuals perceive the problem, construct their experience and assist in the process of modifying the structures, to bring about sustainable change (Christie et al., 2015). According to Mezirow (2011), the critical transformative learning theory is a metacognitive epistemology of evidential (instrumental) and dialogical (communicative) reasoning. This reasoning and reflection will ultimately lead to a transformation of the current situation. Wood (2020) describes critical transformative learning in PALAR as a process of learning from the experience of others via critical self-reflection. Learning must culminate in action (Ravans, 1998; Wood, 2020).

According to Vygotsky (1978), social constructivist theory is a collaborative process of developing new knowledge – knowledge developed from individuals' interactions with their culture and society. Vygotsky (1987) was of the opinion that development appears twice: new knowledge will first appear on a social level (inter-psychological) and later on an individual level (intra-psychological). Even before Vygotsky, Von Glasersfeld (1974) argued that all knowledge is constructed rather than perceived through the senses.

Knowledge in this study was constructed via the participants' active involvement as they drew from their own experiences (Elliott et al., 2000). The new knowledge followed the process of first inter-psychological and later as an intra-psychological process. The participants' existing knowledge formed the foundations of their knowledge. The co-researchers brought their own understandings to the group, then listened and learned, and reflected on what they had heard to adapt their assumptions and change/develop a better understanding of the problem at hand. However, radical constructivism states that the knowledge individuals create tells us nothing about reality, and only helps us to function in our environment. Thus, knowledge is invented and not discovered. The humanly constructed reality is all the time being modified and interacting to fit ontological reality, although it can never give a true picture of it (Von Glasersfeld, 1974). The ALG of this research constructed knowledge by applying prior knowledge and experience to create strategies to improve the teaching skills of the FP teachers in mathematics.

1.7 RESEARCH METHODOLOGY

1.7.1 Research paradigm

A paradigm represents the scientific way in which a study in the field is viewed (Booyse et al., 2011). The participatory paradigm that was used in this study, includes *dialectic epistemology*, referring to how knowledge is created through creative and collaborative dialogue, as the opinions of all co-researchers were reflected upon, evaluated, and considered. The *relational ontological* assumption on how we view the world when engaging in open relationships, established the working relationship between the co-researchers before we collaborated to generate relevant knowledge (Brydon-Miller et al., 2003; Wood, 2020) about the teaching of mathematics in rural schools.

Axiology leads us in a democratic process to achieve social change (Brydon-Miller et al., 2003). The co-researchers, and I as the facilitator, collaboratively considered and respected the different values, morals and the contribution of each member. In this study, axiology was achieved in a just and respectful manner by adhering to the 7Cs and 3Rs as PALAR principles (Wood, 2020). The 7Cs in PALAR comprise communication, commitment, competence, compromise, critical self-reflection, collaboration and coaching. By adhering to the 7Cs (cf. 4.8.2), we can ensure a sustainable systemic change in the community (Zuber-Skerritt, 2018). The ALG meetings were based on the 3Rs (cf. 4.8.1) or features of PALAR. To enable the research to be successful, a *relationship* was first established with the co-researchers. The co-researchers critically *reflect* on all data generated and will be *recognised* for their contribution throughout the study as well as at a ceremony at the end of the research (Wood, 2020).

1.7.2 Research design

The co-researchers followed a *Participatory Action Learning and Action Research* (PALAR) design to improve their teaching of mathematics in rural schools of the uMzinyathi District in KwaZulu-Natal (KZN).

In this study, PALAR was applied as a social science paradigm and not just as a methodology. The PALAR design is qualitative in nature and is considered democratic, equitable, liberating, and life-enhancing and is particularly concerned with the roles played by the researcher, co-researchers, and secondary participants (MacDonald, 2012; Zuber-Skerritt, 2011). By applying the PALAR design, we aimed to create sustainable change in a community through professional development.

The PALAR research design falls under the umbrella of Action Research (AR). In AR the focal point is on a group identifying a problem that they would try and address. After discussion, the group will decide on the most feasible method to address the problem in order to bring about change for the better. In this study, a group of FP teachers worked together to find ways to improve their teaching skills in mathematics to assist learners who experience barriers to learning. By applying the new methods and skills, the learners may benefit.

The PALAR design is a combination of *Participatory Action Research* (PAR) *and Action Learning* (AL). AL is described as learning from actual experience. This can be done in group discussions, personal discovery, and learning from one another, and through a trial-and-error process. In this way, new knowledge is developed and shared. It is a process where groups of people work on real problems, carrying real responsibility in real conditions (Zuber-Skerritt, 2005).

The meta-cognition related to this study is the creation of knowledge through collaborative dialogue and the development of critical subjectivity, where all members of the ALG developed an awareness of the self and others as persons with knowledge, experience, identities, feelings, beliefs, and desires (Wood, 2020). Through systematic data generating and analysis, and regular reflection, the participants in the ALG gained insight into the barriers they face as teachers of mathematics in a rural context and identified and tested out strategies to help them to overcome the barriers. The knowledge they generate will be useful as guidelines for other teachers and may contribute to the learners' progress. More importantly, they learned how to improve their own teaching as part of a community of practice, and this may enable them to sustain their development and become lifelong learners. This was done as a collaborative effort by the participants as co-researchers in the ALG. The co-researchers supported the FP teachers at their schools, who acted as secondary participants in teaching mathematics.

The purpose of using this research design allows the researcher to describe and understand the participants rather than to predict and control them. The goal of using PALAR is to foster capacity, community development, empowerment, access, social justice, participation and collaboration (MacDonald, 2012). The PALAR design consists of a substantive network of approaches to research that is all participative and rooted in actions and experience. As Zuber-Skerritt (2011) observes: "It is a way of thinking, feeling, living and being that influences our values, worldviews and paradigms of learning, teaching and research. It influences our behaviour, strategies, methods, and therefore the capacity for improving practice." (p. 33). This research design is a cyclical research design, moving forward and backward depending on the data generation (Wood & Zuber-Skerritt, 2013).

Since PALAR crafts a collaborative vision through relationship building and research, the participants must form a relationship with the researcher and vice versa. This led to the formation of an ALG (Wood, 2012). Participants of the ALG defined a mutual purpose where personal development and transformation can take place. By identifying their strengths and what each member can contribute to the team, their roles and responsibilities within the team were established. Broad research goals were set and an ethical contract was drafted. The ALG crafted a collaborative vision by identifying a problem or problem area – in this study, FP teaching of mathematics in rural schools – and then formulated the research questions. The research methods were determined and specific research skills identified. Together a critically informed action plan was developed to improve what is already happening. In this plan the *what*, *who*, *where*, *when*, and *how* of the research were set out. The action was taken to implement the plan. Collaborative collection and analysis of data took place. This was done by observing the effects of the critically informed action plan, in the context in which it occurs, and by critical reflection (Wood et al., 2013; Wood, 2020). The findings formed the basis for further planning. Continuous reflection and re-planning guided the research. Through a succession of cycles, the aim of the research was achieved, agency was developed between the co-researchers that lead to transformation, both in the individuals and in the community (refer to Figure 1.1).

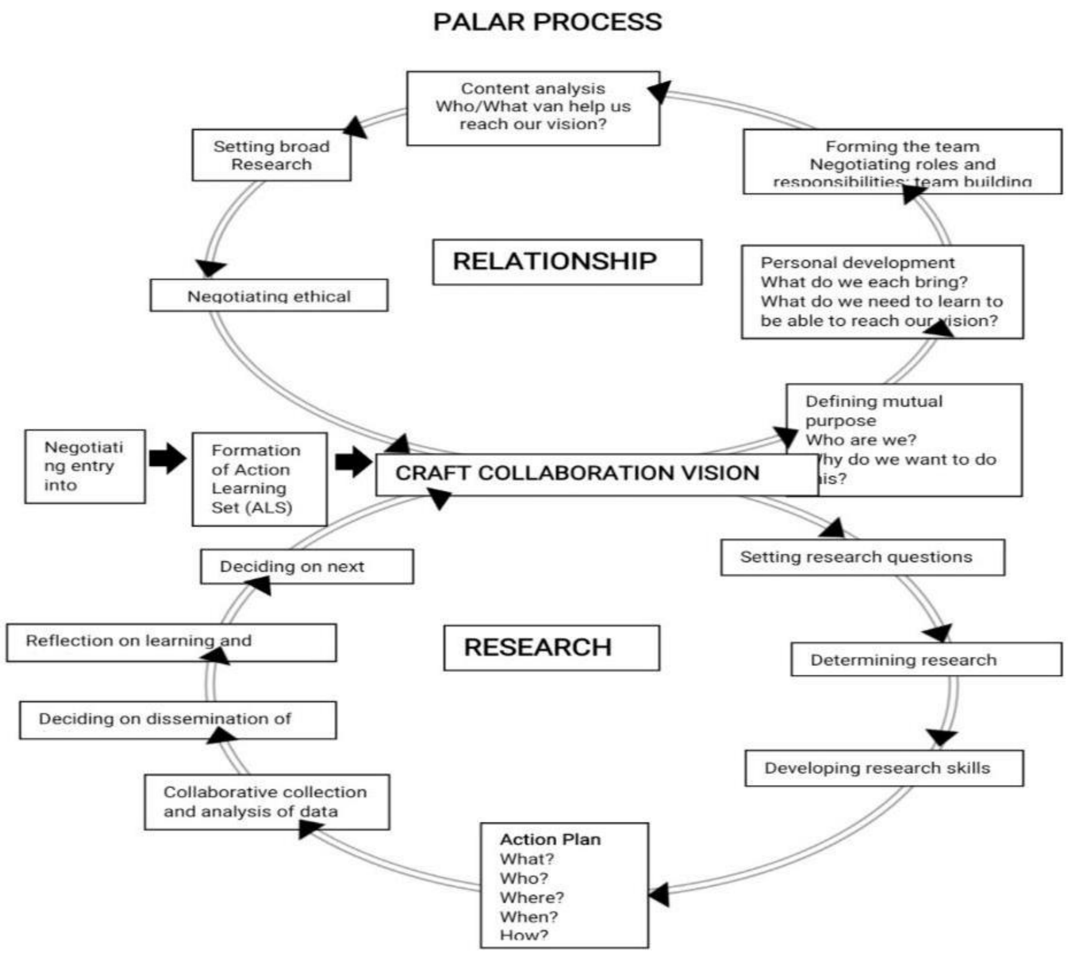

Figure 1.1: The PALAR process

(Wood, 2020.)

This study consisted of three main cycles. These cycles are not static but interactive and may be amended as the research progresses.

1.7.2.1 Cycle 1

Relationship building and negotiation of the research process

During the first cycle of the research, time was spent in the rural community of the uMzinyathi District. I conducted workshops on the SIAS policy (DBE, 2014) and got to know the people in the community. Discussions took place with the principals of some of the schools, and with six to eight FP teachers from the schools that were willing to participate. The participants discussed an ethical working agreement, completed the consent form and introduced themselves, with the purpose to build a relationship in the group.

The main aim of this first cycle was to establish an ALG and to build relationships with participants from the ALG and people from the community. ALG meetings were held with six to eight teachers from the rural schools that acted as co-researchers and form the ALG. The purpose of these ALG meetings was to establish a mutual relationship. To do this, we followed the outline of the relationship cycle in the PALAR process and asked ourselves questions such as:

- Who are we?
- Why do we want to take part in the research project?
- What do we want to learn from this project?
- What do we want to achieve in this project?
- What do we each bring to this project?
- What role would each like to take on?

During these discussions, the strengths that each member is bringing to the table, emerged. These strengths determine their role and responsibilities as co-researchers. The research process was negotiated and a number of face-to-face meetings were held during this cycle.

Each ALG meeting commenced with a relationship-building activity, followed by a planning session for the action to be taken to address the research aims and objectives. A reflection session and intervention of the actions followed. After the initial ALG meeting, the following proposed research sub-questions were addressed:

- What challenges and barriers do FP mathematics teachers in rural school’s experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?

These questions formed the first round of research that the participants need to go and investigate. Visual and written reflective journals (cf. 4.10.3) were kept by each member to document their findings. Audio recordings of the ALG meetings (cf. 4.10.1) were transcribed verbatim and used as additional data. A communication system was put in place because of the distance between me and the rest of the co-researchers. Through e-mail, WhatsApp and voice notes, a continuous channel of communication was established. The data was analysed by the ALG. These findings formed the basis of the discussions in Cycle 2.

1.7.2.2 Cycle 2

Learning how to improve the teaching of mathematics within a rural context

During Cycle 2 of the research, there were three to four ALG meetings. These ALG meetings were either face-to-face or held virtually. Each meeting commenced with a relationship-building session to negotiate needs and reflect on the data collected. The primary focus of this cycle was to transform or disturb (Mezirow, 2011) the participants' way of approaching the teaching of mathematics. The focus in this cycle was to investigate different strategies to improve mathematics teaching to learners who experience barriers to learning and to implement the most appropriate strategy.

During a face-to-face ALG meeting, the participants analysed the data generated on the first three research questions by using a fishbone diagram (cf. 4.10.4). Through collaboration, the co-researchers came to an agreement on strategies to implement in their classrooms. Through constant reflection and communication, cyclically, the data generated by the ALG culminated in a critically informed action plan (Wood, 2020). The co-researchers implemented the action plan, evaluated it and reflected on the implementation of the plan. Transformation or disturbances (Mezirow, 2011) of the participants' way of approaching mathematics may take place by introducing alternative ways to enhance their mathematical teaching skills. This is a trial-and-error process. Through this process, we were able to find out what works in the classroom and how to adjust the action plan to be more effective.

By evaluating and reflecting on their own actions, the ALG members seek a possible strategy to improve their teaching skills in mathematics to learners who experience barriers to learning. The teachers' receptiveness to change and how the teachers perceive the action plan and their own experience, were reflected upon. The necessary adaptations were made to ensure its practicality.

1.7.2.3 Cycle 3

Ensure sustainability by disseminating the learning

During Cycle 3, the co-researchers made the necessary adaptations to the critically informed action plan and then later presented it to other schools in the community to improve the mathematics teaching of the FP teachers in the specific rural community.

1.7.3 Site of research

The study focused on rural schools in the uMzinyathi district in KZN in South Africa. This district is situated near a small town in a remote area, 75 km from the nearest city. It is mainly a farming community (Bosman, 2022; RSA, 2020). There is currently no full-service school, special school, or resource centre in the district to support teachers and learners that experience barriers to learning. In the absence of the above, the rural schools thus need to fulfil all the roles and responsibilities of the full-service school, special school and resource centre. These schools acted as a hub of knowledge and expertise to equip and support teachers at the community rural schools. As part of the ALG, the teachers were equipped to support the teachers at their respective rural schools as well as the teachers in the community.

1.7.4 Selection of participants

The gatekeeper approached principals at three to four primary rural schools from the uMzinyathi district, to ask FP teachers in their schools to volunteer to participate in the research project and to present the project to them. The principals were welcome to object or accept the offer. Six FP teachers participated on a voluntary basis. The selection criteria relied on the teachers and principals who were interested in improving their teaching of mathematics, provided that they were at the time teaching in the FP and were daily in contact with learners who experience barriers to learning.

In this study, it was important to select participants, and more especially the co-researchers with first-hand knowledge and experience of the field of study (Smit, 2001). Six teachers from the selected rural schools of the uMzinyathi district of KZN were recruited as co-researchers in the study. The ALG then consisted of the co-researchers and me as the research facilitator. These teachers were selected because of their specific knowledge of this topic, and their responses may therefore be viewed as reliable and relevant (Eloff & Kriel, 2003). The ALG was a conglomerate of cultures and with it, experience and knowledge. None of the co-researchers were mother tongue English speaking but everyone was comfortable in speaking English. For this reason, the ALG meetings were all conducted in English.

The secondary participants consisted of the rest of the staff at the rural schools, where the action plan was implemented. Data generation was done by both the co-researchers and me, as the research facilitator.

1.8 DATA GENERATION, DATA ANALYSIS AND MY ROLE IN THE RESEARCH

1.8.1 Data generation

The generation of data in qualitative research is an interpretation of observations and discussions, aimed at discovering underlying meanings and patterns of relationships (Hofstee, 2018). Before the data generation commenced, an advisory committee was established to guide the research facilitator regarding the process of generating data in each Cycle. With every method of data generation, ethical considerations have to be taken into account (Forrester, 2010). The participants need to trust and respect one another's privacy as well as the privacy of the teachers at the rural schools with whom they will engage in discussions.

The six teachers from the rural schools were acknowledged as co-researchers and participated in the generation of data. Forming a relationship with the teachers and engaging them as co-researchers, are a fundamental part of the PALAR research design (Wood, 2020). At the onset of the research, with the first visit to the rural schools, the process of the project was explained to the participants. Consent forms were completed and the participants did a relationship-building activity, where they introduced themselves. The aim of the ALG as well as their roles as co-researchers were explained to the participants.

The *ALG meetings* (cf. 4.10.4) took place face-to-face; electronically, through e-mails, WhatsApp group discussions; and through voice notes, in order to build a relationship between the co-researchers and to share data with one another. The meetings took place after school hours for approximately 45 minutes each, depending on the specific topic under discussion. All meetings were audio-recorded and transcribed verbatim as additional data. The transcriptions must be rigorous, orthographic and verbatim. Braun and Clarke (2006) describe six phases of analysing data for thematic analysis: familiarising yourself with the data; generating initial codes; searching for themes; reviewing themes; defining and naming themes; and producing the report. These phases guided the analysis of the data. The themes that were identified in the data set, were corroborated with co-researchers to enhance the trustworthiness of the study. Rigour and validity play an important role in the ethical responsibility of the research (Cohen & Swerdik, 2002; Merriam, 2002).

During the initial ALG meeting, the participants were exposed to the idea of a *reflective journal* (cf. 4.10.3) and what it entails. The reflective journals were used by the co-researchers to document their findings and to reflect on their findings; and later in the ALG meeting, the co-researchers referred to them as a source of information. Written and visual reflective journals (Creswell, 2012) were used by all the participants and they utilised their cell phones to capture and record events and discussions. These reflective journals captured the participants' thoughts, feelings and observations in notes, drawings, sketches and photos. This data is of particular importance in the research, where the purpose is to make changes in practice (Neethling, 2015). The more the participants reflect in the journal, the more the journal serves its purpose of professional as well as scholarly development (Zuber-Skerritt, 2011; Neethling, 2015). Data that had been generated in the reflective journals contributed to the ALG meetings, as it allowed the participants to present their findings to the ALG in a structured and reflected manner.

The *fishbone diagram* (cf. 4.10.4) is usually used as a vehicle to investigate cause and effect (Arp, 2020; Ciocoiu, 2010; Shinde et al., 2018) but for this research it was adjusted for the research context, to combine the data generated when addressing the first three research sub-questions. The data enabled the co-researchers to identify, plan, integrate and reflect on strategies to implement in the classroom context.

All data was generated, evaluated and reflected upon; and later analysed by the ALG collaboratively to address the research question.

1.8.2 Data analysis

Interpretation of qualitative data endeavours to answer the "why", "how" and "what" questions (Zuber-Skerritt, 2011). Data generated via transcriptions of ALG meetings, reflective journals and fishbone diagram, were analysed, reflected on and interpreted to facilitate a deeper understanding of the research question reading: "How can FP teachers in rural contexts improve their teaching of mathematics?"

In the first and second Cycle, thematic analysis (Braun & Clarke, 2006) was used to analyse data generated from the reflective journals, and the transcriptions from the ALG meetings. The themes that emerged through the analysis process were further explored as the research continue. Data was generated through discussions with the teachers at the respective rural schools by the co-researchers. The data was evaluated and reflected on by each member of the ALG and then presented to the other members at an ALG meeting. Co-researchers listened to all participants' feedback and then reflected on the plan forward. The themes that emerged from the first three research questions were joined on a fishbone diagram to analyse all the data together. This is done to determine the strategies to be implemented in their classes. In Cycle 2, data was generated and analysed on the implementation for improving mathematical instructions to learners who experience barriers to learning. This was done to determine the amendments to the critically informed action plan.

In Cycle 3 the co-researchers made the necessary amendments to the critically informed action plan and presented it to the teachers in the rural community of the uMzinyathi district.

1.8.3 Role of the co-researcher and facilitator

In PALAR the role of the researcher may change as the research continues. As the research facilitator, the researcher can be involved in a continuum ranging from a total observer to a hands-on participant (De Vos et al., 2007). At the onset of the research, it is of pivotal importance that the researcher realises that collaboration is crucial, with a mutual goal of trying to make a change in a community (Wood, 2020). As the research facilitator, I spend time in the community, get to know the people and get known by them. An ALG can be formed only once an entry has been negotiated. The role of the researcher then changes to that of co-researcher. The researcher forms part of the ALG in the planning, evaluation and reflection of all data generated. I went through a process of reflection, analysis, synthesis, interpretation and explanation before a conclusion can be drawn. It is expected of me to acknowledge the participants for their contribution to the research at the end of the research in a small ceremony where refreshments will be provided, but also throughout the research.

The trustworthiness of the research and all participants are significant throughout the research.

1.9 MEASURES TO ENSURE TRUSTWORTHINESS

Rigour and validity play a vital role in educational research. An assortment of scholarly sources was reviewed, and Herr and Anderson (2005) were found to be the most appropriate for this study. Herr and Anderson (2005) present criteria for validity that are applicable across the whole continuum of action research. They describe the criteria for validity as follows:

Dialogic validity is the goal to generate new knowledge through collaborative dialogue. This study incorporated teachers from rural schools as co-researchers to form an ALG. The constant reflection and discussions contributed to dialogic validity.

In *Outcome validity,* the success of the research or project is tested. This study adhered to outcome validity as it set the goal of supporting FP teachers at rural schools, to improve teaching skills in mathematics by developing and implementing a critically informed action plan.

Catalytic validity describes how the participants and the researchers are willing to rethink and redefine their roles. Constant dialogue and ALG meetings ensured catalytic validity. I formed part of the ALG that reflects on the progress of the research. Through this process, both the participants and I experienced personal and professional growth.

To ensure *democratic validity* collaboration with all parties involved is important. In this PALAR study, constant reflective dialogue to collect and interpret data took place between the co-researchers.

Process validity refers to what extent the problems were solved in a manner that permits ongoing learning of the individual and the system. To ensure process validity the data for this study were collected from the co-researcher's reflective journals and transcriptions from ALG meetings as well as the use of a fishbone diagram.

1.10 ETHICAL CONSIDERATIONS

Ethics may be defined as a method, procedure or perspective for deciding how to act when analysing complex problems and issues (Gajjar, 2013). Permission for the research was obtained from the Ethics Committee of the Faculty of Education at North-West University. The ethical considerations were communicated to the participants in a letter, and also in person by an independent gatekeeper who is not involved in the project. The considerations are:

Voluntary participation: All participants were given the choice of participation or non-participation. I made it clear that there are no rewards or payments for participation and that it is strictly voluntary. Participants were also assured of their right to withdraw from the study at any time (Gajjar, 2013).

No harm to participants: I saw to it that procedures were in place to ensure that the participants were not harmed during the process. In this study, it mainly implies that participants should respect one another and that no information can be used to put another person in jeopardy (Gajjar, 2013).

Anonymity and confidentiality: Anonymity implies that you will not be identified as a participant (Gajjar, 2013). This research at all times adhered to the Protection of Personal Information Act (POPIA), 4 of 2013 (RSA, 2013) rules. Due to the positions of the co-researchers, it was only possible to commit to partial anonymity and confidentiality in this study. In the report on the findings, pseudonyms are used to refer to participants' responses (Gajjar, 2013). The participants need to trust and respect one another's privacy as well as the privacy of the teachers at the rural schools with whom they will engage in discussions.

Deception: There is no need for the researcher to hide the true nature of the study to prevent the participants from altering their natural behaviour (Gajjar, 2013). By doing the analysis of the data collaboratively, the co-researchers not only learn from one another but can also take ownership of the data.

Storing of data: All data will be stored on a Google Document in the cloud and on a Universal serial Bus (USB) with password protection in the office of the promotor/co-promotor at North-West University (NWU) for a period of five years and then destroyed.

Feedback on findings: The co-researchers will be aware of the findings, as they do the analysis of the data collaboratively. They will thus take ownership of the research. It will also be available to the principals of the schools on request and other schools in the community on request.

The structure of the study will be discussed in the next section.

1.11 PRELIMINARY STRUCTURE OF THE STUDY

Chapter 1 presents the orientation to the study.

Chapter 2 reviews the perspectives on mathematics curricula and teaching both internationally and nationally.

Chapter 3 centres around the teaching of mathematics to learners with barriers to learning with a focus on rural schools.

Chapter 4 provides the theoretical and conceptual framework guiding this research methodology.

Chapter 5 discusses the relationship-building and negotiation of the research process. The findings of Cycle 1 will also be laid out.

Chapter 6 comprises of discussions, reflections and critiques in Cycle 2 and 3 on the experiences of participants to develop and implement the critically informed action plan.

Chapter 7 presents the findings, conclusion and recommendations of the research.

CHAPTER 2

PERSPECTIVES ON MATHEMATICS CURRICULA AND TEACHING

2.1 INTRODUCTION

Chapter 1 gave a brief overview of what the study entails. In this chapter, a background on mathematics and a comparison of the curricula of Brazil, Russia, India, China, and South Africa (BRICS countries) will follow. Since this study focuses on improving Foundation Phase (FP) mathematics teaching in rural contexts, it was important to also investigate the advantages of the *differentiated curriculum and assessment policy statement* (DCAPS) (DBE, 2018), which was recently implemented in South Africa. I will furthermore focus on curriculum changes needed to address and support learning and teaching. The discussion will centre on the current state of mathematics in South Africa and unpacking of the mathematics curriculum and assessment policies.

2.2 BACKGROUND ON MATHEMATICS

According to the Department of Basic Education (DBE, 2014), "Mathematics is a language that makes use of symbols and notations to describe numerical, basic geometric, and graphical relationships." (p. 5). The DBE (2018) further defines mathematics as

> *A human activity that involves observing, representing, and investigating patterns and quantitative relationships, in physical and social phenomena, and between mathematical objects themselves that helps the mental developmental processes to enhance logical and critical thinking, accuracy, and problem-solving techniques that will contribute to decision-making (p. 5).*

Mathematics is a language with its own register (Dabell, 2022) that only expresses mathematical meaning (Setati, 2005) when used within the mathematical context (cf. 2.9.1.2). The terminology used in a mathematical context may have a totally different meaning when used in normal speech. A background on mathematics will shed more light on the origins of mathematics.

To get a realistic view of the nature of mathematics, it is necessary to understand how mathematics evolved over the years. Mathematics discussions seemingly first took place among Greek mathematicians from 500BC to 300BC (Li & Schoenfeld, 2019). The Greek mathematicians laid the foundation of what we today describe as "mathematics". Their focus, however, was on generalised mathematical theories and proofs, with specific emphasis on geometry and measurement (Li & Schoenfeld, 2019). Ancient Greece was the birthplace of formal mathematics. It was absorbed into Islamic mathematics and eventually into Western European mathematics. It has spread to become what we have known worldwide as mathematics in the last several centuries (Joyce, 2014). In most other cultures, practical mathematics was applied in their everyday lives. It is, however, evident in the construction of some buildings that geometry was fairly advanced in some cultures (Joyce, 2014). According to Manoushagian (2021) mathematics was presented and preserved in different ways in different countries.

The most important difference in the evolution of mathematics is probably the development of the concept of the "zero" as a placeholder. The concept of zero was first recorded in Mesopotamia in 3 B.C. as two angled wedges, similar to the parenthesis ( ). Around 4 A.D., the Mayans independently developed their own mathematical system that depicted an eyelike character to denote the zero. In the year 628, a Hindu astronomer and mathematician in India named Brahmagupta created the first contemporary counterpart of the digit zero (Feliksiak, 2021). A dot underneath a number was his sign for the numeral zero. He also devised conventional methods for achieving zero through addition and subtraction, as well as the outcomes of operations using the digit. From India, the concept of zero spread to Cambodia in the seventh century, and eventually to China and the Islamic countries in the eighth century, where the open circle was used to depict the zero. It was only in the twelve century that the zero reached Western Europe (Jana, 2021).

Figure 2.1: Timeline for the development of the zero

(Composed from Jana, 2021; Manoushagian, 2021)

This singular change changed the Western ideas of mathematics and assisted in the advance of science. The concept of zero did not permeate through the rest of the world at the time, as showed in Figure 2.1 (Jana, 2021; Manoushagian, 2021).

The focus on mathematics teaching changed over the years. Li and Schoenfield (2019) explained that over the years, there has been a greater emphasis on the methods and practices of mathematics (e.g., problem-solving), but the vast bulk of the attention still remained on what material should be taught to learners. A paradigm shift toward teaching and learning took place over the last half-century. Mathematics no longer follows a drilling and memorising approach (teacher-centred), but an internal cognition approach (learner-centred) where learners are actively involved in the construction of mathematical concepts (Gao, 2014; Li & Schoenfeld, 2019). The difference between the teacher-centred and learner-centred approaches to mathematics is illustrated in Table.2.2. In the teacher-centred approach, learners were encouraged to listen to the teacher and follow the guidelines that were given to them. Mathematic tables, for example, were drilled and practiced until the learner had grasped the concept. The learner-centred approach is a much more problem-solving approach. Learners are given the opportunity to self-explore and collaborate with peers and the teacher to find solutions to the problem at hand (Anuradha, 2021).

Table 2.1: Teacher-centred approach versus learner-centred approaches

TEACHER-CENTRED	LEARNER-CANTERED
The learners completely focus is on the teacher	The teacher and learner share the focus in the class
Learners are silent and listen to the teacher	Collaboration between learners and learners with the teacher takes place
Work is drilled and practiced until the learner can reproduce the work	Problems are presented to the learners to explore different solutions
Learners are following the instructions as given by the teacher to come to an answer	Learners are given the opportunity to acquire knowledge independently through self-learning
The classroom is calm and orderly	The classroom can be chaotic and noisy

Adapted from Anuradha (2021)

Since mathematics is a global language, it is important to explore the international trends in the curricula.

2.3 COMPARING THE SOUTH AFRICAN MATHEMATICS CURRICULUM TO THAT OF BRAZIL, RUSSIA, INDIA AND CHINA

In order to better the education in a country, Wolhuter (2020) advises that we compare different countries' education systems with one another. Given the large contextual differences between South Africa and countries from the Global North, this may not be the ideal comparison. Brazil, Russia, India, China, and South Africa – better known by the acronym BRICS – are five major emerging market economies that cooperate in trade, politics, culture, and education (Dooley, 2020; SAG, 2022). Education is an important factor in determining the economic well-being of a country, and the International Monitoring Funding (IMF) indicated that it as a contributing factor to reducing poverty in South Africa (Filmer et al., 2021).

The BRICS countries' significant diversity implies that research and epistemologies produced in these countries may be valuable to modern Western cultures and situations (Wolhuter & Chigisheva 2020). Wolhuter (2020) suggested that it will be appropriate to compare South Africa's education mathematics curriculum to that of other BRICS countries, and also that South Africa can benefit from these comparisons. He based his views on the differences in affluence, learner-teacher ratio, economic well-being and the level of educational development and concluded that diversity relating to different facets, emerges as one of the primary issues emulated in the BRICS countries. One of the noted examples is that English is the international *lingua franca* (Wolhuter, 2020), whereas Portuguese is the official language in Brazil. Russia recognises 35 official languages; India has 22 languages; and China has 55 ethnic lingos, each with its own particular language patterns (Wolhuter, 2020). South Africa recognises 11 official languages, along with other dialects, and some of the languages spoken are not recognised as official. Even though English may be the lingua franca in the world, it is not the primary language of education in any of the BRICS countries. This in itself creates a challenge for instructing mathematics.

In the next sections, the similarities and differences between the mathematics curricula in each of the BRICS countries will be addressed.

In **Brazil** most primary schools – as many other educational institutions – belong to the public system of education. Primary schools are thus subjected to the policies and curriculum set out by the municipal, state, or federal levels. Reuwsaat et al. (2020) explains that the education system was designed in such a way as to provide schools with indicators on what should be taught, while allowing the schools to establish their curriculum within their socio-economic environment and their specific needs. The curriculum includes knowledge of numbers and their uses, the number system and operations, measurement and geometry. These were adapted to apply to the community, the traditions, and the characteristics of the specific community of learning (Alves, 2010 as cited in Knijnik & Wanderer, 2015). Brazil does not keep noteworthy basic educational statistics, but it is clear that not all learners in Brazil attend primary schools and in general, a third of learners repeat a grade in primary school. This contributes to the high dropout rate of learners after primary school (Psacharopoulos, 2015). Knijnik and Wanderer (2015) and Reuwsaat et al. (2020) argue that learners lack mathematical knowledge when entering the school system, since they often acquire concepts, and construct informal mathematical knowledge through play and experiences. This acquiring of knowledge reflects on the theories of Piaget (cf. 2.10.1) and Vygotsky (cf. 2.10.2). It is therefore imperative that the teachers establish learners' prior knowledge to enable them to plan their teaching, learning, and assessment accordingly. The current curriculum obstructs the above-mentioned goal, since assessment practices are mostly done after a lesson to evaluate knowledge level (Reuwsaat et al., 2020). Reuwsaat et al. (2020)

further voiced concern that a more formal sporadic assessment substituted a class-based assessment that led to teachers teaching for the learners to pass, instead of covering the learning content. I concur with Knijnik and Wanderer (2015) and Reuwsaat et al*.* (2020) that the teaching and learning of mathematics along with formal assessment practices in primary schools in Brazil still has a long way to go.

Russia's national curriculum for mathematics stipulates the outcomes of what learners should achieve at the end of each phase of general schooling. The primary goal of the mathematics curriculum in the FP is to develop basic mathematical intelligence to solve problems (Mullis et al*.*, 2016). Accordingly, the curriculum focuses on numbers and values; arithmetic operations; solving word problems; spatial relations and geometric figures; and working with information. The curriculum describes the recommended content as well as the minimum learning requirements for passing the phase. The educational authorities in Russia put a high value on mathematical intelligence and therefore employ qualified and able teachers in the curriculum (Karp & Zvavick, 2021). Although the curriculum accommodates additional outcomes for advanced learner achievement (Mullis et al*.*, 2016), there are no specifications for adapting the curriculum for learners who experience barriers to learning (Karp & Zvavick, 2021; Valeeva, 2014). For learners struggling with mathematics, the learning content can be adapted to an achievable level, but these learners will not pass the national exam at the end of the phase and therefore will not have the opportunity to continue their schooling (Karp & Zvavick, 2021).

Table 2.2 explains the layout of the prescribed Russian mathematics curriculum for primary schools, which is similar to the South African FP curriculum. The Russian mathematics curriculum is from grade 1 (the South African grade R, preparatory year for children 5/6-years old) to grade 4 (South African grade 3) and is set according to topic areas (South African, content areas), recommended content, minimum learning requirement, and additional learning opportunities (Mullis et al*.*, 2016).

Table 2.2: Mathematics content and requirements for Russian schools, grades 1-4

TOPIC AREA	RECOMMENDED CONTENT	MINIMUM LEARNING REQUIREMENTS	ADDITIONAL LEARNING OPPORTUNITIES
Numbers and values	Reading and writing numbers from 0 to 1 million; classes and categories; units of measurement of weight (grams, kilograms, hundredweight, and tons), capacity, and time (seconds, minutes, and hours); comparing and	Read, write, and compare numbers up to 1 million; establish rules for number sequences and write sequences according to a given or a self-determined rule; group numbers according to given or self-determined criteria; classify numbers according to one or more criteria and explain; and	Select units of measurement for given quantities (e.g., length, mass, area, and time) and explain

TOPIC AREA	RECOMMENDED CONTENT	MINIMUM LEARNING REQUIREMENTS	ADDITIONAL LEARNING OPPORTUNITIES
	ordering homogeneous quantities, and fractions	read, write, and compare quantities	
Arithmetic operations	Naming the components of arithmetic operations; addition and multiplication tables; the relationship among the arithmetic operations; finding unknown components of arithmetic operations; division with a remainder; numeric expressions; using the properties of arithmetic operations in calculations; algorithms of written operations; methods of verifying computations	Carry out written calculations (i.e., addition, subtraction, multiplication, and division of 0 to 10,000 into one-digit and two-digit numbers) using addition and multiplication tables and algorithms of written arithmetic operations (including division with a remainder); perform oral addition, subtraction, multiplication, and division on one-digit, two-digit, and three-digit numbers within 100; solve arithmetic operations for unknown components; calculate the value of a numeric expression (containing 2 or 3 arithmetic operations, with and without brackets)	Perform operations with known quantities; use the properties of arithmetic operations to perform calculations; and verify calculations using reverse action, estimation, assessment of results
Solving word problems	Solving word problems by arithmetic methods; solving problems involving the relationships “more (or less) on” and “more (or less) in”; dependencies between quantities describing movement, work, purchase and sale, etc.; speed, time, and distance; measuring work, time, and labour productivity; quantity of goods, including their price and value; planning solutions to a problem; representing information using charts, tables, and other models; and finding parts of a whole and a whole based on its parts	Use mathematics to represent the relationship between given quantities in a problem, develop a plan for solving the problem, and explain the chosen strategy; apply arithmetic methods to solving educational problems (1 to 2 steps) and problems in everyday life; solve problems involving fractions ($^1/_2$, $^1/_3$, $^1/_4$, $^1/_5$, $^1/_{10}$); verify solutions step by step and evaluate how realistic they are	Solve problems in 3 to 4 steps; find multiple ways of solving a problem
Spatial relations and geometric figures	Corresponding arrangements of objects in space and on a plane; recognising and depicting geometric figures including points, line segments, broken lines, angles, polygons, triangles, rectangles, squares, circumference, and circles;	Describe the relative position of objects in space and the coordinate plane; recognise, name, and represent geometric figures; construct geometric shapes with specified dimensions with a ruler and a set square; use the properties of rectangles and squares to solve problems; recognise and name geometrical	Recognise, distinguish, and name geometric solids (e.g., parallelepipeds, pyramids, cylinders, and cones)

TOPIC AREA	RECOMMENDED CONTENT	MINIMUM LEARNING REQUIREMENTS	ADDITIONAL LEARNING OPPORTUNITIES
	using drawing tools to perform constructions; geometric shapes in the world; recognising and naming cubes, spheres, parallelepipeds, pyramids, cylinders, and cones	solids, and relate real-world objects to models of geometric shapes	
Geometric quantities	Geometric quantities and their measurement; measuring the length of a segment; units of length (mm, cm, dm, m, km); perimeter; calculating the perimeter of a polygon; area of geometric figures; units of the area; exact and approximate measurement of the area of geometric figures; calculating the area of a rectangle	Measure the length of a segment; calculate the perimeter of a triangle, a rectangle, and a square, and the area of a rectangle and a square; and approximate (by eye) the size of geometric objects and distances	Calculate the perimeter of a polygon, and the area of a figure made up of rectangles
Working with information	Collecting and representing information related to counting and measurement; recording and analysing information; drafting simple expressions using the logical connectives and words "and," "no," "if … then," "true or false," "every," "all," and "some;" verifying the truth of statements; drafting finite sequences of objects, numbers, geometric figures, etc., according to a rule; drawing up, writing, and executing simple algorithms, planning for information retrieval; reading, completing, and interpreting data in a table; reading bar graphs; creating simple information models	Read and fill in simple tables; read simple bar graphs, and understand simple expressions containing logical connectives and words (e.g., "and," "if … then," "true or false," "every," "all," "some," and "no")	Read simple pie charts; complete simple bar graphs; draw up, write, and execute instructions; plan a search for information; recognise the same information presented in different forms; plan simple research, and collect and present the information using tables and charts; interpret the information obtained through simple research

(Extracted from Mullis et al., 2016.)

In comparison to the South African curriculum, it is very similarly structured, with the same content areas, but the academic level seems much higher in terms of breadth and depth. Russia and South Africa went through similar political turmoil, which brought with it a three-fold process of political demarcation (Wolhuter, 2020). The political changes in these two countries led to a redesigning and overcorrection of the educational system, which in turn led to decentralisation, de-ideologisation of the curriculum, and a shift in the focus of the curriculum. The two countries will thus be compared at the end of this discussion.

India has seen a decline in educational outcomes over the last decade (Menon, 2020) and it is visible when comparing India with the other BRICS countries (Agarwal & Bandyopadhyay, 2018). Menon (2020) further points out that one of the major factors contributing to the decline in performance is that learners are promoted under the "no-detention policy". This entails that a learner may not be failed if he[1] cannot reach the outcomes as set in the curriculum. Learners may only fail in grade 8, but by then they have fallen behind so far in their learning, understanding, and skills that they most often drop out of school. Agarwal and Bandyopadhyay state that during 2018, 1.11 million teachers, including FP mathematic teachers, were not qualified or were undertrained. To ensure quality education, the latter was investigated and adjustments to the teacher's training programme were implemented (Vippu et al., 2019). Thereupon a new curriculum was introduced in 2020, named the *National Education Policy of India – 2020* (GoI, 2020). The curriculum is based on the slogan "What you do is so loud that I can't hear what you say" (Maharajh et al., 2021, p. 5).

Learners in the Preparatory stage (age 8 to 11 years) follow a "Building on the play, discovery and activity-based learning programme" in mathematics (Aithal & Aithal, 2020:2). The programme encompasses learning through play, games and the discovery of mathematical concepts that expand insights into mathematics and stimulate cognitive and emotional development. Since the programme focuses on play-based learning, it excludes formal teaching lessons (Maharajh et al., 2021). Vlachopoulos et al. (2017) criticise the programme when arguing that critical thinking should be complementary to teaching through play and that it will be better for the learners to work in a combined method. They further argue that upon entering the pre-school phase, no competent foundation in mathematics is laid if the only focus is self-exploration (Maharajh et al., 2021). When including activity-based learning, the mathematics curriculum has a more structured approach in which learners are gradually exposed to formal classwork and textbooks – this is also known as the scaffolding approach (cf. 3.5.2.2). Vygotsky (1987) referred to this process as the zone of proximal development. This process describes the teachers leading the learner to the point of understanding (cf. 2.10.2). This approach will prepare the learner better for the pre-school phase (Aithal & Aithal, 2020). To address the above-mentioned challenges, the *Draft National Education Policy 2025* envisions reform in the education system and assessment policy to include

[1] In this thesis, pronouns of one gender are understood as including reference to the other gender as well, unless the contrary is clear from the context.

structured mathematics teaching and learning approaches, adjust the class ratio to 30:1 and enhance the professional development of teachers.

China exerted efforts to reform its education system and the curricula to optimise teaching and learning (Gao, 2015). The Chinese mathematics curriculum specifies five strands, namely number and quantity, geometry, algebra, statistics and probability, and mathematical connections (Wang et al., 2017) that are implemented according to the grade level. The recent mathematics curriculum changes were made with the idea of "Mathematics for all", meaning that everyone must have the opportunity to learn and apply mathematics in their diverse context (Wang et al., 2017, p. 5316). Therefore, amendments to the content and requirements for assessment in the curriculum were made to enrich the focus on mathematical views, mathematical activities, and mathematical abilities (Shi et al., 2012).

When the mathematics curricula of Brazil, Russia, India and China are compared to that of **South Africa**, Russia's curriculum seems to correlate in structure with what South Africa is currently offering. Table 2.2 shows a correlation between the *South African Curriculum and assessment policy statement* (CAPS) (2011a) and the content areas/topic areas of the Russian curricula. The content areas for South Africa include numbers, operations, and relationships, whereas Russia describes them as numbers and values. The content in these two areas is the same but the academic level in the Russian curriculum seems to be much higher than in the South African curriculum. Grade 3 learners in South Africa are expected to count up to 1000 but in Russia, it is expected of the learners to count up to 1 million. The next content area/topic area for South African learners is patterns, functions, and algebra. Russia still makes use of the term *arithmetic operations*. Here, the vast discrepancy in academic level is also visible. In CAPS (2011a), the learners are working from 1-1000, whereas the Russian curriculum expects learners to work from 1-10 000. Algorithms of written operations containing 2 or 3 arithmetic operations, with and without parenthesis, are not yet done on this level in South Africa. "Space and shapes" in the Russian curriculum are called "Spatial relations and geometric figures" in the South African curriculum, but the learning content is very similar to that of South Africa.

"Geometric quantities" in the Russian curriculum are very similar to "measurement" in the South African curriculum. There is a slight deviation in academic level – for example, decimetre is included in the Russian curriculum but omitted in the South African curriculum. "Data handling" in the South African curriculum is named "working with information" in the Russian curriculum. Here the South African curriculum seems to be the more descriptive of the two. The Russian curriculum also has an additional topic area, namely that of solving word problems. Word problems are integrated in the South African curriculum in all the content areas. Again, the integration of word problems into all the content areas is a holistic approach to addressing word problems. Integrating problem-solving skills into all content areas will allow the learners to address all the content areas in an everyday setting. Overall, the academic level of the Russian curriculum is well above that of the South African curriculum. The reason for this high academic level is that the Russian curriculum aims to identify learners who meet the learning requirements and achieve in the school curriculum, especially mathematics (Valeeva, 2015). These learners then move on to a secondary school that specialises in mathematics. The Russian learners that are not able to reach the outcome in the curriculum, receive assignments appropriate to their achievement level and therefore need less attention from the FP teacher. Because they struggle to meet the requirements to enter secondary or vocational schools, these learners tend to drop out of the school system (Valeeva, 2015). Researchers like Ohtani (2018) advocate for changes in the Russian mathematics curriculum. He suggests that coherency and articulation of mathematics need to be developed through the curriculum among all grades. Another suggestion is to elaborate on a functional and authentic assessment system.

As with the Russian curriculum, the current CAPS (DBE, 2011a) do not accommodate South African learner diversity adequately (Jojo, 2019; Kempen & Steyn, 2016; Schmidt, 2017). These authors' recommendation is that an in-depth investigation be done of education for learners who experience barriers to learning in South Africa. Further recommendations on their part are that the mathematics curriculum, along with the overall curriculum, be adapted to accommodate these specific learner needs. It is, however, necessary to start at the beginning when the South African curriculum is reviewed. There have been several changes to the national curriculum after 1994.

2.4 NATIONAL CURRICULUM CHANGES IN SOUTH AFRICA AFTER 1994

It is not uncommon for one country to adopt an education system from another (Li, 2017), especially in a country like South Africa with a conglomerate of languages, religions, cultures, and demographic diversity. Wolhuter (2020) affirms that "the mere adoption of a curriculum from another country, is however, not a substantial solution to the current educational [mathematical] problems in South Africa" (p. 5). South Africa adopted a good number of curricula from other countries over the decades, but soon realised the problematic implementation of those curricula.

In 1994, after the election of a democratic government, the African National Congress (ANC) government deemed it crucial that the curriculum needed to be changed, to promote transformation and to establish common citizenship amongst South Africans (Jacobs et al., 2014; Magagula, 2015). They further argued that the previous curriculum was seen as reinforcing racial injustice and inequality (Magagula, 2015) and appointed a task team to investigate the matter. Outcomes-based education (OBE) was introduced and a new curriculum was launched, namely

Curriculum 2005 (DoE, 1997). The OBE-based curriculum was loosely structured and the primary focus was on continuous assessment rather than formal assessment tasks. The *National Curriculum Statements* (NCS) (DBE, 2002) was rolled out, and shortly thereafter examined and revised, which led to the creation of the *Revised National Curriculum Statement* (RNCS) (DBE, 2004) (Chisholm, 2005). In 2000 Curriculum 2005 was reviewed because the NCS did not bring about the expected outcome the ANC government envisioned (DBE, 2011b) and the *Curriculum and Assessment Policy Statements* (CAPS) (DBE, 2011a) was promulgated in 2011 with a much more structured approach (Magagula, 2015; Neethling, 2015). The CAPS (2011a) is thus a revised version of OBE, formulated to rectify the mistakes made in OBE (Magagula, 2015). It is more rigid, with specifications on what to do and how and what to assess. The introduction of each of these curricula brought with it several challenges (Schmidt, 2017), which the DBE is trying to address through curriculum adaptations. These changes had a significant influence on mathematics teaching and learning.

Mathematics is widely considered as a difficult subject. This is even more so with the constant changes to the curriculum. The first change after 1994 to the curriculum was the move to OBE (DoE, 1997). OBE (DoE, 1997) was characterised by collaborative learning. With group work in mathematics, it is difficult for teachers to identify learners that are struggling with specific parts of the work and to address it promptly (Jojo, 2019). The NCS (DBE, 2002), and RNCS (DBE, 2004), were written vaguely, with complex terminology that led to confusion for some teachers. Jojo (2019) further mentioned that the mathematics curricula were both loaded and the teachers did not all receive adequate training to optimally present the learning content. With the introduction of the CAPS (2011a) some of these challenges were addressed.

2.5 ADVANTAGES OF THE CURRICULUM AND ASSESSMENT POLICY STATEMENT

The advantage of the CAPS (2011a) is that it has detailed guidelines for the teachers with week-by-week planning, and it provides guidelines on progression and pacing as well as assessment requirements that lessens the administrative burden on the teachers (Grussendorff, 2014). Since CAPS (2011a) is a national curriculum aiming at ensuring consistency throughout the country, learners are now able to transfer between schools and provinces and simply continue with the curriculum in the new location.

CAPS (2011a) offer a more structured mathematics curriculum that enables government officials and subject advisers to monitor the progress and performance of the learners (Jojo, 2019). Thus, it allows for greater support to the teachers and better learner performance. Ramatlapana and Makonye (2012) are critical of the inflexibility of the curriculum (cf. 2.9.2) and argue that it restricts the mathematics teachers in their professional autonomy (cf. 2.9.1.1), whereas Feza (2014) is in favour of the structured approach to teaching. He supports the more direct instructional approach and reasons that it is to the advantage of teachers in rural areas, which are often located in disadvantaged communities, where learners experience barriers to learning.

Grussendorff (2014) feels that the CAPS (2011a) for mathematics takes emphasis away from the reformatory agenda that was visible in the prior curricula. It instead places more focus on the core curriculum and what is essential for the learners to master to succeed in mathematics. She is also of the opinion that the CAPS (2011a) has less educational jargon, which makes it more user-friendly, especially for teachers in the FP that might not be fluent in English.

A curriculum such as CAPS (2011a) must be compiled in a manner that accommodates learner diversity in the class (DoE, 2001; DBE, 2011a). Even though some changes were made to the curricula over the years, these curricula were predominately written for the mainstream learner (Kempen & Steyn, 2016). It is challenging to implement CAPS (2011a) for learners from rural communities and learners who experience barriers to learning. Below, I will investigate the changes that were made to the curriculum to accommodate these learners.

2.6 CURRICULUM CHANGES TO ADDRESS THE NEEDS OF LEARNERS WHO EXPERIENCE BARRIERS TO LEARNING

The *Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System* (EWP 6) (DoE, 2001), advocates that the system be changed to accommodate the learner with his/her needs. According to Smit et al*.* (2020) the system is failing our learners who experience barriers to learning. Since 1994, it appears as if South Africa has never had a curriculum to adequately address the specific needs of learners who experience barriers to learning (Donohue & Bornman, 2014; Kempen & Steyn, 2016). As previously mentioned, (cf. 2.3), this phenomenon is not unique to South Africa (Sunardi et al*.*, 2016). In the absence of a standardised curriculum for these learners, the *South African National Association for Special Education* (SANASE, 2002) compiled a learning programme that was more appropriate for these learners but never promulgated. This learning programme was nationally used in special schools but not formally recognised by the DBE. Following this development, a standardised CAPS-aligned learning programme was developed by the DBE. The *Differentiated Curriculum and Assessment Policy Statement* (DCAPS) is currently still a draft document (DBE, 2018). Before this, teachers' practices in respect of learners who experience barriers to learning were often described as time-wasting activities, the wrong transmission of content, limited content coverage, teaching the same content to different grades, and low expectations of learners (Langhan et al*.*, 2012). The teachers often have poor subject knowledge (Spaull, 2013) and are not using the correct teaching methods to support these learners who experience barriers to learning (Donohue & Bornman, 2014; Kempen & Steyn, 2016).

2.6.1 The draft Differentiated Curriculum and Assessment Policy Statement

There are learners in the General Education and Training band who have an aptitude for and an interest in practical knowledge and vocational skills, for whom the CAPS Grades R to 12 (DBE, 2011a) needs to be differentiated to make education more accessible. These are often the learners that experience some form of barrier to learning. The DBE formed a task team to address the specific needs of these learners. The draft DCAPS (DBE, 2018) was developed to address the specific needs of learners who experience barriers to learning. It is stated that learners who experience barriers to learning will benefit from this curriculum because of its more applied and functional level, as well as that it takes the learners' interest and aptitude into consideration (DBE, 2018). In 2017, the DCAPS (DBE, 2018) was piloted and implementation started in 2018 at special and mainstream schools, but it has not yet been promulgated through parliament and that is why it is currently still called a learning programme and not a curriculum.

Learners with moderate to severe disabilities can be accommodated on the DCAPS (2018) programme, to prepare them for the Technical Occupational pathway or the world of work. In this DCAPS (2018), learners are offered the opportunity to develop to their full potential (DoE, 2001). At the completion of this learning programme, learners will obtain a recognised and accredited statement of achievement (DBE, 2018). This will then prevent these learners from experiencing failure and dropping out of the school system. The main aim of the DCAPS (DBE, 2018) is to remove the barriers the learners may experience. The learning programme also aims to:

- ensure that all learners are recognised for their efforts, irrespective if they meet the requirements of the CAPS (2011a);
- provide a general standardised education programme that is suitable for diverse learner needs;
- prepare the learners to be independent citizens to contribute to their community (DBE, 2001);
- promote lifelong learning;
- prepare learners to function better in a fully inclusive society and employment; and
- be able to provide employers with a profile of the learner's competence.

The DCAPS (2018) is written for the three primary subjects, namely English (both Home Language (EHL) and First Additional Language (EFAL)), mathematics, and life skills. For the purpose of this study, I will mainly focus on DCAPS (2018) mathematics.

2.6.2 The draft Differentiated Curriculum and Assessment Policy Statement for mathematics

The DCAPS (2018) mathematics was specifically developed to make mathematics practical and to give learners the opportunity to apply mathematical knowledge and skills in a way that is meaningful to their own lives. It is stated that the learners now get the opportunity to apply what they have learned in the classroom, to their everyday lives (DBE, 2018). The functional skills embedded in the DCAPS mathematics learning programme (DBE, 2018) are to:

- acquire mathematical knowledge and skills;
- apply them in real-world situations;
- manage their own budget (grants and income, living expenses);
- be a meaningful participant in society;
- facilitate the transition from school to work;
- apply and utilise in the work situation;
- utilise numerical data in real life (cooking and baking, measuring); and
- equip the learners for self-fulfilment.

The DCAPS (2018) mathematics is totally aligned with the CAPS (2011a) mathematics, and this makes it easier for the teacher to work concurrently on both the DCAPS (2018) and the CAPS (2011a), in the same class. The content areas in the DCAPS for mathematics stayed the same as in the CAPS (2011a), (cf. 2.8) (Table, 2.3). Content areas for the DCAPS (2018) are number operations and relationships, patterns, functions and algebra, space and shapes, measurement, and data handling. Even though the content areas stayed the same, only the core curriculum is presented to the learners with significant cuts in the length and depth of the content (DBE, 2018).

When taking only the numbers, operations, and relationships as an example (Table 2.2), it becomes clear that the content is spread progressively over the grades and terms, but at a significantly lower academic level than in the CAPS (2011a). It is of note that division is only done in the next phase and not in the FP.

Table 2.3: DCAPS grade overview of numbers, operations and relationships

NUMBERS, OPERATIONS, AND RELATIONSHIPS				
TOPICS	**GRADE R**	**GRADE 1**	**GRADE 2**	**GRADE 3**
1.1 Count objects	Count concrete objects to at least 1-10 reliably	Estimate and count concrete objects to at least 1-20 reliably	Estimate and count concrete objects to at least 1-50 reliably Count by grouping is encouraged	Estimate and count concrete objects to at least 1-200 reliably Count by grouping is encouraged
1.2 Count forwards and backward	Recite counting rhymes and songs Count forwards from 0 to 5	Recite counting rhymes and song Count forwards and backward from 0-10	Count forwards from 0-50 Count forwards and backward in multiples of: 2s from 0-20 10s between 0 and 50	Count forwards from 0-200 Count forwards and backward from any number between 0-100 in multiples of: 2s from 0-200 5s from 0-200 10s from 0-200
1.3 Number symbols and number names	Recognise, identify, and read number symbols from 1-5	Recognise, identify and read number symbols from 1-10 Write number symbols 1-10	Recognise, identify and read number symbols from 1-100 Know the number names 1-5 Know number names in multiples of 10s up to 50 Write number symbols 1-20	Recognise, identify and read the number symbols from 1-200 Know the number names 1-10 Know number names in multiples of 10s up to 100 Write number symbols 1-50
1.4 Describe, compare and order numbers	Use ordinal numbers to show order, place, or position: Develop an awareness of ordinal numbers e.g., first, second, third	Order, compare, and represent numbers to 5 Order and compare whole numbers according to more than and less than Use ordinal numbers to show order, place, or position	Order, compare, and represent numbers to 10 Order and compare whole numbers according to more than and less than, equal to Order numbers from smallest to biggest up to 1-5	Order, compare, and represent numbers to 50 Order and compare whole numbers according to more than and less than, equal to, and greater than Compare whole numbers according to,

NUMBERS, OPERATIONS, AND RELATIONSHIPS				
TOPICS	**GRADE R**	**GRADE 1**	**GRADE 2**	**GRADE 3**
		Position objects in a line from first to fifth	Compare whole numbers according to big, small, smaller than, bigger than, up to 10 Position objects in a line from first to tenth or first to last	more than, less than, is equal up to 50 Position objects in a line from first to 20th or first to last (ordinal numbers)
1.5 Place value			Begin to recognise the place value of two-digit numbers to 20 Decompose two-digit numbers into multiples of tens and units Identify and state the value of each digit	Begin to recognise the place value of two-digit numbers to 99 Decompose two-digit numbers into multiples of tens and units Identify and state the value of each digit
1.6 Problem-solving techniques	Use concrete apparatus e.g., counters and physical number ladder	Use concrete apparatus e.g., counters and physical number ladder Practise doubling	Use concrete apparatus e.g., physical number ladders; counters, and pictures Practice doubling and halving Use number lines supported by concrete apparatus	Building up and breaking down numbers Practise doubling and halving Use number lines Use 100 chart Rounding off in tens Calculators
1.7 Addition and subtraction	Solve verbally stated problems with answers up to 5	Use concrete objects to solve problems involving addition and subtraction with answers up to 10	Solve word problems (story sums) in context and explain own solution to problems involving addition and subtraction with answers up to 20	Solve word problems (story sums) in context and explain own solution to problems involving addition and subtraction with answers up to 100
1.8 Repeated addition leading to multiplication			Solve addition problems of 2s and 10s with answers up to 50	Solve addition problems of 2s, 5s, and 10s with answers up to 100

NUMBERS, OPERATIONS, AND RELATIONSHIPS				
TOPICS	**GRADE R**	**GRADE 1**	**GRADE 2**	**GRADE 3**
1.9 Grouping and sharing leading to division	Solve and explain solutions to word problems in context (story sums) that involve equal sharing and grouping with whole numbers up to 5	Solve and explain solutions to word problems in context (story sums) that involve equal sharing and grouping with whole numbers up to 10	Solve and explain solutions to word problems in context (story sums) that involve equal sharing and grouping with whole numbers up to 20	Solve and explain solutions to word problems in context (story sums) that involve equal sharing and grouping with whole numbers up to 50
1.10 Sharing leading to fractions	Introduction to half using concrete objects	Introduction to half using halving of concrete objects	Introduction to half using halving of concrete objects	Solve and explain solutions to practical problems that involve equal sharing leading to solutions that include unitary fractions e.g. half, quarter
1.11 Money	Develop an awareness of and recognise South African coins	Recognise and identify South African coins like 50c, R1.00, R2.00, R5.00	Recognise and identify South African coins like 50c, R1.00, R2.00, R5.00 and notes like R10.00, R20.00, R50.00, R100.00, R200.00	Recognise and identify South African coins like 50c, R1.00, R2.00, R5.00 and notes like R10.00, R20.00, R50.00, R100.00, and R200.00 Solve money problems involving totals and change up to R100.00
1.12 Techniques (method or strategies)	Use concrete apparatus e.g., counters	Use concrete apparatus e.g., counters Practise doubling and halving Use number lines Use 100 chart	Use concrete apparatus to solve maths problems e.g., drawings or concrete objects Practise doubling and halving Use number lines Use 100 chart	Use the following techniques when solving problems and explain solutions to problems: Building up and breaking down numbers Practise doubling and halving Use number lines Use 100 chart Round off in 10s
1.13 Addition and subtraction	Solve verbally stated addition	Solve verbally stated addition	Add to 20	Add to 99

NUMBERS, OPERATIONS, AND RELATIONSHIPS				
TOPICS	**GRADE R**	**GRADE 1**	**GRADE 2**	**GRADE 3**
	and subtraction problems with concrete objects up to 5	and subtraction problems with concrete objects up to 10	Subtract from 20 Practise number bonds up to 5 Use appropriate symbols (+,-,=,□)	Subtract from 99 Practise number bonds to 10 Use appropriate symbols (+,-,=,□)
1.14 Repeated addition leading to multiplication		Add the same number repeatedly up to 10	Add the same number repeatedly up to 20 Use appropriate symbols (+, =)	Add the same number repeatedly up to 50 Multiply numbers 1 to 10 by 2, 10, 5 to a total of 50 Use appropriate symbols (+, x, =)
1.15 Division		*Not done in the FP*		
1.16 Mental mathematics	Number concept range 5 Count everyday objects Count forwards	Number concept range 10 Name the number before and after a given number Compare numbers and say which is more or less	Number concept range 20 Name the number before and after a given number Compare numbers and say which is 1 or 2 more or less Solve addition and subtraction problems (number bonds) to 5	Number concept: range 100 Name the number before and after a given number Compare numbers and say which is 1, 2, and 3 more or less Solve addition and subtraction problems to 20 Order a given set of selected numbers
1.17 Fractions			Use and name unitary fractions including halves	Use and name unitary fractions including halves and quarters Recognise fractions diagrammatically Write fractions as 1 half

Extract from DCAPS mathematics (DBE, 2018)

Unfortunately, not all teachers are aware of the existence of the DCAPS (2018). In rural areas where teachers do not receive the necessary support and where teachers need to address diverse learner needs, this poses a problem. This study addressed the latter, in a sustainable manner through the Participatory Action Learning and Action Research (PALAR) design. The DCAPS (2018) addresses the current problems experienced by teachers in mathematics in South Africa, and in the sections below I will accordingly discuss the current state of mathematics in South Africa.

2.7 CURRENT STATE OF MATHEMATICS IN SOUTH AFRICA

The DBE Annual performance plan, 2020/2021 (DBE, 2020:28), states the following:

> *Studies indicated that large proportions of South African children reach grade 5 without achieving basic numeracy proficiency. These outcomes at grades 5 are a reflection of the quality challenges that persist in the FP (p. 28).*

However, several authors – such as Reddy et al. (2015), Spaull (2019), and Van der Berg et al. (2019) – instead believe that there are signs of improvement in the standard of mathematics. These authors, however, agree that the school system has a long way to go, to deliver quality mathematics for all learners. In South African schools the teaching and learning of mathematics are not yet at the standard that the education policies and curricula intended. This is evident from research done by DBE, universities, and independent research agencies (DBE, 2019).

Spaull (2015) already stated in 2015 that only the top 16% of learners in Grade 3 are performing on the appropriate level. The discrepancy between the poorest 60% of learners and the wealthiest 20% is approximately three grade levels below the performing standards for grade 3. Fritz et al. (2020) demonstrated in a study that the intended curriculum is beyond the grasp of most South African grade 1 learners. These learners will struggle to develop new mathematical concepts because of their lack of fundamental knowledge (cf. 2.9.1.2), which should have been laid in the lower grades. Fritz et al. (2020) suggested that the curriculum for mathematics for grade 1 should place more emphasis on counting skills, ordinal relations between numbers, set-based number representations, and part-part-whole relations.

2.8 CURRICULUM AND ASSESSMENT POLICY STATEMENT

In the CAPS (2011a) for the FP, mathematics is divided into five content areas that need to be covered in a specific grade, namely numbers, operations, and relationships; patterns, functions, and algebra; space and shape (geometry); measurement; and data handling. Each content area has a main focus and the outcomes that need to be addressed and mastered to pass a specific grade. The curriculum also sets out what needs to be assessed and when it needs to be assessed. Each grade progressively builds on the previous grade, as is summarised in Table 2.4 below.

Table 2.4: Content areas, Main focus, and Progression of CAPS in the Foundation Phase

Content area	Main focus	Progression
Numbers, operations, and relationships	Development of number sense	The number range increases. Different kinds of numbers are introduced. The calculation strategies change.
Patterns, functions, and algebra	Expositor to patterns develops a sense of order and sequencing	The completion and extension of patterns represented in different forms. Being able to identify and describe patterns.
Space and shape	Development of a sense of space and shape	Focus on new properties and features of shapes and objects. Move from learning the language of position and matching different views of the same objects to reading and following directions.
Measurement	Measurement focuses on informal and formal ways of measuring	New forms of measuring. New measuring tools, starting with informal tools and moving to formal measuring instruments. New measuring units, calculations, and problem-solving with measurement should take cognisance of the amount of work that has already been covered.
Data handling	Developing the skills to handle data	Collect. Organise. Represent. Analyse and interpret. Record and report.

(Extracted from DBE, 2011a)

The CAPS (2011a), in general aims, to produce learners that can:

- use critical and creative thinking in making decisions regarding the identification and solution of problems;
- work effectively as individuals and with others as members of a team;
- manage and organise themselves in handling their activities responsibly and effectively;
- collect, analyse, organise and critically evaluate relevant data;
- use visual, symbolic, and/or language skills in various modes to communicate effectively; and
- recognise that problem-solving contexts do not exist in isolation and demonstrate an understanding and interpretation of the world as a set of related systems (DBE, 2011b).

It is a challenge for teachers as well as learners in rural areas and learners that experience barriers to learning to master all the content as prescribed by the curriculum because of its inflexibility (Neethling, 2015).

CAPS (2011a) aim to ensure that there is clear guidance and consistency for teachers. Thaanyane (2010) noted that CAPS (2011a) is based on the content to be taught and learned. Neethling (2015), however, describes the inflexibility of the curriculum as concerning. According to her, the curriculum requirements do not allow flexibility to cater to diverse learner needs. Because of the inflexibility of the curriculum the specific needs of learners who experience barriers to learning, may not be met. In line with Neethling's (2015) argument, the inflexibility of the curriculum, according to Ramatlapana and Makonye (2012), limits the functional independence of mathematics teachers. Furthermore, the pressure on the teachers to do content coverage does not allow time for an adequate adaptation of the curriculum to accommodate learners who experience barriers to learning (Adewumi et al*.*, 2017; Laurillard, 2013; Neethling, 2015). Laurillard (2013) further notes that no curriculum is suitable for all learners, as all curricula need to be adaptable to the learners' specific needs.

For a curriculum to be successful, it is of the utmost importance to be flexible (Adewumi et al*.*, 2017). The flexibility of the curriculum speaks to the content and how the content is being conveyed to the learner (Neethling, 2015). To make a curriculum flexible and accessible to all learners it is important to incorporate the appropriate assessment, support (cf. 2.8.1) and intervention strategies. To make learning possible and accessible to all learners, it is important to include relevant learning and teaching support material (LTSM) (cf. 2.9.1.3). Diverse learning styles and the rate at which each learner learns, need to be taken into consideration. Classroom management and organisation must also meet the diverse learning needs of all learners (DBE, 2014; DoE, 2001; Geldenhuys & Wevers, 2013; Loreman, 2007; Väyrynen, 2003). The CAPS (2011a) requirements limit the time that a teacher can spend on specific learning content. This restricts them from making the necessary adaptations and differentiation (cf. 2.6.1) to the curriculum to accommodate learners who experience barriers to learning (Neethling, 2015; Nel et al*.*, 2012). Unfortunately, for learners that experience barriers to learning and learners in rural areas, with very few resources, these curricula are a challenge from the onset (Gina, 2018; Langhan et al*.*, 2012).

CAPS (2011a) was developed for all schools in South Africa (DBE, 2014). These included mainstream schools, full-service schools (FSS), and rural and special schools. Even though CAPS (2011a) is relatively rigid, the DBE states that the way it is presented to the learner can be flexible to enable learning, especially for learning diversity (DBE, 2010; DBE, 2011a). To make the latter possible, the necessary support structures need to be in place in the DBE. The following is a brief discussion of the support structures currently in place in the DBE.

2.9 SUPPORT STRUCTURES TO FACILITATE CAPS

All relevant support structures in the school community, including teachers, district-based support teams (DBST), school-based support teams (SBST), parents, and special schools as resource centres, must identify and minimise barriers in order to manage inclusion. Teachers should know how to identify and assist the needs of learners' experiencing barriers to learning, to address learner diversity in schools (DBE, 2018).

The *White Paper 6* (DoE 2001) stipulates that the task to support learners who experience barriers to learning is the primary responsibility of the teacher. In rural communities, this is quite a daunting task (Bosman, 2022). The *Screening, Identifying, Assessment and Support* (SIAS) document (DBE, 2014) details the process to be followed to identify individual learning needs in the home and the school context. The level and extent of additional support that is needed for a specific learner must be established and the process that needs to be followed to enable all learners access to the learning content is described.

The SIAS (DBE, 2014) also describes the different levels of support that are available for each learner. Learners need to be supported within the school where they are currently attending and not be moved to a separate school or class. There is, however, a warning against the unnecessary placement of learners in special schools. The SIAS process identifies the best learning sites for support and provides guidelines on the important role of parent involvement. Teachers must document the strategies that they intend to use to address the learners' specific needs in an Individual Support Plan (ISP). After the implementation of these strategies, the teacher must document the outcome (Dalton et al*.*, 2012). The SIAS policy (DBE, 2014) further describes the process by which the teachers need to be supported. The above-mentioned support should be provided by the SBST. The SBST in turn receives support from the DBST. In the absence of the SBST, the DBST must support the parents, teachers, and the school. Although this is stipulated in the mentioned documents, it is not always happening at the grassroots (Kempen & Steyn, 2016). These support structures have a huge impact on the education to learners, teacher knowledge, and experience as well as on the curriculum itself. In the absence of these support structures, challenges may manifest. Evidentially, however, there are challenges with the curriculum as a whole, as will be pointed out below.

2.10 CHALLENGES EXPERIENCED WITH THE CURRENT CAPS CURRICULUM

The policies related to the curriculum are well written and clearly state how the curriculum coverage should take place, but this is not always possible in the South African context. Xhalisa (2011) describes this phenomenon as a "disjuncture between policy and practice" (p. 12) and focuses attention on the extent of the discrepancy between the two. It is clear that mathematics teaching needs to be investigated and some adjustments need to be made to enable all learners access to the curriculum. Before suggesting any changes, I will first focus on the challenges currently experienced in mathematics.

2.10.1 Lack of resources

To ensure that all learners perform to the best of their ability in mathematics, it is important to see to it that they receive the necessary resources. Several research reports, such as those by Gous et al*.* (2014), Krishnaratne et al*.* (2013), Neethling (2015), Quane and Glanz (2011), Sayed (2002), as well as Wildeman and Nomdo (2007), agreed that quality education cannot take place when the lack of resources is not addressed. Considering the current economic state of the country, the DBE – and along with it, the Government of South Africa – cannot provide schools with much-needed physical and human resources (Du Plessis & Mestry, 2019). Van der Nest (2012) classified mathematical resources into three categories, namely human, cultural and material resources, which I will discuss in that order.

2.10.1.1 Human resources

Adler (2016) stated that learners must be made aware of the fact that they are capable of doing mathematics, regardless of their environment or situation. This can only be done if the teachers are dedicated to supporting the learners to achieve their full potential. This is possible, but with a shortage of teachers (Neethling, 2015) and inadequate subject knowledge on the part of the teachers (Taylor, 2021) it becomes problematic. The Head of the Department of Basic Education's *National Education Evaluation and Development Unit* (NEEDU) argues that the learners' poor performance in mathematics is largely due to the poor subject knowledge of teachers (Jojo, 2019). Venkat and Spaull (2015) refer to a study in which FP teachers were tested on Grade 6 mathematics content. Their test scores indicated that 79% of these teachers had content levels below the standards of the Grade 6 curriculum. Taylor (2021) referred to tests done on first and final-year B.Ed. students and concluded that these students were not ready to teach the CAPS (2011a) to learners. South Africa needs to cultivate appropriately qualified mathematics teachers to ensure that there is a sufficient number of students to enter university. The fact that some teachers in the system are not qualified to teach mathematics, poses a huge challenge.

Spaull (2015) suggested a strategy to enhance the mathematics performance in South Africa as a whole. Spaull's (2015) plan entails that (i) improvement of mathematics teaching and learning must begin urgently; (ii) extra mathematics lessons for all learners and teachers be mandatory, (iii) and there needs to be a more sustained focus on teacher training and development. Jojo

(2019) suggests that all teachers must undergo compulsory in-service training before permanent employment is considered. Moloi (2012) furthermore argues that current educators need to receive compulsory refresher training. This will enable the teachers to be able to teach mathematics, even in under-resourced communities.

Even though teachers in rural areas and urban areas received the same initial training, in-service training in rural areas is a huge challenge. Teachers must know how to use the available resource material and be able to think out of the box and use natural materials readily available (Adler, 2016, Hlalele, 2014). The teachers must be able to apply knowledge stemming from common sense in using what is available as resources to teach mathematics.

Kempen and Steyn (2016) found that teachers feel that they do not receive sustainable and efficient support from the SBST and DBST. According to teachers, learners that experience barriers to learning, delay the progress of the whole class (Murungi, 2015). If teachers do not understand the learners' disabilities or their barriers, it is understandable that they find it difficult to modify and adapt the curriculum to address these unique learning needs (Kempen & Steyn, 2016).

According to Du Plessis and Mestry (2019) some teachers do not follow the CAPS (2011a), but rather focus on their own lesson plans and completing the work as easily and quickly as possible. This may be one of the reasons why learners do not grasp the foundational concepts of mathematics as required by the curriculum.

2.10.1.2 Cultural resources

When cultural resources in the South African context is discussed, it is important to consider the rural communities which are most affected by factors relating to poverty, cultural influences on education, and limited parental involvement (to name a few), which influence teaching and learning (Boshoff 2021; Du Plessis & Mestry, 2019; Neethling, 2015). Rural schools will be dealt with in detail in Chapter 3.

When culture is considered, it is necessary to look at the traditional way of teaching mathematics versus the Western way of teaching mathematics. Van der Walt et al. (2019) quoted Vygotsky (1978) in her view of acquiring mathematics knowledge (cf. 2.10.2). Both these authors argue that mathematical knowledge is meaningful when attaining that knowledge through experience. In cultural mathematics teaching, mathematics will be taught through play and exploration, but in the more Westernised approach, mathematics is thought of in a more abstract and decontextualised manner. It would possibly be in the learner's best interest to infuse the two ways of teaching to ensure optimal mathematical knowledge acquisition. According to Brown (2009) neuroscientists have determined that it will take 400 repetitions to form a new synapsis in the brain; but when the repetition is done in combination with play or exploration, it will only take between 10 to 20 repetitions for the brain to form a synapse (Van der Walt et al., 2019). A synapse is created when neurons in the brain connect to create new knowledge. The process through which it occurs, is called *neuroplasticity* (Sarrasin et al., 2020).

Some examples of indigenous games that can be applied to gain mathematical knowledge – since there are several mathematical concepts embedded in the games – include Marabaraba, Ncuva, and snakes and ladders, that learners play from a very young age. Teachers need to research the possibility of integrating some of these indigenous games that the learners are playing in their community and culture, into their lesson plan because the learners might have prior knowledge of mathematics that we need to acknowledge and build upon in the FP (Furuto, 2014). Different cultural games are played in different regions of the country and the teacher needs to find out with which cultural games the learners are already familiar. By doing this, the teacher can assist the learners in establishing a connection between the cultural knowledge in mathematics and the abstract mathematical concepts that are taught at school (Van der Walt et al., 2019).

Culture and language go hand in hand. Learners are predominately taught in English, which is not their mother tongue and most of the time not that of the teacher either. It is extremely challenging for the teacher to convey the learning content in an unfamiliar language (Molteno, 2017; Shayne, 2020) and this may result in the learners experiencing barriers to learning (Jojo, 2019; Molteno, 2017; Neethling, 2015) (cf. 3.7.4). Molteno (2017) and Nowicki (2019) emphasise that if neither the teacher nor the learners are confident in the language of teaching and learning (LoLT), it may lead to a lack of confidence, followed by apathy towards learning as a whole. Molteno (2017) reiterates that South African teacher training institutions do not adequately prepare non-English speaking teachers to teach in English. Once these teachers are in the class, they pass on their grammatical and pronunciation mistakes to the learners (Nel & Muller, 2010).

Even though the DBE in collaboration with United Nations International Children's Emergency Fund (Unicef) developed a multi-language draft document in 2013 (DBE, 2013) to encourage schools to offer mother-tongue teaching and learning up to grade 12, this is not currently being practiced. The Department encourages schools to offer reading, writing, and mathematics in mother-tongue in the FP, but after the FP, the learners transition to English. Learners experience tremendous problems with this transition (Businesstech, 2020; Molteno, 2017), and research in Niger and Zambia revealed that learners' performance declined within the first two years after transitioning to English (Molteno, 2017).

Learners find it challenging and perform poorly in an unfamiliar language, especially in mathematics, which requires decontextualised use of language (Molteno, 2017) (cf. 2.9.1). Molteno also argues that learners need to build new knowledge on their existing frame of reference. If this prior knowledge is in a different language than the language of learning and teaching (LoLT), this may lead to the learners experiencing barriers to learning.

In a multicultural and multilingual South Africa, most schools prefer to use English as the LoLT. The limited availability of textbooks in African languages (Dabell, 2022; Molteno, 2017) and parents' preference for English may be some of the reasons why English is used as the LoLT. According to Molteno (2017), parents in rural areas consider English as vital for success in life and that "real education can only be obtained in a world language" (p. 22).

Mathematics constitutes a language with its own register. Mathematics register comprises the terminology that is specifically related to mathematics – for example, in mathematics *volume* refers to the capacity of an object, and not to loudness as in other contexts (Dabell, 2022). Setati (2005) reiterates that the mathematics register belongs to the subject of mathematics and only expresses mathematical meaning when used in the mathematical context. This is an even greater challenge for learners in the FP when they have to adapt to the structure of formal schooling as well as learning English, and additionally being exposed to the mathematics register in the mathematics class. Mathematics terminology, such as *parallelogram* and *multiplication*, are words that are not applied in learners' everyday vocabulary outside of class (Dabell, 2022).

2.10.1.3 Material resources

The lack of material resources is one of the greatest challenges in South African mathematics classrooms (Maharajh et al., 2016) (cf. 3.7.3). Material resources, or more commonly known as *learning and teaching support material* (LTSM), are provided by the DBE. Mathematics in each grade has a comprehensive and concise policy document and assessment guide, plus a workbook. The Department usually provides workbooks, to be utilised by all FP grades. These workbooks are not always delivered on time or are not delivered at all. Learners often have to share a workbook. These workbooks are prescriptive in that they determine the pace and order in which the content needs to be addressed. The prescribed books leave less time for educators to do curriculum interpretation, as they need to complete a specific task in the prescribed time frame. This leaves teachers with limited time to ensure that all learners get the correct and most needed support that they require to grasp the new concepts (Neethling, 2015).

Hlalele (2014) has an alternative view on the teaching of mathematics related to material resources. He is of the opinion that teachers need to think unconventionally and utilise whatever resources are available. To teach FP mathematics, teachers should be able to use natural resources (Adler, 2016; Adu, 2022). When teachers use twigs, leaves, lids, and recycled materials, no additional resources are required. Teachers may improve their teaching by making the best use and management of natural resources, according to Hlalele (2014). It is not always possible to comply with the prescriptions of the CAPS (2011a), however, because of the learners that experience barriers to learning, the limited resource material, and the teachers not always being able to teach mathematics properly (Jojo, 2019).

2.11 TEACHING FOR LEARNING DIVERSITY

Every culture is characterised by diversity. Teachers must concretely demonstrate respect for diversity (Adewumi et al., 2017), especially in a mathematical context. Diversity in the context of mathematics describes not only race, language, ability and religion, etc., but knowledge types, learning types, and differences in intelligence.

Jean Piaget (1896-1980) (cf. 2.10.1) and Lev Vygotsky (1896-1934) (cf. 2.10.2) are seen as the fathers of the social *constructivism* theories. Social constructivism forms the basis for the acquiring of mathematical knowledge (Naude & Meier, 2014). This theory will thus also form the cornerstone for this study. Even though both Piaget and Vygotsky focused on the development of the learner, Piaget's attention was on the learner's development of knowledge through their own interaction with the concrete world. On the other hand, Vygotsky concentrated on the social aspects of learning (Naude & Meier, 2014). I will discuss the different theories that underpin this study in Chapter 4. However, it is important to note the different approaches to mathematical learning and teaching as developed by Piaget and Vygotsky.

2.11.1 Piaget's theory on acquiring mathematical knowledge

Piaget based his theory on two key factors. A challenging environment coupled with the curious nature of a learner creates the ideal situation for learning and teaching mathematics. Piaget describes the way learners construct their own knowledge through three types of knowledge acquisition. Firstly, *physical knowledge* is the mathematical knowledge learners gain by playing and exploring with their senses (Naude & Meier, 2014). Furuto (2014) referred to the indigenous games that the learners play for, example Morabaraba, Ncuva, and snakes and ladders, as a rich source of physical knowledge. Learners from different cultures also come to school with an array of knowledge but with vast differences in their cultural backgrounds (cf. 2.9.1.2), This knowledge is what Piaget describes as *social knowledge.* Social knowledge is the knowledge that learners acquire by engaging with others, whether it is in group work with their friends or with the teacher.

In rural communities, the learners may not always be as stimulated, but the teacher must acknowledge this as social knowledge and build on the existing knowledge (cf. Chapter 3).

Thirdly, Piaget describes *conceptual knowledge* as the new mathematical concepts and knowledge that learners intellectually construct for themselves via reflection and repetition. These three types of knowledge are not sequential but are interchangeable processes. This type of knowledge is the internal conceptualisation of the mathematics knowledge the learner acquired (Naude & Meier, 2014).

2.11.2 Vygotsky's theory on the learning of mathematics

Vygotsky describes the learning of mathematics as a three-levelled process, with level one being when learners interact with others in their community. The second level is more related to learning that takes place in the school. The third level is a level that consists of a space between two borders. On the one side is the ability of the learner to solve problems with the help and assistance of a more knowledgeable person such as the teacher. On the other end of the spectrum is the individual ability of the learner to single handily solve the mathematical problem (Naude & Meier, 2014). Between these two opposites is the so-called *zone of proximal development* (ZPD). In the ZPD the teacher presents the learners with the new mathematical concepts. Through a process of scaffolding (cf. 3.5.2.2), the teacher leads the learners to understand and apply the newly acquired concepts. This process of scaffolding in the ZPD is very appropriate especially for learners who experience barriers to learning. In the ZPD learners will then receive optimal support from the teacher and other learners. Vygotsky's social constructivist theory is a collaborative process of developing new knowledge. According to Vygotsky (1987) knowledge is developed from individuals' interactions with culture and society and appears on two levels. New knowledge will first appear on a social level (inner psychological) and later an individual level (intra-psychological). It is on the social level that the community and the teacher play an integral part in mathematical concept construction. If the cultural resources in the community and school are deprived, it influences the learners' ability to develop new knowledge (cf. 2.9.1.2). In rural areas, the learners may not be exposed to the Western way of learning mathematics (Van der Walt et al., 2019) but if the teacher uses the prior cultural knowledge, the learners may benefit from this. Von Glasersfeld (1974) explains that all knowledge is constructed rather than perceived through the senses. According to Vygotsky, learning acquisition is not just an isolated incident but rather an act of sharing knowledge (Naude & Meier, 2014).

2.11.3 Bruner's theory on teaching mathematics

Concrete Pictorial Abstract (CPA) theory – or working from the concrete to the abstract in mathematics – forms an integral part of teaching mathematics, especially in the FP (Douglas, 2019). The CPA was developed by Bruner in 1966. Through this approach, learners first get the opportunity to experience the mathematical problem by using concrete material to discover the solution to the problem. The next stage will be to supply learners with pictures representing the concrete objects to solve the mathematical problem. Lastly, learners will make use of abstract notations using mathematical symbols (Douglas, 2019). This is explained graphically in Figure 2.2.

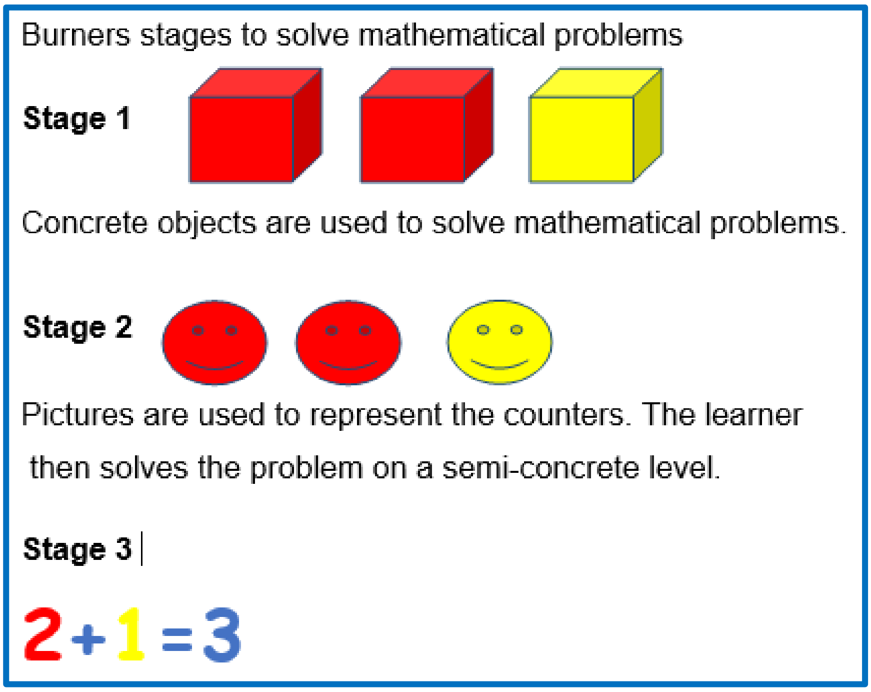

Figure 2.2: Bruner's stages to solve mathematical problems

(Abstract notation using mathematical symbols (Douglas, 2019)

Teaching for diversity also means recognising and respecting learners' different learning types. Three of the learning types that are identified, are auditory, visual and kinaesthetic learning. Those are also applicable to the learning of mathematics. In *auditory learning*, learners optimally take in learning content by receiving the content through listening. *Visual learning* is when learners process information better when it is presented in a visual format such as diagrams, graphs, and detail notes. *Kinaesthetic learning* takes place when the learner can explore the learning content through movement or physical activity (Kelly, 2020). When teaching mathematics to FP learners, the teacher should be sensitive to the learning types in her class. The teacher should be able to accommodate all these above-mentioned learning types when preparing a lesson.

Diversity in teaching mathematics encompasses an array of teaching styles and methods. It is, however, crucial for the teacher to consider the multiple intelligence of the learners in front of her. Gardener (2018) describes the way to differentiate multiple intelligences in specific modalities and not as a single ability. Teachers need to be aware of the multiple intelligences in their classes and teach accordingly.

2.11.4 Multiple intelligence

For learners to best construct mathematical meaning, the teacher must create and plan the learning experience in a way to accommodate all learners, considering their diversity (Naude & Meier, 2014). Gardner (2018) proposed the theory of multiple intelligence, which builds on the theory of Piaget (cf. 2.10.1). Multiple intelligence describes a range of cognitive domains in which the learner will be able to optimally grasp mathematical concepts if addressed in a way most suitable for their learning preference. The teacher thus has to create a range of learning opportunities that respond to a variety of learning styles (Naude & Meier, 2014).

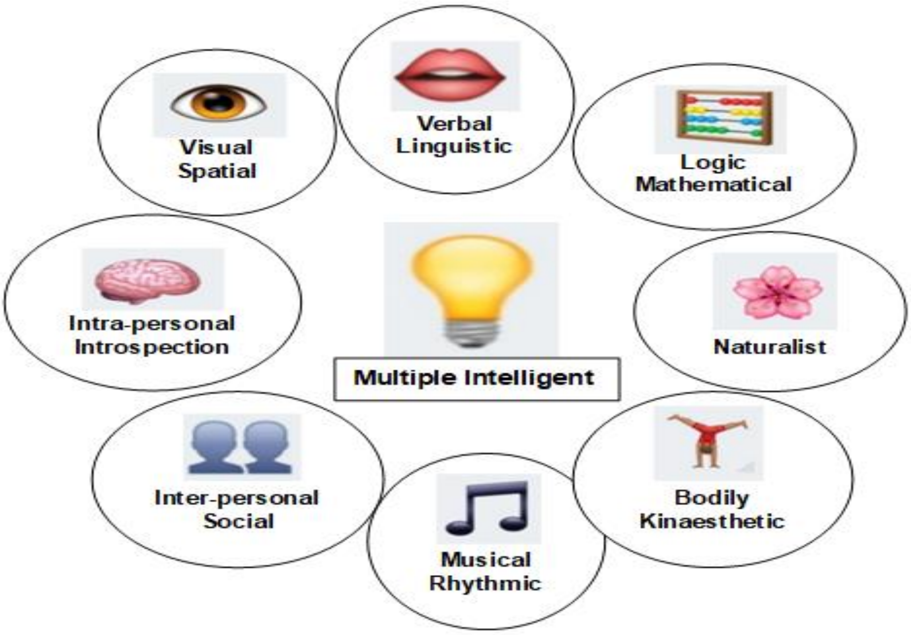

Figure 2.3: Multiple Intelligences according to Howard Gardner

(Adapted from Gardner, 2018:1)

Logical/mathematical Intelligence is used when thinking conceptually. These learners will excel in mathematics. It will be to their advantage if the teacher will use logical explanations and geometrical shapes to explain the work (Gardner, 2018).

Visual/Spatial Intelligence is used when thinking in pictures. When teaching a learner with *Visual/Spatial intelligence* preference, algebra, it is often useful to use charts, graphs, and coloured pens (Gardner, 2018).

Bodily/Kinaesthetic Intelligence is used in handling objects and doing physical activities. These learners need hands-on experience when doing mathematics. The learner will perform better when concrete objects are used to explain and perform mathematical activities. Physical activities can also be incorporated into the lesson to accommodate these learners (Gardner, 2018).

Musical/Rhythmic Intelligence is used in sound, rhythm, and patterns. To cater to these learners, the FP mathematics teacher can let the learners sing the work. Learners with musical/rhythmic intelligence will do well in activities where they work with patterns (Gardner, 2018).

Interpersonal Intelligence is used when the work can be discussed in a group work activity. They need to communicate their findings and interact with their friends in a lively discussion to establish a thinking process (Gardner, 2018).

Intrapersonal Intelligence is used to do self-reflection. Through reflection and studying the learning content on their own, these learners master the learning content. The teacher needs to allow these learners to process the mathematics before confronting them with work (Gardner, 2018).

Naturalist Intelligence is used to explore the world through nature. These learners easily distinguish patterns in nature and can relate that to mathematics. They love to work with natural resources (Gardner, 2018).

It is a huge responsibility for teachers in the FP, to be able to accommodate and respect learner diversity in their class. It is clear from the above that all these factors and theories are not always addressed in the rural class. In the following sections, I will discuss the way forward.

2.12 THE WAY FORWARD

It is well-noted that schools in rural areas are under-resourced (Maharajh et al., 2016). However, in mathematics, this should not be an insurmountable problem. Teachers should be able to use natural resources to teach FP mathematics. By using twigs, leaves, lids, and recycled materials, no additional resources are required (Hlalele, 2014). Hlalele (2014) argues that through the optimal use and management of natural resources, teachers can optimise their teaching (cf. 2.10.1.3).

The curriculum for teacher training is more or less the same throughout the country (Du Plessis & Mestry, 2019; Neethling, 2015) (cf. 2.10.1.1). Thus, teachers in rural areas are as well-qualified as any other teacher in urban areas. In-service training is a huge problem, however, specifically in rural areas like the uMzinyathi district. With the long distances between the uMzinyathi district and a city, there are barely any training opportunities available for these teachers. Visits from district officials are limited to phone calls and very little support is given to the teacher. In urban areas, in-service training is done regularly (Boshoff, 2021) (cf. 2.6.2; 2.9.1.1; 2.9.1.3). This study aims to improve FP mathematics teaching in rural contexts by bridging the gap between rural and urban schools through in-service training. By empowering the FP mathematics teachers through this project, the community at large, as well as the learners who experience barriers to learning, can benefit from this study.

The DBE, and indeed every teacher, must not merely provide education for all but rather focus on the provision of quality education for all. Smit et al. (2020) suggested that collaboration between DBE and universities should take place to ensure better and more specialised training for teachers, to support the learners who experience barriers to learning, and to empower teachers to be able to teach in rural areas. A bottom-up and top-down approach in the education system as a whole is needed to be put in place. Teachers need to take responsibility and support one another, to improve their support to learners who experience barriers to learning (Smit et al., 2020). Teachers need to understand their role as agents of change and development (Hlalele, 2014).

2.13 CONCLUSION

To enable learners to reach their full potential, the curriculum needs to be differentiated and the class size must be small enough for the teachers to attend to each learner's individual needs (Sunardi et al., 2016). Policies and practices in South Africa need to be adapted to create a sustainable education system that is accessible to all learners. The curriculum needs to be amended in a manner to address the enormous challenges we face in education (Kempen & Steyn, 2016).

To make the educational system more functional, Jojo (2019) suggested that professional development needs to be more targeted and long-term, to address the systemic changes that are necessary for sustainable change. To ensure sustainability in mathematics, a stable curriculum policy, and the required resourcing and infrastructure at the schools are of high importance (Jojo, 2019). This support ideally needs to come from the DBE (Moloi, 2012) (cf. 2.9).

It is evident from the literature that educators need support to enable them to be more competent in teaching mathematics (Jojo, 2019; Kempen & Steyn, 2016; Lawrence, 2008; Motshekga, 2013). In the rural environment, it is very difficult for the department to address the specific needs of the teachers and the learners that experience barriers to learning (Du Plessis & Mestry, 2019; Jojo, 2019; Lessing & De Witt, 2011). Chapter 3 will therefore investigate mathematics teaching to learners who experience barriers to learning with the primary focus on rural schools.

CHAPTER 3

TEACHING MATHEMATICS TO LEARNERS WITH BARRIERS TO LEARNING: FOCUSING ON RURAL SCHOOLS

3.1 INTRODUCTION

In Chapter 2 the perspectives on mathematics curricula and teaching were shared. It became obvious that the *Curriculum and Assessment Policy Statement* (CAPS) (DBE, 2011a) holds specific challenges for learners who experience barriers to learning. In this chapter, the focus will shift from perspectives on the teaching of mathematics in general to how mathematics should be taught to Foundation Phase (FP) learners who experience barriers to learning in a rural context.

Learner diversity in this study will not only refer to the diversity in religion, culture disability, and language, but to all barriers to learning that learners may experience. To achieve an understanding of how to improve the teaching of mathematics in rural schools, especially to learners who experience barriers, it is necessary to first investigate the concept of *inclusive education*, since all schools in South Africa are supposed to be inclusive (DBE, 2001).

3.2 INCLUSIVE EDUCATION SUCCEEDING SPECIAL EDUCATION

Since the Salamanca Conference and Declaration on Special Needs Education (UNESCO, 1994) the approach to education regarding learners who experience barriers to learning, changed substantially worldwide. Education for All (UNESCO, 1994) became prominent in all countries affiliated to the *United Nations Educational, Scientific and Cultural Organisation* (UNESCO) (Naicker, 2011; Sunardi et al., 2016; Swart & Pettipher 2016).

UNESCO, United Nations International Children's Emergency Fund (UNICEF), the World Bank, the United Nations Development Programme, and the United Nations Population Fund paved the way for the *Education for All movement*. The initial World Conference on Education was held in Jomtien in 1990. At the follow-up conference in Spain (Osttveit,2022), the Salamanca Declaration was signed and inclusive education became policy in many countries all over the world (Sunardi et al., 2016). Buli-Holmberg (2016) emphasised that the most efficient education system for educating learners who experience barriers to learning, is to adopt an inclusive approach (Mugambi, 2017). Because of the Salamanca Declaration, there has been a major shift in the approach to teaching learners that experience barriers to learning over the last decade, internationally as well as in South Africa (Naicker, 2011). South Africa has signed and ratified the Convention of the Rights of Persons with Disabilities and thus committed to the creation of a free and just society, inclusive of all persons with disabilities as equal citizens (Department of Social Development, 2016).

Inclusive education brought with it a totally new approach to special education and overthrew the perceptions of what used to be “special education” (Hay, 2021). Hay (2021) explains that the practice of classifying learners on the ground of disability is no longer the only consideration because human beings are too complex to be classified on the grounds of one singular criterion. Learners are seen as holistic beings and their intrinsic (cf. 3.4.2) as well as extrinsic factors (cf. 3.4.1) are taken into consideration when offering support. Consideration needs to be given to whether the model that was in use, is compatible with the bio-ecological model of the inclusive approach. The bio-ecological model is imbedded in and forms the foundation of the inclusive education approach. Therefore, the move away from the medical model to the bio-ecological model of Bronfenbrenner (cf. 3.3), which is embedded in inclusive education, brought a new approach to education (Bronfenbrenner & Morris, 1998; Department of Social Development, 2016; Swart & Pettipher 2016).

In the *medical model*, emphasis is placed on the intrinsic barriers that hinder learners from reaching their full potential (Hay, 2012). The learner had to be remediated to fit into the education system. Inclusive education, on the other hand, tries to address the intrinsic (cf. 3.4.2) as well as the extrinsic barriers (cf. 3.4.1). With the move to inclusive education came terminology changes, and learners who experience barriers to learning are no longer referred to as “learners with special needs” (LSEN) (Swart & Pettipher 2016). The education system thus had to be adapted to minimise these barriers, to ensure that all learners have an equal chance of success (Swart & Pettipher 2016). A systematic change took place, where the focus is on adapting the learning content and environment to accommodate the learners’ specific needs (Swart & Pettipher, 2016).

The move from the medical discourse to the rights discourse consists of four discourses, according to Fulcher (in Naicker, 2011), namely the medical, charity, lay, and rights discourse. When describing the medical discourse, Naicker (2011) refers to the term *impairment*, which is linked to a disability: the disability is thus conceived as an objective attribute and not a social barrier. In the first of the discourses, described as the *medical discourse*, the learner is then excluded from mainstream education and placed in a special school or class. The *charity discourse* is the second discourse, described by Naicker (2011) as “benevolent humanitarianism” (p. 13). Learners with specific disabilities are viewed as in need of assistance and as objects of pity and as depending on others. Naicker (2011) emphasises that the decision on the school placement of these learners and decisions about their future are most of the time made by a non-disabled person with the disabled person having no voice. The third, the *lay discourse*, relates to prejudice, hate, ignorance, and injustice. The lay discourse refers to the isolation of persons with disabilities because of their differentness from the norm. Naicker's (2011) last discourse is the *rights discourse*, where the rights of the person with a disability are recognised but also the unique contribution that these people can make to society. This is ultimately what inclusive education tries to achieve.

Internationally, the terminology *inclusive education* has a variety of interpretations. Swart and Pettipher (2011) describe inclusive education as the development of an inclusive community and education system that provide for the needs of a diverse community. Bronfenbrenner and Morris (1998) extended the concept of diversity in the community by describing the influence that the different spheres may have on one another (cf. 3.3). Mugambi (2017) extended the definition of inclusive education by incorporating the value system of a community as being a key factor to consider in inclusive education. Inclusive education is also viewed as the ability to embrace and address all barriers to learning, with success (Hay et al., 2021). The Department of Social Development (2016) describes inclusion as "…a universal human right and aims at embracing the diversity of all people irrespective of race, gender, disability or any other differences". For this study, I will use with the definition in the Education White Paper 6, *Special needs education: Building an inclusive education and training system*. (EWP 6) (DoE, 2001). This document defines *inclusive education* as a system that acknowledges that all children and youth can learn and that all learners need support. All learners have the right to be educated in their community with the necessary support that they require.

In EWP6 (2001) the Department of Education (DoE) set goals to minimise, remove and prevent barriers to learning in the education environment and attend to the individual and specific needs of each learner (Payne-van Staden & Van der Merwe, 2021). To achieve these goals, the early identification and addressing of the barriers to learning, that the learner is experiencing is of the utmost importance (Smith et al., 2020).

The implementation of inclusive education worldwide is experiencing some challenges (Berlach & Chambers 2011; Smith et al., 2020). Despite the policy changes and commitment of the different countries worldwide and the Department of Basic Education (DBE), inclusive education has not yet been fully implemented in many countries, including South Africa (Du Plessis, 2013; Louw & Wium, 2015; Smith et al., 2020). In general, education for all (UNESCO, 1994) remains of poor quality (Donohue & Bornman 2014; Smith et al., 2020). The education system as a whole has not been converted to address the specific needs of learners with diverse needs (Du Plessis, 2013). Engelbrecht et al. (2013) think that the gap between policy and practice cannot be bridged (Smith et al., 2020) and the progress toward inclusive education is too slow (Reddy et al., 2013).

South Africa's economic alliance partners, namely Brazil, Russia, India and China (BRICS) (cf. 2.3), also struggle to incorporate inclusive education into their education systems (Ohtani, 2018; Valeevo, 2015; Wolhuter, 2020). It is only when we consider all the above-mentioned that we realised how interlinked the world is.

Bronfenbrenner investigated the influence of the bio-ecological perspective, especially on human development (Hay, 2012). Below is a brief discussion of the bio-ecological perspective of Bronfenbrenner.

3.3 BRONFENBRENNER'S BIO-ECOLOGICAL PERSPECTIVE

Bronfenbrenner's bio-ecological systems theory represents a personal system within a contextual system and how these systems influence one another (Bronfenbrenner & Morris, 1998). Bronfenbrenner's approach allows us to better understand the problem and plan accordingly to address it. This model enables us to classify phenomena involving person-context interaction (Griffore & Phenice, 2016). As a result, Bronfenbrenner's approach will serve as a theoretical framework for explaining and qualifying the many notions in this study. This approach aids in the systematic explanation of the complex reciprocal relationships and proximal processes that occur between the individual and the layers of systems involved in various forms of education (Neethling, 2015; Smith et al., 2020; Zimmerman & Kontosh, 2007).

Bronfenbrenner identifies four interconnected parameters that influence learners' development. These are classified as four environmental systems, namely micro-, meso-, exo-, and macrosystems (Donald et al., 2020; Nel, 2013; Swart & Pettipher, 2016; Zimmerman & Kontosh, 2007). Bronfenbrenner focuses on the development of the learners within the social context where these learners are growing up. This bio-ecological model plays a key role in identifying the support for diverse learners' needs (Payne-van Staden & Van der Merwe, 2021). In this study, the focus will be on learners within the rural areas of the uMzinyathi district of KwaZulu-Natal (KZN) in South Africa. Through this approach, the complex influence of these different systems on one another becomes clear. The micro-, meso-, exo-, and macrosystems in the whole social context should be analysed and systematically synthesized to determine the influence of society and the school on the learner who experiences barriers to learning (Joubert, 2012).

- **Microsystems** are systems involving patterns of everyday activities, and connections, such as a family, the school, or groups of friends where children are closely involved in regular face-to-face interaction (Bronfenbrenner & Morris, 1998; Smith & Pettipher, 2016). The sustainability of this system is dependent on the influence of these individuals on one another (Alant & Harty, 2011). In this study, the FP and the mathematics teacher are primarily in the microsystem. Thus, this study is particularly interested in the role and influences the teacher may have in the microsystem.

- **Mesosystems** are made up of a collection of microsystems that interact with one another regularly. As a result, what happens at home most probably has an impact on how a learner responds at school, and vice versa (Bronfenbrenner & Morris, 1998; Smith & Pettipher, 2016).

- **The mesosystem** is what is referred to as the *neighbourhood*. In this study, the mesosystem will consist of all the microsystems and their influence on one another; for example, how the rural area and the school and the neighbourhood influence the teachers' ability to convey the curriculum properly to learners who experience barriers to learning.

- **The exosystem** is the system outside the immediate circle of the learner. The learner may not always influence this system, but this system does influence the learner (Alant & Harty, 2011). This system contains the parent's work environment, sports activities, religious communities, etc. This system influences the mesosystem and will thus influence the learner's performance and behaviour.

- The **macrosystem** represents the outer layer and also represents the broader social structures. It comprises cultural values and beliefs, customs, and laws (Bronfenbrenner & Morris, 1998). This layer will always include all other systems and all of the above are time related. In the aftermath of the COVID-19 pandemic, this will most definitely influence the teaching and learning of mathematics to learners who experience barriers to learning in general but more so in the uMzinyathi district where resources are limited. Parents are often not involved in their children's education; this has a severe impact on the learner's educational progress (cf. 3.4).

I discussed Bronfenbrenner's bio-ecological systems theory and the impact the different systems may have on the learner. When considering this approach, it is also important to investigate the barriers learners experience and the impact thereof on learning and teaching.

3.4 BARRIERS TO LEARNING EXPERIENCED BY LEARNERS

The document on Screening, Identifying, Assessment and Support (SIAS) (DBE, 2014:4) refers to barriers of learning as "difficulties that arise within the education system as a whole, the learning site and/or within the learner him/herself which prevent access to learning and development".

According to research of the DBE (2001, 2014); Lomofsky and Lazarus (2014); Neethling (2015); Prinsloo (2011) and Swart and Pettipher (2011) barriers to learning may include but are not limited to the following:

(a) Socio-economic barriers have a significant influence in contributing to barriers to learning. These are aspects such as a lack of basic services for example transport, water and electricity. Poverty, unemployment, and poor living conditions, with a lack of proper housing, can all contribute to the learner's performance.

(b) At-risk factors, for example, are physical, emotional, and sexual abuse, political violence, HIV and AIDS, and other chronic health conditions.

(c) The learner, as well as the parent communities' and teachers' attitudes, may contribute to barriers experienced by the learners. The attitudes of especially the teachers can be influenced by class size, availability of effective support services and resources, workload, and professional development (Engelbrecht et al., 2006; Greyling, 2009; Neethling, 2015; Pather, 2006; Pather, 2011; Tembo & Ainscow, 2001).

(d) An inflexible curriculum and poor implementation of the curriculum are some major factors when considering inclusive education (Neethling, 2015). The CAPS (DBE, 2011a) is currently seen as an inflexible curriculum (cf. 2.8). Even though the CAPS can be adapted, differentiated, and downwind to address the learner's specific needs, this is not currently happening in practice (Kempen & Steyn, 2016).

(e) Language and communication play a vital role in delivering quality education. In a multi-lingual country such as South Africa with 11 official languages and sign language, and where the language of teaching and learning (LoLT) is mainly English (cf. 2.10.1.2), this poses a problem when it comes to curriculum delivery. Learners are predominately taught in English which is not their mother tongue and most of the time neither is that of the teacher. It is extremely challenging for the teacher to convey the learning content in an unfamiliar language (Molteno, 2017; Shayne, 2020) and this may result in the learners experiencing barriers to learning (Jojo, 2019; Molteno, 2017; Neethling, 2015) (cf. 2.10.1.2).

(f) School infrastructure is not always conducive for learning and teaching (cf. 3.7). With regard to inclusive education, the inaccessibility of these facilities to learners who experience barriers to learning is of great concern. According to Agarwal (2020), the concept of *facilities* includes school buildings, resources, and transportation. In rural communities, the school buildings are mostly dilapidated and under-resourced (cf. 2.10). The provincial departments are often not able to supply schools with the necessary resources in rural areas. Teachers regularly need to use natural and recycled learning and teaching material (LTSM) to teach (Hlalele, 2014). In the unavailability of accessible LTSM and assistive technology, learners may experience barriers to learning. To comply with the prescriptions of the CAPS (DBE, 2011a) is, however, not always possible, because of the learners that experience barriers to learning, the limited resource material, and the teachers not always able to teach mathematics properly (Jojo, 2019).

Many learners with disabilities are faced with challenges such as being carried by a parent for long distances to school because of the inaccessibility of transport for learners, especially in rural communities (Agarwal, 2020). The DBE and provincial departments have structures and policies in place to render support to parents, teachers, and learners in need, but these structures may work on paper and in policies, but predominantly not in practice. In rural communities, there is very little support available for teachers and parents (Bosman, 2022; Kempen & Steyn, 2016). As the learners' disabilities differ, so do their needs for support differ. It is not always within the teacher's and parents' ability to cater to the learner's specific needs. If these needs are not met, this can be a primary cause of them experiencing barriers to learning:

(a) A lack of parental recognition and involvement. Parents are not as involved in their children's education as supposed to be. This may be because of their inadequate education levels, the socio-economic situation where they reside, some households being child-headed, and parents having demanding careers or working long hours and far from home (Bosman, 2022). One or more of these factors can be present and may affect the learner's academic performance (Neethling, 2015; Nel et al., 2013).

(b) A lack of human resource development strategies is linked to a shortage of teachers (Neethling, 2015) and inadequate subject knowledge on the part of the teachers (Taylor, 2021). Teachers are not eager to teach in rural areas because they are paid less and some teachers only use the rural schools as a steppingstone before moving to schools in larger or urban areas (Neethling, 2015; Taylor, 2021). In the absence of adequate human resource development of teachers, the learners will not be able to perform to their full potential.

Two major factors contribute to barriers to learning, namely those within the learning site or environment (extrinsic), and those within the learner him/herself (intrinsic). In this study, I will focus on both the extrinsic and intrinsic factors to barriers to learning.

3.4.1 Extrinsic barriers to learning

Extrinsic factors pertain to barriers in the community and in the system itself that hinder the learner to achieve his/her full potential (Intrinsic and Extrinsic Barriers to Learning Examples, 2016), and have been discussed at some length in the previous section. Moosa (2014) defines these extrinsic factors as poverty, linguistic deprivation, the low literacy level of parents, unsuccessful child-rearing practices, lack of motivation, lack of schooling, poor nutrition, environmental toxins, poor medical care, and harmful negative attitudes.

Almost all classes in mainstream schools have learners who experience barriers to learning and most of these stems from extrinsic barriers (Dednam, 2011; Directorate for Education and Skills Innovative Learning Environments, 2022). Only a small number of these learners can be accommodated in special schools. In the rural areas, this is even more relevant because of the absence of special schools and educational support (Kempen & Steyn, 2016). All these and more will influence a learner's performance in mathematics. When considering the rural environment, these extrinsic factors are even more of a barrier.

3.4.2 Intrinsic barriers to learning

Intrinsic describes barriers that are within the learner him-/herself. These would describe for example learners diagnosed with attention deficit hyperactivity disorder (ADHD), Down Syndrome and Autism Spectrum Disorders (ASD), and many more (Vlok, 2016). Moosa (2014) describes intrinsic factors related to barriers to learning as biological and psychological, physical, cognitive, moral, affective, and social factors, as well as self-concept and self-independence. These intrinsic barriers may then be on a spectrum from severe to very mild. Barriers more specifically related to mathematics may include a severe form of dyscalculia, or just a problem that a learner is experiencing with a specific part of the work. Other factors that may influence the learner's performance in mathematics are, for example, linguistic development and the LoLT in which mathematics is presented (Mabena et al., 2021). For learners to perform optimally, a solid foundation to build their mathematics on is of the utmost importance (Wriston, 2015). Wriston (2015) further emphasises that if the foundation in mathematics is not laid properly and if there is a lack of prior knowledge, the learner may experience barriers to learning and more specifically in mathematics.

Dyscalculia is when a learner experiences challenges with doing mathematics. Dyscalculia affects 5-10 percent of people. Learners will not outgrow dyscalculia, but it is on a spectrum and may affect different learners in different ways and is often overlooked (Ansari, 2017). According to Ansari (2017), dyscalculia can present in different ways. Learners can find it difficult to grasp the concept of quantities and concepts like biggest and smallest, which can be challenging. Learners in the FP with dyscalculia will not be able to understand that the numeral 5 is the same as the word five and that these both mean five items. Remembering times, tables and similar mathematical facts also pose a problem. Working with money, counting, and working out change, may be difficult for some learners. It may also be difficult for learners with dyscalculia to read the time on an analogue clock or digitally or both. The estimation of speed or distance is difficult for some learners as well as simple measuring. The overall understanding and logic behind mathematical thinking may be beyond their grasp (Ansari, 2017). All the above-mentioned factors may be present, or a learner may only have some of these problems (Ansari, 2017).

Teachers are not always trained and have limited knowledge on intrinsic barriers to learning and limited support from the provincial Department of Education and peers seems to be a huge barrier for teachers, teaching mathematics (Kempen & Steyn, 2016). These authors suggested that the teacher needs to be trained to address the whole spectrum of intrinsic barriers to learning related to mathematics. Kriel and Livingston (2019) concur with Kempen and Steyn (2016) and emphasise that teachers need to be sensitised to identify learners who experience barriers to learning early. This is then more so applicable to teachers in the FP teaching mathematics. Kriel and Livingston (2019) further suggest that teacher training on the early identification of learners who experience barriers to learning must take place in the FP.

3.5 TEACHING MATHEMATICS TO LEARNERS IN THE FOUNDATION PHASE WHO EXPERIENCE BARRIERS TO LEARNING

Foundation Phase (FP) refers to learners in Grade R (5-6 years old children attending the reception year) up to Grade 3 between the ages of 5-9 years (DoE, 2001; DBE, 2011a). This is a four-year phase that includes critical learning programmes such as numeracy, literacy, and life skills. According to Davis (1994), a learner develops in all aspects of his or her being during this phase, including as a physical being who gains control over his or her gross and fine motor coordination. The learner also develops as a psychosocial being who can control his or her emotions, and as a cognitive being who can comprehend the environment (Davis, 1994).

It is also in the FP that self-concepts are formed, and this is the area in which the foundation of learning is effectively set. This view is supported by Kriel and Livingston (2019), who mention that it is also a vital time for developing an interest in education and favourable attitudes about school. According to Kriel and Livingston (2019), if a learner fails at this stage, he or she will be negatively impacted and may even drop out of school before having the opportunity to fully explore his/her learning potential. Early childhood inclusion, according to Gargiulo and Kilgo (2011), encapsulates the attitudes, policies, and practices that support every learner’s right to engage in a diverse range of activities (Mahlo 2017). Learners in the FP must be exposed to different teaching methods and styles to ensure that the learners develop to their full potential.

3.5.1 Teaching methods and strategies

Teaching methods are the strategies used to assist learners in achieving learning goals, whereas *activities* are the many ways in which these methods are implemented (Jombang, 2017; Landoy et al., 2020). Hoque (2016) extended this definition by defining teaching methods as an orderly, logical, step-by-step, systematic way of doing something. Hoque (2016) further describes *strategies* as a long-term plan of action designed to achieve a particular goal (p3). Teaching methods are thus the vehicle to achieve the goals, set as teaching strategies.

There are many different teaching methods, and Van Wyk (2016) categorise them into four broad types, namely teacher-centred methods, learners-centred methods, content-focused methods and interactive or participative methods.

- In the teacher-centred method, the teacher is the master of the subject, and the learners are mostly passive in the learning process.
- In the learner-centred method, the learners and the teacher are both constructing new knowledge in the process of learning.
- In the content-focused method, the focus is on careful analysis of the content and not on learner development.
- The interactive/participative method integrates a little of all three of the other methods. Situational analysis is of primary importance to determine which of the above-mentioned methods to apply.

Findings suggest that teaching methods and learning environments have a beneficial impact on student accomplishment, implying that competent teaching and a positive learning environment are predictive of promoting student learning (Jombang, 2017). It is essential when working with learners that experience barriers to learning to always consider the situational factors to give the learners the opportunity to optimally develop (Douglas, 2019). Bruner’s Concrete Pictorial Abstract (CPA) method (cf. 2.11.3) of teaching mathematics entails, working from the concrete to the abstract, and this forms an integral part of teaching mathematics, especially in the FP and can address barriers to learning (Douglas, 2019). Linde (2021) has the same view and gives some useful tips for teaching mathematics to learners with barriers to learning. Linde (2021) suggested that lessons be kept brief to prevent information overload and that the mathematical concepts are broken down in a step-by-step manner to ensure all learners understand the specific concept. The next suggestion was to use real-life examples to make the mathematics as practical as possible (Linde, 2021).

Equal learning opportunities need to be adopted in all learning institutions for all learners, including learners with diverse educational needs (Geldenhuys & Wevers 2013; Pillay & Di Terlizzi, 2009; Smith et al., 2020). Teaching methods and teaching strategies as well as the curriculum need to be adapted to suit the learners' specific needs. The teachers must be equipped to cater to diverse learner needs through curriculum differentiation.

3.5.2 Curriculum differentiation

Curriculum differentiation is an important method for meeting the needs of learners who have a variety of learning styles and requirements. Modification, change, adaptation, extension and variation of teaching methodology, teaching strategies, assessment procedures, and curricular content are all part of this process. It considers the abilities, interests and backgrounds of the learner (DBE, 2014).

Differentiation of the curriculum can be done at the content, teaching approaches, assessment, and learning environment levels (DBE, 2011; DBE, 2014), and it is also seen as one of the most challenging tasks of a teacher (Amaro, 2022). Anilkumar (2022) agrees with this statement and continued by stating that poor differentiation can put the learners at risk to widen the gap or rather worsening the barrier that already exists, while teachers are attempting to close and break down the gap. This is, however, an area of learner support that teachers often have limited knowledge and experience in (Donohue & Bornman, 2014; Kempen & Steyn, 2016)

The draft *Differentiated Curriculum and Assessment Policy Statement* (DCAPS) (DBE, 2018), addresses this knowledge gap and assists teachers in the application of differentiated teaching (cf. 2.6.1; 2.6.2). Aligned with this, this study aims to assist mathematics teachers with the necessary tools to do differentiation in mathematics by giving them guidelines and lesson plans to work on while still accommodating the other learners in the class. For optimal learning to take place, it is essential to differentiate the curriculum to suit the learners' diverse learning interests, styles, strengths, and backgrounds (Amaro, 2022). Differentiation can only take place to a point where it is reasonable, though.

Reasonable accommodations in education are to ensure that all learners have an equal chance of succeeding to achieve educational outcomes, but without giving these learners so much support that it is unfair to the rest of the learners in the class (Inclusive Education South Africa, 2018). The necessary and appropriate accommodations to the learning environment, adaptation to the curriculum and assessment, adjustments of the LTSM as well as the provision of assistive devices, are necessary for learners with barriers to learning to excel, or even to only let them have equal access to education (Inclusive Education South Africa, 2018). It is important to be cautious, to not impose a disproportionate or undue burden on learners with disabilities to ensure that they can enjoy or exercise all human rights and fundamental freedoms on an equal basis with others (DBE, 2011; DBE, 2014). One of the environmental factors that the teacher needs to address, is that of the LoLT differing from the learner's home language. In these classes, teachers make use of code-switching to address the language barrier.

3.5.2.1 Code-switching

Code-switching is the process where teachers switch between two languages to convey specific terminology and concepts to the learners (Kaschula, 2019; King & Chetty 2014; Mudau, 2019). It is a process where the teacher diverts from English to an African language when she wants to explain a specific concept to the learners (Burns, 2022). Mudau (2019), reiterates that teachers use code-switching when learners struggle with a specific part of the work. Learners are also allowed to answer in their preferred language, even though the LoLT of the school is English. Teachers usually allow this code-switching by the learners more often at the beginning of the year but as the year progresses, the learners are motivated to answer in English. Teachers can thus encourage learners to participate in class discussions without feeling insecure (Tejano, 2021). Code-switching is therefore a valuable tool to use when learners experience barriers to learning (Mudau, 2019).

The uMzinyathi district, where the research was done, forms part of the greater KwaZulu-Natal (KZN), where isiZulu is the most spoken African language (Bosman, 2022). The teacher will thus deviate from the LoLT of the school and speak isiZulu in her class, most likely because neither she nor the learner is confident enough to speak English (Molteno, 2017). In this way, the learning content is conveyed to the learners in a language that they are familiar with, and the learners understand the concepts. It may be beneficial to learners that experience a problem in a specific area in mathematics and the teacher can then utilise code-switching to ensure the learner grasps the learning content, for example in naming the shapes. Learners are sometimes familiar with the name of a shape in isiZulu but not in English. If the teacher code-switches, the learners will know immediately what she is talking about. The English terminology can then follow.

The practice of code-switching is not actually allowed in most South African schools, where the LoLT of the School is English (Kaschula, 2019; Mudau, 2019). Parents prefer their children to be taught in English (cf. 3.7.4.). King and Chetty (2014), found this practice in the specific environment of rural schools to constitute a purposeful and productive teaching strategy. Teachers use code-switching as a process and alternate between languages to assist the learners in understanding the learning content (Kaschula, 2019; Mudau, 2019). Code-switching is thus a suitable method of differentiation (Kaschula, 2019; King & Chetty 2014), especially if the scaffolding technique is applied (Steyn, 2017).

3.5.2.2 Scaffolding

Scaffolding is temporary support that is provided for learners to temporarily support them with a specific problem or barrier that they may experience (DBE, 2017; Gasaway, 2021). It is a technique used by teachers to support learners by providing meaningful contextual support (Bornman & Roos, 2014). This scaffolding or support is then gradually taken away so that the learner can continue without support (DBE, 2017). Vygotsky (1978) describes scaffolding through his concept of *zone of proximal development* (ZPD), and this alludes to the discrepancy between what the learner can do and what the learner is able to achieve with support from the teacher. By applying scaffolding, the gap between "can do" and "be able to achieve" can be bridged and assists the learner to take responsibility for his/her own learning. According to Gasaway (2021), scaffolding is widely used in mathematics because of the flexible nature of the application. Some examples of scaffolding include:

- The asking of questions to guide the learners' thinking process.
- To supply the learners with easier versions of the specific mathematics problem and then later confront them with the more difficult ones.
- Working with the learners through an example before giving them the work expected of them.
- By breaking up the learning content into smaller workable parts, the learners find it easier to grasp the concepts.

The use of scaffolding to assist learners with barriers to learning is used because of its custom-made nature (Gasaway, 2021). It depends on the learner's need and personality as well as the barrier the learner is experiencing, what support is needed for this specific situation. As with the rest of the work, scaffolding can also be applied in assessment.

3.5.2.3 Adapted assessment

Adapted assessment in the FP is not to determine whether the learner has failed or passed (Naude & Meier, 2014) but to find out if the learner has grasped the learning content that was presented and if the learner is able to apply the learned content (Crabtree, 2021; Dednum, 2011). To ensure that the learner develops to his/her full potential (DoE, 2001), the teachers need to provide the highest level of support but still challenge each learner according to their capability and build their confidence in doing mathematics. Adapted assessment can provide the teacher with detailed information on the learner's knowledge and skills gained on a specific part of the mathematics work (Crabtree, 2021). Adaptations can be made in different ways, as required by the specific learning content and the barriers this learner is experiencing. Unfortunately, not all teachers have adequate subject knowledge in mathematics to be able to do this adaptation or even to identify learners who experience barriers to learning (Jojo, 2019; Taylor, 2021; Venkat & Spaull, 2015) (cf. 2.10.1.1).

3.6 TEACHER'S ATTITUDE AND LACK OF KNOWLEDGE

When the adaptation of the CAPS (DBE, 2011a) is discussed, it should first be acknowledged that all learners are unique. As teachers, we need to identify the specific barrier to learning these learners' experiences (DBE, 2011a). Even though the policies state that teachers take responsibility for teaching, differentiation, adaptation of the CAPS (DBE, 2011a) and assessment (to mention only a small number of the teachers' tasks), this is not always happening in practice (Kempen & Steyn, 2016; Taylor, 2021). All the tasks that are expected from the teachers may influence their practice and performance.

Teachers should monitor their own beliefs, attitudes, and behaviours. According to DBE (2011), this can be done in different ways, such as:

- recognising any biases or stereotyping;
- treating learners with respect, as individuals;
- avoid the use of undermining and biased language;
- considering the unique needs of each learner;
- adapting the teaching methods, approaches, strategies, and assessment methods to accommodate all learners; and
- creating opportunities for all learners to succeed.

According to the SIAS document (DBE, 2014), the curriculum allows teachers to make the necessary adaptations to the curriculum as required by the specific learner. Teachers may also apply for learners to receive the necessary adaptations in tests and exams. This application for accommodations and concessions must be done through the SIAS process, as described in the SIAS document (DBE, 2014). Yet, it is not always possible for a teacher to apply for these concessions and accommodations or even to identify a learner with a barrier to learning if the teacher is not equipped to do so (Jojo, 2019; Taylor, 2021; Venkat & Spaull, 2015). This situation is even more concerning in rural areas (cf.3.7), where there is a lack of sustainable and efficient in-service training and support from the department (Kempen & Steyn, 2016).

3.7 THE CONTEXT OF RURAL SCHOOLS IN SOUTH AFRICA

For present purposes, the definition of rural schools will be that of remote schools away from amenities such as shops, tarred roads, and streetlights (Carelse, 2018). Schools in rural areas are often negatively impacted by a lack of physical resources, basic infrastructure, and information (Du Plessis & Mestry, 2019).

In South Africa, as in most countries, learners in the FP are taught in one class and all subjects are presented by the same teacher. Classroom sizes and learner ratios vary according to the type of school and where the school is situated in South Africa. Schools are categorised according to quintiles 1-5. This categorisation was initially done according to a questionnaire that was sent out to schools, consisting of three questions (Isaacs, 2020).

1. What is the income of the parent(s)?
2. Number of vehicles a family owned.
3. The value of the property.

Based on the accumulative information, the schools were placed into five categories from the poorest (quintile 1) to the wealthiest (quintile 5) schools (Isaacs, 2020). A quintile 1 school will be one of the poorest 20% of schools in a disadvantaged economic community. Quintile 5 schools represent the 20% least poor schools in the country (Isaacs, 2020; Ogbonnaya & Awuah, 2019). Quintile 1-3 schools are non-fee-paying schools and these schools also receive a larger subsidy from the local government than quintile 4 and 5 schools (Ogbonnaya & Awuah, 2019; Van Dyk & White, 2019).

There is a huge gap between the 20% top-performing functional, wealthy schools and 80% poorly funded, dysfunctional schools (Sterne, 2021). Sterne (2021) describes this as the largest discrepancy in education in the world. There is a difference in the provision of education in the different provinces as well. Urban schools and schools near large centres are most of the time better resourced than schools in rural areas. Rural schools are usually surrounded by remote areas and are relatively underdeveloped. This has serious consequences for learners (Du Plessis & Mestry, 2019). Schools in rural areas are often negatively impacted by a lack of physical resources, basic infrastructure, and information (Du Plessis & Mestry, 2019). In figures 3.1 to 3.4 the discrepancies between the interior and exterior of an urban and rural school are visible.

Well-resourced urban school

Figure 3-1: Urban School
(K. Joubert personal photo, n.d.)

Interior of an urban classroom

Figure 3-2: Interior of urban classroom
(K. Joubert personal photo, n.d.)

Rural school

Figure 3-3: Rural school
(K. Joubert personal photo, n.d.)

Interior of rural classroom

Figure 3-4: Interior of rural classroom
(K. Joubert personal photo, n.d.)

There is often a focus on the disadvantages of rural schools and communities. Hlalele (2014), also emphasis the assets of living in rural areas and these must not be overlooked or ignored. According to Hlalele (2014), it is usually the people's choice to live in rural areas and to raise their children in these communities. The attractiveness of living in a rural community is that it is a tightly knit community where family traditions and a strong bond between family members are fostered. The community is committed to protecting one another and supporting their children. Rural areas are usually sparsely populated with a low crime rate. The beautiful open spaces and a sense of belonging are descriptive of these rural areas. It offers a welcoming and safe community to raise children. Attending a rural school should thus not affect the quality of education learners receive, but in reality, several incriminating factors need to be kept in mind (Hlalele, 2014). Because of the limited work opportunities and the high poverty rate, learners are prone to drop out of school and start to work in low-income jobs to support the rest of the family (Hogan, 2020). Teenage pregnancies are on the rise to qualify for child support grants (Mbulaheni et al., 2014), just to support the family. All these factors create a vicious cycle of poverty, that is difficult to break.

Disadvantaged communities often lack professional help and support from government structures (Gilili, 2020; Lessing & De Witt, 2011). In the findings of their research, Boshoff (2021); Du Plessis and Mestry (2019); Neethling (2015), as well as Payne-van Staden and Van der Merwe (2021) identify a lack of qualified teachers, poverty, lack of resources, the language of learning and teaching, parental involvement, and a lack of support structures, amongst others, as some of the main reasons for underperformance of rural schools.

3.7.1 Characteristics of teachers in a rural context

Malhoit (2005) and Hlalele (2014) agree that schools, amongst other institutions, in rural areas are the centre of the community. The teacher at the rural school thus also plays a very important role in the community. Teachers are seen as the example of educated people in the rural community (Ansell, 2018). Apart from their primary task as a teacher, they are also expected to fulfil several other duties in the community and school (Bosman, 2022). Ntini (2006) identifies 22 roles of teachers: planners; counsellors; report writers; proposal writers; teachers in agriculture; voter education; health education; environmental education; general farming education; topical issues education; and craftwork education. Other roles that teachers often need to fulfil are those of assessors, implementers, monitors, evaluators, trainers, marketers, mobilisers, public speakers, guides, and facilitators (Ntini, 2006).

Teachers are expected to offer specialised support to learners in need, for which these teachers are not always trained (Kempen & Steyn, 2016) or are not receiving support from the department and district officials (Kauffman & Landrum, 2013; Louw & Wium, 2015; Payne-van Staden & Van der Merwe, 2021). Although not trained for these roles, the community still looks up to them and expects them to offer support and guidance (Bosman, 2022). Because of the great distances from district offices and larger centra, there are very few opportunities for professional development and to attend training to enhance their much-needed skills (Bosman, 2022; Du Plessis & Mestry, 2019; Kauffman & Landrum, 2013).

The harsh environment in rural education may demotivate teachers to teach at these schools (Bosman, 2022). Teachers are often unwilling to move to rural areas because of the lack of social and cultural opportunities, as well as limited professional development opportunities (Hlalele, 2014). Even if teachers are willing to teach at these schools, they experience the difficult working conditions as demotivating, and teachers are reluctant to stay for long periods (Mollenkopf, 2009).

Bosman (2022) describes teachers in rural areas as key role players in bringing about change in communities and in the lives of the learners they are teaching. Rural teachers must be willing to teach multigrade, multiple subjects and attend to learners who experience barriers to learning because of the absence of specialised education in the area. Without support from the department and district officials, the teachers very often need to act as counsellors for the families, to address socio-economic and emotional problems related to the learners' barriers to learning (Georgiana, 2015, Payne-van Staden & Van der Merwe, 2021).

Agarwal et al*.* (2010) indicate that when seeking to transform the inequalities between urban and rural schools, it is essential to start with the teachers. Teachers are seen as the most essential element in schools, "as they have the ultimate responsibility to navigate the curriculum" (Hlalele, 2014, p. 464), and adapt the curriculum to address the specific needs of the learners in front of them. Hlalele (2014) further suggests that teachers should collaborate when change needs to take place. In this regard, it is important to note that this study is ultimately based on a Participatory Action Learning and Action Research (PALAR) design. The PALAR design involves that teachers should collaboratively identify a problem in the class, and address the specific problem. In this study, the identified problem will be to improve FP mathematics teaching in rural areas.

The teachers must be conscious of the important role they play in the learners' lives, development, and overall well-being (Claessens et al*.*, 2017). Learners grow up with their grandparents, and some are from child-headed households. In the absence of a parent, or the parent's lack of involvement in the learner (cf. 3.7.5), the teacher may be the only real role model for these learners (Bosman, 2022). This is not uncommon in rural areas, including the uMzinyathi district (cf. 3.8), where the research was done (Bosman, 2022). Payne-van Staden and Van der Merwe (2021) also mentioned that teacher training is not adequate, especially in addressing diverse learner needs. They suggested that continuous teacher development with the focus on addressing diverse learner needs is essential for teachers to perform optimally.

In light of all these expectations from the teachers, the teacher's well-being is important. If the teachers do not manage their stress levels, it can also have a devastating effect on the learner's performance (Setlhare et al., 2016; Swartz & McElwain, 2012; Trangos 2017). Motivated teachers are more emotionally stable and can thus better address the learners' specific needs (Bosman, 2022; Spurgeon & Thompson, 2018). When the teachers are enthusiastic about their teaching, it will motivate the learners to be more engaged in their learning, but poverty in rural areas has a major influence on teaching and learning.

3.7.2 Poverty and its influence on learning

Poverty is described by Auge (2021) as having not enough resources that are needed to live a proper life. Poverty is mentioned as one of the most severe challenges of education in rural areas (DoE, 2005; Du Plessis & Mestry, 2019). Schools in certain rural communities, like in the uMzinyathi district, where the research took place, are situated in a very poor socio-economic area (Bosman, 2022). According to Sauvageot and Da Graca (2007), poverty, hunger and underdevelopment are hindering learners' development and thus have a devastating influence on their educational performance (Bosman, 2022; Carter, 2014). Gumede (2021) agrees and reiterates that South Africa remains one of the world's most unequal societies.

A lack of adequate housing, access to quality health care, proper nutrition, and adequate childcare is part of everyday life in rural areas. This contributes to a lack of adequate education and the children are hard hit by poverty and hunger (Hlalele, 2014). In many rural areas, schools are run down and there is a lack of LTSM (Makhwathana et al., 2021; Neethling, 2015). Poverty creates a complex environment for teachers to work in (Sterne, 2021). Effective learning cannot take place when learners are hungry or unwell and lack fundamental skills, parental support, self-esteem, or linguistic competency as a result of poverty (Kriel & Livingston, 2019, Neethling; 2015; RSA, 2014; UNESCO, 1994). There is a direct link between poverty and poor health, emotional and psychological growth, and poor academic performance (Dike, 2017). Poverty in childhood has long-term repercussions, including depression, social and psychiatric issues, and memory loss. It also increases the learner's exposure to child abuse (Auge, 2021). It is upon teachers to create an environment for these learners to perform optimally (DoE, 2001).

Datzberger (2018) concludes that education alone is not helping the impoverished. His findings highlight the following:

- Education policies failed to reform and address the multidimensional needs of the poor.

- The root causes of poverty are not addressed and effective social transformation and change do not take place.
- Transformative policies are written for the education sector alone.
- The political and economic context of a country cannot be detached from education sector reforms. Reforms in the education system are inextricably linked to a country's political economy.
- The emphasis on economic empowerment via education overlooks the need of improving impoverished people's needs.

On the other hand, studies have shown that through education, this cycle of poverty that creates poverty, can be broken (Bosman, 2022; Lavecchia et al., 2019; Lurie, 2015; Neethling, 2015; Pohan, 2013; Setlhare et al., 2016; Trangos, 2017). All the above-mentioned writers have a similar approach to breaking the cycle of poverty and they agree that by teaching learners to read and master basic mathematical skills, the number of people living in poverty worldwide can decrease, and poverty can be reduced by 30%. This study will hopefully contribute to this goal, by trying to make a difference in the uMzinyathi district in KZN. In the uMzinyathi district, where this study was done, 66.0% of people are living in poverty. This district is one of the top 5 districts in South Africa with the highest poverty levels (RSA, 2020) (cf. 3.8).

3.7.3 Lack of resources

Before I investigate the lack of resources, I will first pay attention to what a well-resourced class should look like. Literature (Bosman, 2022; Franklin & Harrington, 2019; Hershner & Chervin, 2014) gives a good description of what a well-resourced class should be equipped with and should look like. Among others, there should be an interesting and inviting atmosphere and the class should be uncluttered, with ample space for movement. It is in the learner’s interest if the class is well resourced and the prescribed learner-teacher ratio is adhered to.

This may be possible on paper, but in rural areas such as the uMzinyathi district, this may only be a dream. In rural areas, it is not only that the people from the community are less affluent but a lack of human, cultural and material resources is also evident (cf. 2.9.1). The state of schools in South Africa is of concern, because out of 23 471 public schools, 20 071 have no laboratory, 18 019 have no library, 16 897 have no internet, 239 have no electricity, and 37 have no sanitation facilities at all (Sterne, 2021). This lack of resources needs to be addressed with great urgency (Gous et al., 2014; Krishnaratne et al., 2013; Neethling, 2015; Sterne, 2021; Quane & Glanz, 2011; Wildeman & Nomdo, 2007). Hlalele (2014) suggests that sustainable change may be brought about by addressing this lack of resources through empowering rural people to help themselves.

It is well-noted that schools in rural areas are under-resourced (cf. 3.7.2); but in mathematics, this should ideally not be a problem. Teachers should be able to use natural resources to teach FP mathematics. By using twigs, leaves, lids, and recycled materials, no additional resources are required (Hlalele, 2014). Teachers often hide behind the lack of resources as an excuse for an inability to address the curriculum or learner needs (Mail & Guardian, 2018). This article further argued that the teacher must focus on what is available, and not on what they do not have. Teachers must take centre stage in the improvement of their own quality of life (Hlalele, 2014). Hlalele (2014) furthermore notes that through the optimal use and management of natural resources, teachers can optimise their teaching. It is often difficult for teachers to overcome the lack of resources if they are not aware of the existence of a DCAPS (DBE, 2018), or have never received training or been exposed to an alternative curriculum or the utilising of natural resources. The short learning programme and resource guide that I aim to introduce after concluding this study, should expose the teachers to the DCAPS (DBE, 2018) as an alternative resource for learners who are experiencing barriers to learning.

3.7.4 Language of learning and teaching

In a multilingual South Africa, with 11 official languages and sign language, learners are often experiencing barriers to learning because of the language differences (Makoelle, 2011; Neethling, 2015). Culture and language go hand in hand. Learners are predominately taught in English which is not their mother tongue and most of the time not that of the teacher either (Mudau, 2019). It is very difficult for teaching and learning to take place in an unfamiliar language (Molteno, 2017; Shayne, 2020). According to Molteno (2017) and Nowicki (2019) caution that if neither the teacher nor the learners are comfortable in the LoLT, it might lead to a lack of confidence and disinterest in learning in general (Kriel & Livingston, 2019). As a result, learners may experience barriers to learning (Adu, 2021; Jojo, 2019; Molteno, 2017; Neethling, 2015;). According to Molteno (2017), teacher training institutions in South Africa do not effectively equip non-English speaking teachers to teach in English. Once in the classroom, these teachers pass on their grammar and pronunciation errors to the learners (cf. 2.10.1.2) (Nel & Muller, 2010; Shayne, 2020).

In a multicultural and multilingual South Africa most schools still prefer to use English as the LoLT (cf. 2.10.1.2). Learners are taught in the mother tongue in the FP but then required to transition to English. The transition to English in Grade 4 seems to have a detrimental effect on the learners' performance (Steyn, 2017). Nowicki (2019), postulates that this transition in LoLT can lead to huge cognitive and linguistic challenges. The limited availability of textbooks in African languages and the parents' preference for English are some of the reasons for the school's decision to offer English as the LoLT (Nowicki, 2019).

Parents' preference for English may be one of the reasons why English is used as the LoLT in some rural schools. According to Molteno (2017) parents in rural areas consider English vital for success in life and that "real education can only be obtained in a world language" (p. 22). Similarly, Mudau (2019) found that parents put huge pressure on the School Governing Body (SGB) and the principal of schools to have English as a LoLT (Mudau, 2019). Parents insist on the use of English as LoLT because they argue that English is a language of commerce and learners must master English to enable them to get a job (Nowicki, 2019).

Only 8% of learners in South Africa speak English at home, and 78% of grade 4 learners cannot read English with understanding (Sterne, 2021). Sterne (2021) claimed that it is in the FP that learners are often left behind. Considering that many learners already experience barriers to learning, being taught in a language that is not their mother-tongue, can only enhance their barriers to learning.

The CAPS document (DBE, 2011a) advises the teacher to use text-based approaches. These approaches show good results in a well-resourced teaching environment, but in rural areas with under-resourced schools, the teachers tend to use code-switching (cf.3.5.3) to facilitate understanding of the content (Wildsmith-Cromarty & Balfour, 2019). The CAPS (DBE, 2011a) is currently not yet available in all the official languages. For teachers that do not speak English as a mother tongue, but as a third or even seventh language, this may be challenging (Cronje, 2021; Langhan et al*.*, 2012). Every teacher interprets the curriculum as he understands it, and not always as it was intended.

Nick Taylor (in Sterne, 2021) suggests that FP teachers should be supported to teach English more effectively. This training should be done by in-service training and/or revising the basic teacher training. In this way, learners might be able to reach their full potential in all subjects, including mathematics (Sterne, 2021). In the uMzinyathi district, learners are only exposed to English at school, but most of the parents are not able to assist their children in English (Bosman, 2022).

3.7.5 Parental involvement

The WP 6 (DoE, 2001) argues that parental support and involvement are important to ensuring successful education. McKenzie et al*.* (2018) also consider parents as vital sources of information and stress that parents' involvement in their children's education can contribute to their children's academic success. Parents with limited resources and knowledge are unable to provide the necessary support to their children. The children are left with the grandparents or the parents are struggling to make ends meet. There is thus a lack of parental involvement and this needs to be addressed by the teachers. Parental involvement is even more crucial for learners who experience barriers to learning (Neethling, 2015). It is important for the learners' progress to ensure that what is done at school, is also carried over to the home environment (Neethling, 2015). Several factors prevent parents from being more involved in their children's education (cf. 2.4.5). Parents of learners who experience barriers to learning, usually find it difficult to accept the learners' disability or barrier. Action must be taken in the community to equip educators with the skills to deal with these challenges. Parents' days can be arranged, where a specialist in the field of barriers to learning can present a short informative session for parents.

Parental involvement in rural areas is also very limited, and parents cannot even provide their children with the bare necessities for school. Parents often leave their children with grandparents in rural areas to pursue a career, or just to make ends meet (Bosman, 2022; Davids, 2009; Davids & Gouws, 2013). Martin (2016) has found that 35% of children in rural schools are not living with even one of their biological parents. Factors that hinder parental support, especially in rural areas, include poverty, single-parent households, lack of supportive family structures, child-headed households, and unemployment (Abrahams, 2013; Karibayeva & Bŏgar, 2014).

With the lack of parental support, teachers need to be supported to fulfil their role *in loco parentis* and to assist in the learners' every need (Epstein, 2018; Mampane, 2018; Bosman, 2022).

3.7.6 Support structures

It is of vital importance for teachers to receive the support that is required for them to fulfil the demanding roles bestowed on them by the community and the school (Du Plessis & Mestry, 2019). The parents, the DBE and provincial departments of education are often unable to provide the necessary support to teachers to perform their everyday teaching duties (Hay et al., 2021; Kempen & Steyn, 2016) (cf. 2.9). Hay et al. (2021); Kriel & Livingston (2019) as well as Nel et al. (2016) explain that a lack of support for teachers jeopardises the success of inclusive education in South Africa. This is then also the situation in rural schools that are far from district offices and large cities (Smith et al., 2015). The lack of support and resources is a mammoth barrier to overcome, and Bosman (2022) describes it as a crisis in education.

Teachers are not trained in addressing the needs of learners who experience barriers to learning (Kempen & Steyn, 2016). Lessing and Dreyer (2007) stressed that the teachers' limited training with regard to strategies to support these diverse learner needs, contributes to the barriers to learning they experience. If teachers are not trained in identifying and addressing the diverse learner needs in their classes, even bigger barriers to learning may arise (Du Plessis & Mestry, 2019; Jojo, 2019 Lessing & De Witt, 2011). Jojo (2019) and Hay et al*.* (2021) suggested that targeted, systemic, and systemic long-term processual development, a stable curriculum policy environment, and a critical level of resourcing and school infrastructure, are required for the mathematics education system to function. The *Education White Paper 6* (EWP6) (DoE, 2001) stipulates that such support to teachers should include the provision of training, mentoring, monitoring, and consultation, to identify and address barriers to learning and to accommodate the diverse range of learning needs (Louw & Wium, 2015; Payne-van Staden & Van der Merwe, 2021). This support ideally needs to come from the department (DBE, 2014; DBE, 2017; Hay et al*.*, 2021; Moloi, 2012;).

The EWP6 (DBE, 2001) as well as the SIAS document (DBE, 2014) stipulate the structures that need to be put in place to support the teacher. At school level, a School Based Support Team (SBST) should be the first support that the teacher receives. The SBST consists of master teachers with specific expertise, as required by the specific challenge that is investigated, therapist and persons from the community, as well as parents that can assist the school or teacher with specific educational challenges (DBE, 2014; Du Toit, 2007). The SBST should collaboratively identify learning barriers, focus on in-service training, promote parent involvement, and track learning support progress (Du Toit, 2007; Hay et al*.*, 2021; Neethling, 2015, Nong, 2020). Unfortunately, this may work in policy and in urban areas, but in remote rural areas such as the uMzinyathi district, the staff do not get the training or access to resources to establish a fully functioning SBST at all schools (Nong, 2020).

Regular collaboration between the SBST and the District Based Support Team (DBST) is essential (Du Toit, 2007; Neethling, 2015). The DBST's primary focus is to support the SBST in addressing barriers to learning (Nong, 2020). The DBST consists of psychologists, therapists, learning support educators, special needs specialists, health workers and social workers. Curriculum managers and administrative specialists, specialist staff and teachers at special schools may also be included in this team of specialists (DBE, 2014; Du Toit, 2007; Hay, 2018). In view of the current budget cuts in education, along with a limited number of staff, the support from the DBST seems to be ideal but difficult to execute (Hay, 2018; Hay et al*.*, 2021).

Because of the lack of support, teachers often decide to form a support group where they support one another and other teachers at their schools through collaboration (Motshekga, 2013). It is evident from the literature that educators need support to enable them to be more competent in teaching mathematics (Jojo, 2019; Kempen & Steyn, 2016; Lawrence, 2008; Motshekga, 2013). This study attempts to address this problem by supporting the teachers in the uMzinyathi district to form a collaborative relationship with their peers and other role players from the community. Collaboratively they attempt to address the lack of training and provide the necessary support to FP teachers to address the needs of learners who experience barriers to learning mathematics.

3.8 THE UMZINYATHI DISTRICT

The uMzinyathi district, where the research was done, is a rural area with mostly poor socioeconomic households. The schools are rated as quintile 1 schools (Isaacs, 2020; Ogbonnaya & Awuah, 2019). This means that the school is non-fee-paying because the parents from the area are not able to afford school fees. This is then also an indication of the poverty levels in the area (Bosman, 2022).

According to the Department of Cooperative Governance and Traditional Affairs (DoCG&TA, 2020) report on the uMzinyathi district, 74 726 (58.9%) of the households in the district are women-headed households. The uMzinyathi district also has 2 230 child-headed households and 32% of the child-headed households are headed by females. 57% of the child-headed households are in traditional dwellings. The dominant illness in the district is HIV/AIDS. HIV/AIDS affects people between the age of 15 to 64. Health facilities in the area are scarce and insufficient. The report further states that the average annual household income is R14 600. There is an overall lack of water, electricity, refuge removal services, and ablution facilities (DoCG&TA,2020).

A report on the water situation in the uMzinyathi district by the Department of Cooperative Governance and Traditional Affairs (DoCG&TA, 2020) is dismal. Figure 3.5 indicates that there are 111 858 people in the district (20.2%) that do not have access to running water inside their houses but who are getting piped water from a community stand, and a total number of 84 191 (15.2%) of the people need to fetch water from rivers. Only 23% of the community members have access to running water inside their yards. Only a small portion of the population has running water inside their houses.

With the scarcity of water, it is understandable that 60% of the households are still using pit toilets (DoCG&TA, 2020). Figure 3.6 shows that there is a small percentage of the population that has access to flush or chemical toilets but in the very rural parts of the district, but there are no toilet facilities available, and the people need to use other options (DoCG&TA, 2020). These factors have a negative effect on schooling in the district.

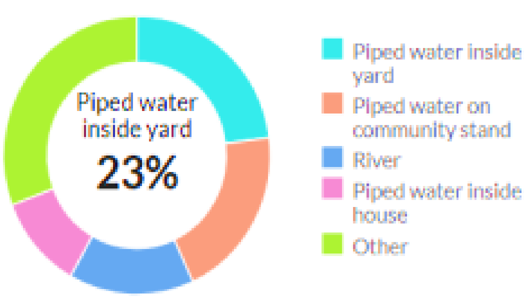

Figure 3-1: Availability of of water per population

(DoCG&TA, 2020)

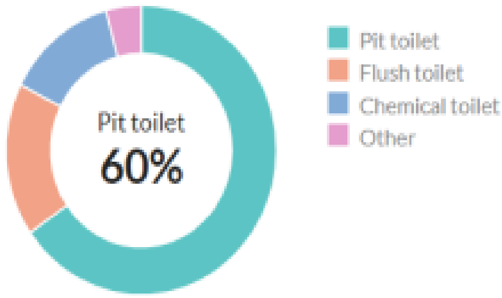

Figure 3-6: Availability toilets per population

(DoCG&TA, 2020)

As with water, the uMzinyathi district also does not have a steady availability of electricity, with 22% of households that has no access to electricity at all (DoCG&TA, 2020).

With the high poverty rate in the district, it is difficult for parents to afford money for transport and school clothes for their children. This usually results in the learners being frequently absent from school (Bosman, 2022). Feeding schemes are put in place via the DBE but these are not always effective because of ill management and the remoteness of the schools (Bosman, 2022).

3.9 IMPROVING MATHEMATICS TEACHING IN THE UMZINYATHI DISTRICT

The main aim of this study is to improve mathematics teaching in the uMzinyathi district in KZN. Hlalele (2014) is adamant that in order to bring about change in education and the rural areas, it is important to consider and include people from the local community. Hlalele (2014) further claims that the primary focus of rural development must be to enable the rural people to take control of their own destiny by utilising natural resources.

3.10 CONCLUSION

When mathematics is taught to learners who experience barriers to learning, it is important to consider both the extrinsic (cf. 3.4.1) and intrinsic (cf. 3.4.2) barriers these learners experience. The teacher must have a holistic approach to teaching these learners and realise the bio-ecological (cf. 3.3) influence that these barriers have on the learner's academic performance. To address these barriers to learning, several specific teaching methods can be used, including differentiation of the curriculum (cf. 3.5.2), code-switching (cf. 3.5.2.1), scaffolding (cf.3.5.2.2), and adapting the curriculum and assessment (cf. 3.5.2.3).

This is a daunting task for teachers in rural areas, with limited resources and support. The uMzinyathi district where this study was done, is a rural area with poor socio-economic resources (cf. 3.8). Parent involvement (cf. 3.7.5) is limited, and support structures (cf. 3.7.6) are virtually non-existing. This project aims to equip the teachers who are teaching in this harsh environment, to improve their teaching of mathematics through a process of collaboration.

Chapter 4 will focus on the theoretical and conceptual framework guiding this research methodology.

CHAPTER 4

THE THEORETICAL AND CONCEPTUAL FRAMEWORK GUIDING THIS RESEARCH METHODOLOGY

4.1 INTRODUCTION

Chapter 3 dealt with teaching mathematics to learners who experience barriers to learning in the rural environment considering both the extrinsic (cf. 3.4.1) and intrinsic (cf. 3.4.2) factors as well as the roles expected of the teachers (cf. 3.7.1).

In this chapter, the study will be contextualised, and the research paradigm, different theories underpinning this study and methodology of choice will be discussed in detail. Participatory Action Learning and Action Research (PALAR) as the applicable research design for this community-based research will be discussed (Wood, 2020). The data generation and data analysis methods, ethical issues, validity and trustworthiness, as well as the contributions to the authenticity of the research, will be indicated. The chapter will conclude with a summary of the content focusing on collaboration and support between all co-researchers to improve the Foundation Phase (FP) teaching skills in mathematics.

4.2 CONTEXTUALISING THE RESEARCH

Most of the learners in rural areas are in ordinary schools because of the absence of full-service schools and special schools/special schools resource centres (Dednam, 2011; Directorate for Education and Skills Innovative Learning Environments, 2022). For this reason, Kempen and Steyn (2016) indicate that teachers in rural areas have a daunting task to fulfil in educating and supporting learners with barriers to learning (cf. 3.7.1).

4.3 PROBLEM STATEMENT

A systematic review of the literature provided a background to the problem under investigation in this study, titled “Improving FP mathematics teaching in rural contexts: A participatory action learning and action research approach”. What emanated from the literature is that teachers find it difficult to adapt the curriculum in a manner to accommodate the specific needs of a diverse learner population, especially those experiencing barriers to learning in mathematics (Jojo, 2019; Kempen & Steyn, 2016; Langhan et al., 2012; Moosa, 2014). This study focuses on improving the teaching of mathematics in rural schools through a collaborative professional development initiative.

Given the above-mentioned literature, it seems clear that support for teachers is needed and that it may not be efficiently facilitated in rural schools. This may be because teachers feel they do not receive sustainable and efficient support from the School Base Support Team (SBST) and District Base Support Team (DBST) in delivering and interpreting the general Curriculum and Assessment Policy Statement (CAPS) (DBE, 2011a; Hay et al., 2021; Kempen & Steyn, 2016). The lack of support appears to hinder the effective and sustainable implementation of inclusive education, particularly within rural schools (Hay et al., 2021; Neethling, 2015).

Through a participatory model of collaborative professional development, teachers in the FP working in rural contexts were given the opportunity to improve their teaching of mathematics.

4.4 RESEARCH QUESTION

4.4.1 Main research question

Hofstee (2018) suggested that the problem identified be formulated as a research question to gain a better understanding of the topic to be researched. In this study the lack of an appropriate curriculum and support for teachers to support learners who experience barriers to learning, culminates in a research question that is formulated as follows

How can Foundation Phase teachers in rural contexts improve their teaching of mathematics?

From the research question, the following sub-questions emanate.

4.4.2 Sub-questions

The following sub-questions guided the study:

- What challenges and barriers do FP mathematics teachers in rural school’s experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?
- What strategies can we develop to improve FP teachers’ teaching of mathematics to minimise these challenges?
- What guidelines can be derived from their learning to improve the teaching of mathematics in the FP in rural contexts?

4.4.3 Objective of the research

The objective of this research primarily was to investigate and develop strategies to improve the teaching of mathematics, in FP to learners who experience barriers to learning in a rural context.

In order to achieve this objective, six FP teachers and I, as the research facilitator, formed an ALG to work collaboratively as co-researchers to first investigate what challenges and barriers teachers in rural school’s experience regarding FP mathematics teaching. In the process of my investigation, I focused on specific curriculum challenges. I further had to determine how educators are currently dealing with learners with mathematical barriers in rural schools.

All this data was incorporated into a fishbone diagram from where I could determine what the teachers are currently experiencing in mathematics and then consider possible strategies that we can develop to improve FP teachers’ teaching of mathematics to minimise these challenges. We collaboratively decided on piloting the DCAPS (DBE, 2018) in our classes.

We had to plan, act, reflect and implement the DCAPS (DBE, 2018) to make the necessary adaptations to the teacher’s manual, to contextualise it for the rural environment. We used a PALAR design to work collaboratively on amending the headings and introduction, translating it into isiZulu and simplifying the language to the teacher’s manual. Photos of learning and teaching material from natural and recycled material were incorporated into the teacher’s manual to optimise its usability.

The research process simultaneously provided an opportunity for personal and professional development for the co-researchers as well as the secondary participants in this research. The guidelines derived from the learning to improve the teaching of mathematics led to the overall objective of this research project, to develop strategies to improve the teaching of mathematics in FP to learners who experience barriers to learning in a rural context.

4.5 PURPOSE OF THE STUDY

According to Hofstee (2018), the purpose of a research study is to attain new knowledge about the world around us and develop new theories to better the community. The purpose of this study is two-folded. Firstly, it is to support FP teachers at rural schools in the uMzinyathi District in KwaZulu Natal (KZN), by doing a community engagement project to improve teaching skills in mathematics. By rendering appropriate support to the teachers, the learners who experience barriers to learning ultimately benefit from this project. Secondly, the research was done to collaboratively improve the co-researchers’ knowledge of the problem at hand, through facilitating and participating in the PALAR inquiry.

4.6 THEORETICAL FRAMEWORK OF THE RESEARCH

The two theories that guided the thinking in this study were the critical transformative learning theory (CTLT) (Mezirow, 2011) and the social constructivist theory (SCT) (Vygotsky, 1978). To contextualise the process of transformation in PALAR, and the significant role transformation plays in this research, this discussion will begin with a discussion of andragogy.

4.6.1 Andragogy

In Andragogy, or better known as *adult education*, adults use prior knowledge and experience to shape their way of learning (Mezirow, 2003). This may not be the ideal way for all adults to learn, because it expects of the educator to give something of himself, and the adult learner may feel vulnerable (Akintolu & Letseka, 2021). Seyoum and Basha (2017) find it a useful tool in educational studies, though, while Akintolu and Letseka (2021) describe adult knowledge as an ever-evolving process where knowledge becomes redundant and new knowledge is created.

Alexander Knapp developed andragogy in 1833, and in the 1960s Malcolm Knowles popularised the concept (Maddalena, 2015). Andragogy in this research study concurs with Merriam's (2001) description that andragogy is merely good practice and must not be seen as a separate learning theory but as a focus of the research. This resonates with this study, where transformation of the co-researchers in the action learning group (ALG) resulted in change. Andragogy in this participatory research was significant because as co-researchers, we were first and foremost teachers with different knowledge, skills and experience contributing to the collaborative research and we acknowledged one another's contribution by treating one another as equals in the ALG. Andragogy thus provides the framework in which transformation takes place (Taylor & Cranton, 2012).

4.6.2 Critical transformative learning theory

This study was grounded in the critical transformative learning theory (CTLT), because as co-researchers, with prior knowledge on the topic, we wanted to understand the problem at hand, and change it for the better (Cohen et al., 2018; Garneau, 2016; Rehman & Alharthi, 2016). CTLT is concerned with understanding how individuals perceive the problem, construe their experience, and assist in the process of modifying the structures, to bring about sustainable change (Christie et al., 2015).

Mezirow (2011) describes the CTLT as a metacognitive epistemology of evidential (instrumental) and dialogical (communicative) reasoning. Fazio-Griffith and Ballard (2016) describe three tenets of CTLC, namely (1) centrality of experience, (2) critical reflection and (3) rational discourse. These tenets will be discussed below.

4.6.2.1 Centrality of experience

The *centrality of experience refers* not only the specific context or environment in which the research takes place but includes the context from which the co-researchers and the secondary participants acquire their prior knowledge and experience (Fazio-Griffith and Ballard, 2016). In this research, the centrality of the experience was added in the form of the research question that reads: *How are educators currently dealing with learners with mathematical barriers in rural schools?* The research was done in the rural environment of the uMzinyathi district, where all the co-researchers are currently teaching. From the co-researcher's prior knowledge and experience, this question was answered through actions happening in the different cycles.

4.6.2.2 Critical reflection

By using critical reflection, the co-researchers got the opportunity to firstly reflect on their prior actions and experiences and then on the research questions posed to them to investigate in the different cycles. During the ALG meeting we, as co-researchers, reflected on our different viewpoints and based on that, made decisions on the actions to be taken (Fazio-Griffith and Ballard, 2016). In the process we reflected on the "what, how, and why" questions of the research (Wood, 2020). Reflection is essential to make sense of what one has experienced (Wood, 2020). Critical reflection forms a primary part of the research. Before and after all actions as co-researchers, we reflected on all our actions as well as the actions taken by the secondary participants. These reflections were documented in the reflective journals and referred to at the ALG meetings as well as when compiling the fishbone diagram (Figure 6.1).

4.6.2.3 Rational discourse

Brown (2004) describes rational discourse as the verification of meaning. In this research we as co-researchers had meaningful discussion and reflections during the ALG meetings and with the secondary participants. Since we all have specific knowledge and expertise, we could contribute to addressing the research question.

4.6.2.4 The application of the critical transformative learning theory in PALAR

Wood (2020) describes CTLT in PALAR as a process of learning from the experience of others via critical self-reflection. This resonates with Ravans (1998), who states that learning must culminate in action. Fleming (2022) also points out that CTLT is not just about the acquiring of knowledge, but that it leads to awareness of humanity by addressing challenges through ecological and community involvement. This reasoning and reflection will ultimately lead to a transformation of the current situation. In the ALG we used our prior knowledge to give new meaning to the problem at hand. By applying CTLT in the ALG we evaluated our actions, reflected on the actions in the reflective journals and then presented it to the rest of the co-researchers at an ALG meeting, where the integration of their knowledge lead to the transformation of not just the situation but also their own perspectives. Likewise, Foote (2015) describes transformation as a process of establishing a frame of mind. According to Foote (2015) this framework is through reflection with the integration of experiences and different viewpoints in a discussion process. In the ALG we first had to build trust by respecting others, reflecting on our viewpoints as well as valuing the viewpoints of the rest of the co-researchers. As a group, we had to take responsibility for our collaborative actions (Pedler, 2008).

The ALG created a safe environment where we as co-researchers could centralise our experience. We shared knowledge and experience without fear of discrimination or victimisation. Throughout the research, we had to critically reflect on our notes in the reflective journals. This was a cyclic process of returning to our notes, and by doing so we also realised the transformation in our perspectives. Through rational discussions in the ALG meetings, a total shift in perspectives took place.

4.6.2.5 The critical transformative learning theory in practice

The CTLT played a major role in transforming into what we have found to be the results of the research project. Transformation took place on different levels and thus affected not only us as the co-researchers, but ultimately benefited the learners who experienced barriers to learning. In the ALG meetings and in the process of generating, evaluating, reflecting and presenting the data at the meeting we experienced a paradigm shift. As co-researchers we now focused on what the learners are able to do and not on the barriers to learning. We viewed ourselves as knowledgeable contributors to the community and to education as a whole.

Beside the transformation as part of the co-researchers in the ALG, my personal perspectives also had to transform. With my background in special education in a city with well-resourced schools, the impoverished rural community with such limited support transformed the conservative way in which barriers were addressed. I had to move beyond my comfort zone to address the environmental barriers these teachers are facing daily. Being an equal member in the ALG gave me the opportunity to learn from the teachers on grass root level in the context of the research.

The Differentiated Curriculum and Assessment Policy Statement (DCAPS) (DBE, 2018) was originally compiled for learners with severe intellectual disabilities. This research was utilised to address the barriers to learning in mathematics which learners with intrinsic as well as extrinsic barriers experience in a rural context. The DCAPS (DBE, 2018) had to be transformed and can now be used in rural areas around South Africa to address the specific barriers these learners experience.

Through translating the teacher’s manual into isiZulu and simplifying the language, as well as incorporating learning and teaching support material (LTSM), we transformed the use of the DCAPS (DBE, 2018) to be utilised in the wider rural community but also in other parts of South Africa where isiZulu is spoken or understood by the teacher. We used the CTLC as well as the SCT in this research as theories to create knowledge. Through the CTLC and SCT, transformation took place on different levels: initially inter-psychologically, in the ALG, where we had social discussion in the process of answering the research sub-questions and later intra-psychological when doing intro-reflection.

4.6.3 Social constructivist theory

According to Vygotsky (1978), the social constructivist theory (SCT) is a collaborative process of developing new knowledge. Knowledge is developed from individuals’ interactions with their culture and society. Vygotsky (1987) believed that development appears twice, meaning that new knowledge will first appear on a social level (inter-psychological) and later an individual level (intra-psychological). Even before Vygotsky, Von Glasersfeld (1974) held that all knowledge is constructed rather than perceived through the senses.

Knowledge in this study was constructed via the co-researchers’ active involvement in constructing knowledge from their own experiences (Elliott et al*.*, 2000). The new knowledge will follow the process of first an inner-psychological and later an intra-psychological process. The co-researchers’ existing knowledge will form the foundations of their knowledge. The co-researchers brought their understandings to the group, then listened and learned, and reflected on what they had heard, to adapt their assumptions and to change or develop a better understanding of the problem at hand. However, radical constructivism (Von Glasersfeld, 1974) states that the knowledge individuals create, tells us nothing about reality but only helps us to function in our environment. Thus, knowledge is invented and not discovered. The humanly constructed reality is all the time being modified and interacting to fit ontological reality, although it can never give a true picture of it (Von Glasersfeld, 1974). The ALG of this research constructed knowledge by applying prior knowledge and experience to create strategies to improve the teaching skills of the FP teachers in mathematics.

Through the CTLC and SCT, transformation took place on different levels: initially inter-psychologically, within the ALG, where we had social discussions in the process of answering the research sub-questions; and later intra-psychologically, when intro-reflection took place.

These theories led to the generation of the data and assist with the analysis of the data that will be discussed in the research methodology.

4.7 RESEARCH METHODOLOGY

The research methodology describes how the research was done through specific steps and justifies why this specific methodology was applicable for the study and how the data was generated and analysed (Jansen & Warren, 2020). It thus describes a systematic process to find a sustainable solution to the research problem. For this research, a qualitative approach was applicable, since co-researchers collaboratively constructed knowledge within the participatory paradigm of dialectic epistemology, relational ontology and axiology guiding the study.

4.7.1 Research paradigm

A paradigm is a theoretical concept of how a system of different structures works together and responds to one another within a specific time frame (Huitt, 2018). Booyse et al. (2011) describes a paradigm as a representation of the scientific way in which study in the field is viewed. Zuber-Skerritt (2011) describes a paradigm as "a way of thinking, feeling, living and being that influences our values, worldviews and paradigms of learning, teaching and research. It influences our behaviour, strategies, methods, and therefore the capacity for improving practice." (p. 6) The paradigm is thus the guide through which the study will be conducted and it describes a way to observe the world (Bosman, 2022).

In this research the co-researchers observed the reality from the perspective of the rural area where they live and work. It is from this perspective that the co-researchers brought depth to the research. Their perceptions of real-life teaching of mathematics will give insight into the specific problems these teachers are experiencing. By exposing the co-researchers and teachers to the DCAPS (DBE, 2018), a new perspective began to emerge. This may not be the best or only option to consider, but it changed the teachers' existing perception. Adaptations had to be made to the teacher's manual for the DCAPS (DBE, 2018) to make it more user-friendly to enhance its practicality.

Furthermore, my perceptions of the teaching of mathematics underwent a total reform. Coming from an environment of special education in a well-resourced school, I was exposed to the everyday contextual barriers that can hamper the teaching of mathematics. The DCAPS (DBE,

2018) which was initially designed for a different profile learner, are here implemented in a rural environment to address the curriculum challenges in the teaching of mathematics. Through the research, several paradigm shifts, including theoretical, cognitive and emotional shifts, had to be made to create a new contextual theoretical framework.

A paradigm consists of different elements, such as dialectic epistemology, relational ontology, axiology, and methodology (Nguyen, 2019). When the PALAR design of research is used, self-reflection forms a primary part of the paradigm in the research (Wood, 2020). Zuber-Skerritt (2012) describes the three levels that can influence the learning process as follows:

- Practical outcomes of the problem;
- epistemological outcomes, where transformation takes place in how the participants think about knowledge creation and theory; and
- ontological outcomes, where transformation takes place in how they interact with one another, and how they see their position in the world (Wood, 2012).

The participatory paradigm includes dialectic epistemology, referring to how knowledge is created through creative and collaborative dialogue, as the opinions of all co-researchers will be reflected on, evaluated and considered as their knowledge and truth. The relational ontological assumption on how we view the world when we engage in open relationships will establish the working relationship between the co-researchers before we collaborate to generate relevant knowledge (Brydon-Miller et al., 2003; Wood, 2020) about the teaching of mathematics in rural schools. Axiology refers to ethical principles and will be achieved in a just and respectful manner by adhering to the 7Cs and 3 Rs as PALAR principles (Wood, 2020). These elements will be described concerning the project at hand.

4.7.1.1 Dialectic epistemology

Kivunja (2017) believes that the notion of a paradigm encompasses epistemology, which refers to how we view the world. Dialectic epistemology encompasses the processes within which knowledge is created and even the limitations of beliefs and perceptions. We need epistemology to create our perception of truth (Thaxton & Danahy, 2021). Dialectic epistemology is the process of collaboratively creating knowledge as co-researchers (Wood, 2020). This newly created knowledge deepened our understanding of the research problem.

The co-researchers used intuitive knowledge when applying their experiences, beliefs and intuition as sources of knowledge. Authoritative knowledge was integrated into the research by applying the knowledge acquired from books and knowledgeable individuals as well as relying on the co-researchers in the ALG. This trust and relationship between the members of the ALG are where the new knowledge was created. It is through this process of knowledge building that faith is established in the data (Kivunja & Kuyini, 2017; Wood, 2020).

The dialectic epistemology was considered in this study, as the opinions of all co-researchers are valued and reflected on, evaluated, and considered as their knowledge and truth. The FP teachers and I formed the ALG and acted as co-researchers. The members of the ALG investigated the research questions. We created a set of knowledge by analysing the data and then developed our own set of knowledge as we collaboratively, through discussion, reached a consensus on piloting and implementing the DCAPS (DBE, 2018) and translating the teacher's manual into isiZulu, simplifying the language and integrating learning and teaching material (LTSM) from natural and recycled resources. Our thinking process were fundamentally creative, critical, and analytical. This enabled us to reflect on the improvement of the teaching of mathematics to learners who experience barriers to learning. The dialectic epistemology will be considered in this study, as the opinions of all co-researchers will be reflected on, evaluated, and considered as their knowledge and truth.

4.7.1.2 Relational ontology

Kivunja and Kuyini (2017) posits that the notion of a paradigm encompasses ontology that is concerned with the assumptions we make to believe something is real and methodological procedures that are used to investigate to gain knowledge about the world. Scotland (2012) explains that ontology is the verification process of what we believe is true and the essence of reality (Creswell, 2012; Denzin & Lincoln, 2017). Applied ontology is a process in which we orientate the co-researchers concerning the research problem and then guide them to find workable solutions (Kivunja & Kuyini, 2017). Wood (2020), describes relational ontology as being related to the term *Ubuntu*, which means "I am because we are" (p. 25). The relational ontological assumption of how we view the world when we engage in open relationships established the working relationship between the co-researchers, before we collaborated to generate relevant knowledge (Brydon-Miller et al., 2003; Wood, 2020) about the teaching of mathematics in rural schools.

Relational ontology and dialectic epistemology contributed to this study, not only in terms of addressing the research questions but also with regarding to reaching a collaborative solution to the problem, ensuring sustainability and "promise to have a long-lasting effect on our thinking" (Bosman, 2022, p. 107). The ontological assumption in this study is grounded in participatory and relational ontology (Wood, 2020) since the co-researcher will collaborate to generate new relevant knowledge about the teaching of mathematics in rural schools.

4.7.1.3 Axiology paradigm

Axiology leads us in a democratic process to achieve social change., and according to Nguyen (2019) axiology focuses on ethical behaviour and core values. These core values and ethical principles that are grounded in action research, must be considered when research is done. These principles are autonomy, sovereignty, beneficence, justice, caring, respect, commitment, transparency and democratic practice (Brydon-Miller et al., 2003), and align with the 7Cs and the 3Rs as PALAR principles.

The co-researchers and I collaboratively considered and respected the different values, morals and contributions of one another. We achieved this by collaboratively approaching each discussion in a just and respectful manner. This study was guided by the ethical principles of privacy, accuracy, property and accessibility that were identified by Kivunja and Kuyini (2017).

Privacy

Privacy in research refers to the protection of all participants, but also the right to control access to their participation in the study (Allen, 2017). In this research, co-researchers were expected to trust and respect one another's privacy as well as the privacy of the teachers, who acted as secondary participants at the rural schools with whom we engaged in discussions.

The WhatsApp group was used for open discussion among the co-researchers, where we all had the right to an opinion which needed to be acknowledged and respected. Because of the distance between myself as the research facilitator and the co-researchers, for some of the discussions we had to make use of alternative means of communication. WhatsApp groups, e-mails and one-on-one communication were used. We had the opportunity of face-to-face ALG meetings, however, where we amalgamated our findings and strategized the way forward. In this way, the privacy of the co-researchers was not purposefully jeopardised.

Accuracy

The validity and fidelity of the research are primarily based on the accuracy of the data (Kivunja & Kuyini, 2017). All data was gathered in English, which is not the mother tongue of any of the co-researchers. Every co-researcher's insight into the findings and their specific skills in either spelling or language proficiency contributed towards the accuracy of the data and ensured that the data was not misinterpreted.

Property

According to Kivunja and Kuyini (2017), “property” means the ownership of the data. The co-researchers took ownership of the data through a process of collaboration. Through systematic data-generating and analysis, and regular reflection, the co-researchers gained insight into the barriers they face as teachers of mathematics in a rural context and identify and test out strategies to help them to overcome the barriers. The knowledge they generate was useful as guidelines for other teachers and contributed to the learners’ progress. More importantly, they learned how to improve their teaching as part of a community of practice, and this will enable them to sustain their development and become lifelong learners.

All the decisions that were taken regarding the research, were done through an ALG meeting where a collaborate decision was taken on the problem at hand. I explained the process of data analysis to the co-researchers when data was being analysed during the initial relationship building workshop. The analysis of the data was done by all the co-researchers. Through this process of data analysis, the co-researchers took ownership of the data and thus always had full access to the data.

Accessibility

In research it is important that the co-researchers always have access to the data (Kivunja & Kuyini, 2017). Allowing them access also allows the co-researchers to better reflect on the data and to produce new and perhaps more workable solutions to the current problem under investigation.

The meta-cognition related to this study is the creation of knowledge through collaborative dialogue and the development of critical subjectivity, where all members of the ALG developed an awareness of the self and others as persons with knowledge, experience, identities, feelings, beliefs and desires (Wood, 2020). The co-researchers worked together to understand a problematic situation and change it for the better.

The research design was specifically selected with this collaboration process in mind. It contains all the elements to answer the research question, but also benefits all the participants as well as the community, and ultimately the learners who are experiencing barriers to learning.

4.8 RESEARCH DESIGN

The co-researchers followed a Participatory Action Learning and Action Research (PALAR) design to improve the teaching of mathematics in rural schools of the uMzinyathi District in KZN.

In this study, PALAR was applied as a social science paradigm and not just as a methodology. The PALAR design is qualitative and is considered democratic, equitable, liberating and life-enhancing and is particularly concerned with the roles played by the researcher, co-researchers, and participants (MacDonald, 2012; Zuber-Skerritt, 2011). By applying the PALAR design, we aimed to create sustainable change in a community through professional development.

The PALAR is a combination of Participatory Action Research (PAR) and Action Learning (AL). AL is described as learning from experience. This can be done in group discussions, personal discovery, and learning from one another, and through a trial-and-error process, new knowledge is developed and shared. It is a process where groups of people work on real problems, carrying real responsibility in real conditions (Zuber-Skerritt, 2005). The PALAR is a research design under the umbrella of Action Research (AR). In AR the focus is on a group identifying a problem that they would try and address. After discussion, the group decides on the most feasible method to address the problem to bring about change for the better. In this study, a group of FP teachers worked together to find ways to improve their teaching skills in mathematics to address learner who experiences barriers to learning.

The purpose of using this PALAR research design allows the researcher to describe and understand the participants, rather than to predict and control them (Neethling, 2015). The goal of using PALAR is to foster capacity, community development, empowerment, access, social justice, participation and collaboration (MacDonald, 2012). The PALAR design consists of a substantive network of approaches to research that is all participative and rooted in actions and experience. PALAR is also rooted in basic philosophical principles. These principals are known as the 3Rs (cf. 4.8.1) and 7Cs (cf. 4.8.2) of the PALAR design (Wood, 2020; Zuber-Skerritt, 2018).

4.8.1 The 3Rs of PALAR

Wood (2020) describes the basic philosophical principals as the rules on which the PALAR research design is founded. Kearney et al. (2013) identified three important components to PALAR, namely "the development of democratic, authentic, trusting and supportive relationships; the process of continual critical reflection in a collaborative learning context; and recognition of the achievements of all participants" (p. 15). These three components form the key to a truly participatory approach to knowledge creation. Wood (2020) refers to these as the 3Rs in PALAR. To enable the research to be successful, a relationship was first established with the co-researchers before the start of the research; and a relationship-building activity was done at the beginning of each ALG meeting. The co-researchers critically reflected on all data that was generated in their reflective journals. At the ALG meeting, all data was presented, and the co-researchers listened to the different opinions. Again, all co-researchers reflected on all the data before them to come to a collaborative decision for the planning of the next steps in the research. This data formed the foundation for the next cycle. The co-researchers were recognised for their contribution throughout the study and also at a ceremony at the end of the research.

The ALG meetings were based on the 3Rs features of PALAR. To enable the research to be successful. In this study, we adhere to the 7Cs and 3Rs as PALAR principles (Wood, 2020).

4.8.2 The 7Cs of PALAR

The 7Cs in PALAR comprise communication, commitment, competence, compromise, critical self-reflection, collaboration and coaching. Below, I will reflect on how the 7Cs were applied in the research.

Table 4.1: 7Cs of PALAR

PRINCIPAL OF PALAR	APPLICATION WITHIN THIS RESEARCH
Communication	As "communication is the key to relationships and learning" so is listening (Wood, 2020:30). Emphasis was placed on dialogical communication between the co-researchers during the ALG meetings. As co-researchers, we had the opportunity to listen and learn from one another but also to differ from the others.
Commitment	Participation in this project was voluntary, therefore the co-researchers were committed to improving their teaching of mathematics and accepted our roles in the ALG. Being part of the analysis of the data, the decision-making process as well as the future creation workshops, gave the co-researchers a sense of ownership of the project (Wood, 2020).
Competence	The advantage of this research was that the synergy formed in the ALG felt like a micro family.
Compromise	Compromising was an aspect that all of us as co-researchers had to work on. We were teachers and when we teach/talked/discuss issues at hand, others must listen. We were in a situation where we all had to listen and learn from one another, to contribute to the discussion and the research. To summarise this C4, as educators, we had to accommodate different views and adjust our thinking (Mezirow, 2011).
Critical self-reflection	To critically reflect on your actions was quite daunting to me because I had to do self-reflection as the research continued to, ensure that I do not move back into the teacher's role but be a co-researcher and listen to the views of others. The co-researchers used their reflective journals to write their reflections and used them as referral notes during the ALG meeting. Since the journals captured more than their research journey, we only captured data applicable to the research.
Collaboration	The co-researchers collaborated well, even though their situations and opinions differ at times. The teachers as secondary participants collaborated enthusiastically.

PRINCIPAL OF PALAR	APPLICATION WITHIN THIS RESEARCH
Coaching	The ALG was a conglomerate of cultures and with it, experience and knowledge. We had the opportunity to learn from one another. I acted as the research facilitator, from a practical point of view. I struggled at first to lead from behind (Zuber-Skerrit, 2013) and to follow the democratic principles of PALAR (Wood, 2020) because I needed to complete the research project according to a planned timeline. In time, I came to realise that I had to be led by the reflections and discussions taking place in the ALG meetings to make the research journey a success story. After I changed my attitude, the relationship between the co-researchers changed and the research project got positive momentum.

By adhering to the 7Cs, and by following the PALAR process, I could ensure a sustainable systemic change in the community (Zuber-Skerritt, 2018).

4.8.3 The PALAR processes

Figure 4.1 describes the PALAR process as it was applied in this research. The PALAR research design is cyclical, moving forward and backwards depending on what data was generated (Wood, 2020; Wood & Zuber-Skerritt:201). This study consisted of three main cycles in which the research sub-questions were collaboratively addressed. These cycles were not static, but dynamic and amended as the research progresses.

In the first cycle, relationships were built between the participants who act as co-researchers in the ALG, and the research process were negotiated. Since PALAR crafts a collaborative vision through relationship building and research, the co-researchers had to form a relationship with the researcher, and vice versa. This led to the formation of an ALG (Wood, 2012). Several meetings were held during this cycle. Each ALG meeting commenced with a relationship-building activity followed by a planning session for the action to be taken to address the research aims and objectives. A reflection session and intervention of the actions followed. The co-researchers of the ALG defined a mutual purpose where personal development and transformation took place. By identifying their strengths and the contributions of each member to the team, their roles and responsibilities in the team were established. Broad research goals were set, and an ethical contract was drafted. The ALG crafted a collaborative vision by identifying a problem area for this study, namely improving FP teaching of mathematics in rural schools, and then formulated the research questions.

At the ALG meetings, the following proposed research sub-questions were addressed:

- What challenges and barriers do FP mathematics teachers in rural school’s experience?

- How are educators currently dealing with learners with mathematical barriers in rural schools?

The answers to these questions were documented as data in the reflective journals. Most of the meetings were face-to-face but a communication system was put in place, where some of the findings were communicated. Through e-mail, WhatsApp and voice notes, a continuous communication channel was established, because of the distance between me (as the research facilitator) and the co-researchers. The answers to the first two research questions were reflected upon and formed the basis for the second cycle.

In the second cycle, the co-researchers generated data on the third research question:

- What strategies can they develop to improve their teaching of mathematics to minimise these challenges?

The data was evaluated and reflected on by the co-researchers at an ALG meeting (Wood et al., 2013; Wood, 2020); and the data from the three research questions were reflected upon and analysed on a fishbone diagram.

This analysis culminated in a critically informed action plan. At an ALG meeting, the DCAPS (DBE, 2018) was introduced to the co-researchers. The DCAPS (DBE, 2018) was piloted, evaluated and reflected on in the co-researchers' reflective journals. The co-researchers reflected on the practicality of the DCAPS (DBE, 2018) in their classrooms and recommendations were made by the co-researchers during the following ALG meeting where adaptations could be made to ensure its practicality.

During Cycle three, the co-researchers made the necessary adaptations to the teacher's manual and then later presented it to other schools in the community to improve the mathematics teaching of the FP teachers in the specific rural community. Continuous reflection and re-planning guided the research. This led to amendments to the teacher's manual and the development of the Learning and Teaching Support Material (LTSM) by using natural and recycled materials. The teacher's manual had to be translated into isiZulu and an introduction was inserted and the language was simplified to make the content more user friendly for the teachers of the rural community. Through a succession of cycles, the aim of the research was achieved and transformation took place, both in the individuals and in the community (Zuber-Skerritt, 2011; Kemmis et al., 2014).

PALAR PROCESS

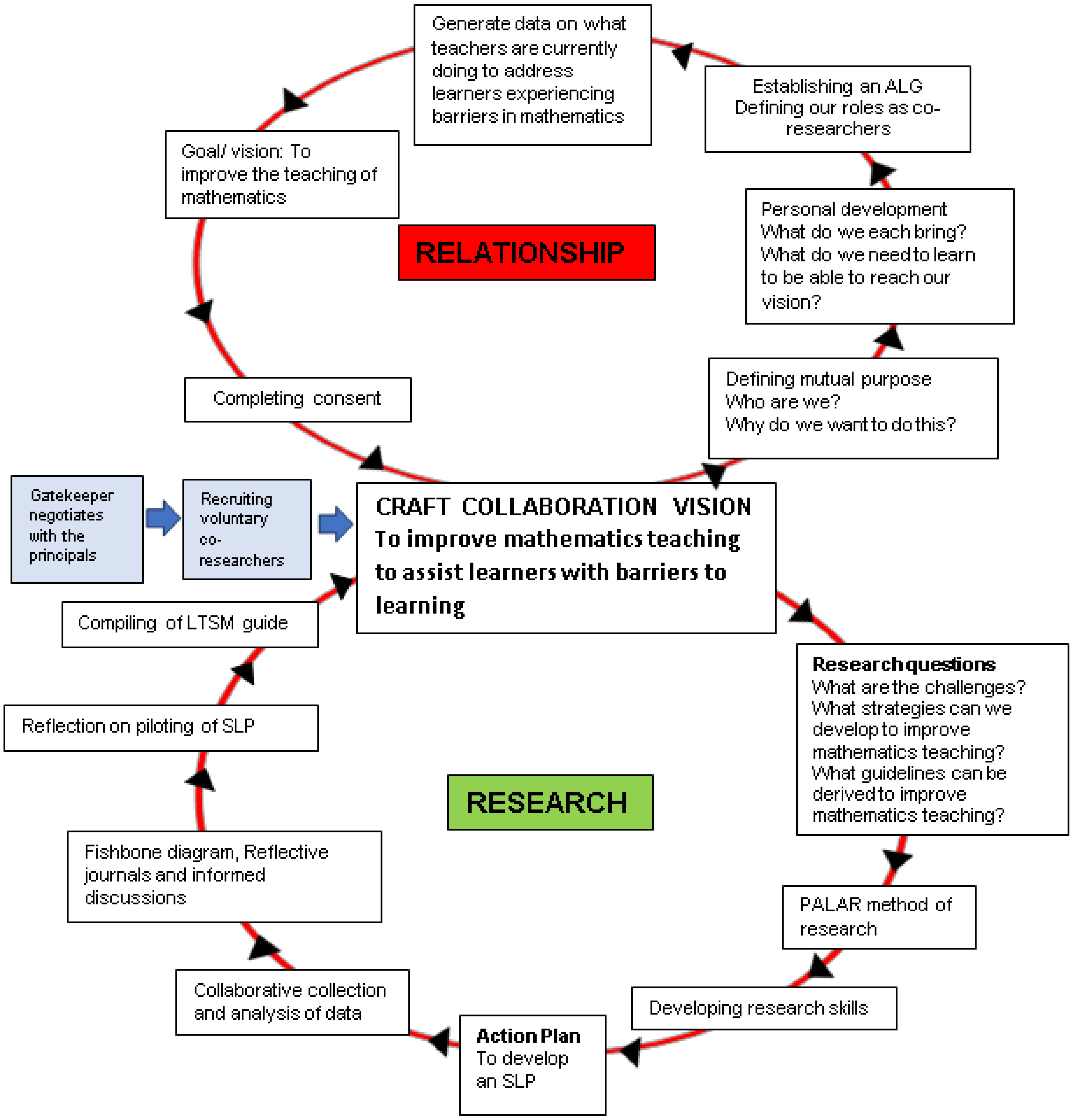

Figure 4.1: PALAR PROCESS

(Wood, 2020)

4.9 RESEARCH METHODS

The research methods describe how the research was done (Hofstee, 2018). The research methods for generating the data are discussed in the next section.

4.9.1 Site of research

The study focused on rural schools in the uMzinyathi district in KZN in South Africa (cf. 3.8). This district is situated near a small town in a remote area, 75 km from the nearest city. It is mainly a farming community, and one of the poorest communities in South Africa (RSA, 2020). There is currently no full-service school, special school or resource centre in the district to support teachers, or to support learners that experience barriers to learning. In the absence of the above, the rural schools thus need to fulfil all the roles and responsibilities of the full-service school, special school and resource centre. These schools need to act as a hub of knowledge and expertise to equip and support teachers at the community rural schools. Both these schools were quintile 1 schools, and thus no-fee schools (DBE, 2004b, cf. 3.7). They were therefore schools where no school fees were paid, in the poorest of the poorest communities (Ogbonnaya & Awuah, 2019; Van Dyk & White, 2019; Isaacs, 2020). One of the schools was not willing to participate in this research, and an independent school from the district requested to form part of the project.

For this study, as well as for confidentiality purposes, the schools, as well as the teachers, will be referred to by means of pseudonyms. The two schools will be referred to as KP and CP. The teachers represented on the ALG will be referred to as T1 to T7; and all members of the ALG, including myself, will henceforth be referred to as co-researchers.

4.9.2 Selection of participants

The gatekeeper approached principals at three to four primary rural schools from the uMzinyathi district, to ask FP teachers in their school to volunteer to participate in the research project and present the project to them. The principals were free to reject or accept the offer. Six FP teachers participated voluntarily. The selection criteria relied on the teachers and principals who were interested in improving their teaching of mathematics, if they were teaching in the FP at the time of the research and were in daily contact with learners who were experiencing barriers to learning.

In this study, it was important to select participants, and more especially the co-researchers with first-hand knowledge and experience of the field of study (Smit, 2001). Six teachers from the selected rural schools were recruited as co-researchers in the study. The ALG consisted of the co-researchers and me as the research facilitator. These teachers were selected on the basis of their specific knowledge of this topic; therefore, their responses may be viewed as reliable and relevant (Eloff & Kriel, 2003).

One school (KP) is a government school under the Department of Basic Education (DBE) and a quintile 1 school (cf.3.7). The second school (CP) is an independent school in a very rural area.

Feeder areas for both schools are the same, but the independent school is much better resourced than the government school and the learner-teacher ratio is lower. The feeder areas of these schools are vast, and learners must travel long distances to get to school. At both schools, the language of learning and teaching (LoLT) is English. The learners' home language is mainly isiZulu.

The ALG consists of teachers from both schools and I. Table 4.2 below describes the compositor of the ALG with referral to their schools, gender, race, home language, qualifications and years of experience.

Table 4.2: Biographical information on the seven Foundation Phase teachers in the action learning set

MEMBER	SCHOOL	GENDER	RASE	HOME LANGUAGE	GRADE TEACHING	QUALIFICATIONS	YEARS OF EXPERIENCE
T1	Research facilitator	F	White	Afrikaans	Gr R-3	MEd	32
T2	KP	F	Black	isiZulu	Gr2	BEd (Hons)	7
T3	KP	F	Black	isiZulu	GrR	BEd	22
T4	CP	F	White	Dutch	Gr3	BEd	3
T5	CP	F	Black	isiZulu	Gr1	BEd	15
T6	CP	F	White	German	Gr3	BEd	9
T7	CP	F	White	French	Gr2	BEd	28

The secondary participants were the rest of the volunteering staff at the rural schools, where the action plan was implemented. The co-researchers presented their findings to rest of the co-researchers at an ALG meeting.

This study adhered to andragogy in that only adults were selected to participate in the process of data generation and analysis. Only the team of co-researchers participated in the ALG meetings. The co-researchers did, however, had discussions and observed the secondary participants in their data generation. Feedback was given from the co-researchers to the secondary participant to keep them in the loop on how the research is progressing.

4.10 DATA GENERATION PROCESS

The generation of data in qualitative research is an interpretation of observations and discussions, aimed at discovering underlying meanings and patterns of relationships (Hofstee, 2018). Before the data generation commenced, an advisory committee was established to guide the researcher/participant regarding the process of generating data in each cycle.

With every method of data generation, ethical considerations had to be considered (Forrester, 2010). The co-researchers trusted and respected one another's privacy as well as the privacy of the teachers at the rural schools with whom they had engaged in discussions.

From the different methods through which data can be generated in PALAR, the methods that were identified as the most appropriate, will be discussed below.

4.10.1 Action learning group

An action learning group (ALG) is a group of five to seven people with similar interests, that investigate and solve a common problem (Scott, 2022). In this study, the ALG consisted of seven teachers from the rural area of the uMzinyathi district and me. The ALG was a conglomerate of cultures, along with experience and knowledge. We had the opportunity to learn from one another. As "communication is the key to relationships and learning", so is listening (Wood, 2020, p. 30).

At the onset of the research, with the first visit to the rural schools, the process of the project was explained to the participants. Consent forms were completed and the co-researchers did a relationship-building activity, where they introduce themselves. The aim of the ALG has been explained to the co-researchers as well as their roles as co-researchers. The six teachers from the rural schools were acknowledged as co-researchers and participated in the generating of data. Forming a relationship with the teachers and engaging them as co-researchers is a fundamental part of the PALAR research design.

In PALAR, dialogical communication forms the bases for relationship building (Wood, 2020). The ALG meetings were either face-to-face or electronic. E-mails, WhatsApp group discussions and voice notes were used to build a relationship between the co-researchers and to share data, because of the distance between the co-researchers and myself. The meetings took place after school hours for approximately 45 minutes each, depending on the specific topic under discussion. All meetings were audio-recorded as additional data. The transcriptions were done rigorously and orthographically, transcribed verbatim by me and e-mailed to the co-researchers for validity and trustworthiness. The ALG meetings assist in viewing the world through the eyes of the co-researchers and give insight into the problems that they face on a daily base (Leedy & Ormrod, 2010).

Collaboratively, we investigated the challenges teachers are currently experiencing in mathematics regarding learners with barriers to learning. After discussion, reflection and considering different options through drafting a fishbone diagram (Ciocoiu, 2010; Wong, 2011; Shinde et al., 2018; Arp, 2020), a unanimous decision was made on how to address the problem at hand. Dilworth and Willis (2003) advised that the co-researchers meet at an offsite setting, but this was not possible because of logistical problems. We alternated the discussions between the two schools so that all co-researchers would at some point be comfortable in their environment. As I formed part of the ALG it is important to determine my role in the ALG.

4.10.2 My role in the action learning group

In PALAR the role of the researcher may change as the research continues. As the research facilitator, the researcher can be involved in a continuum ranging from a total observer to a hands-on co-researcher (De Vos et al., 2007). At the onset of the research, it is of pivotal importance that the researcher should realise that collaboration is crucial, with a mutual goal of trying to achieve a change in a community (Wood, 2020). As the researcher facilitator, I spent time in the community, got to know the people and got known by them. Only once the entry had been negotiated, an ALG could be formed. My role as the researcher then changed to that of a co-researcher. As a co-researcher, I was involved in the ALG in the planning, evaluation and reflection on all data that was generated. I went through a process of reflection, analysis, synthesis, interpretation and explanation before a conclusion could be drawn. I expressed my appreciation to the co-researchers for their contribution to the research in a small ceremony with refreshments at the end of the research, but also throughout the project.

Initially, the focus of the ALG was to build a relationship between the co-researchers and to value one another's expertise in different areas of teaching mathematics. We did an art project to decorate our reflective journals and we had to share our values, knowledge and skills with the group. By working together, we got to know one another, and we could identify each member's role in the ALG.

Even though I facilitated the ALG meetings, I also tried to challenge the co-researchers to enhance their understanding of the problem under investigation. This was done through motivating the co-researchers to conduct investigations on their own and to generate data on the research question. The co-researchers also had to collect and creatively build LTSM and send the photos to me, because I acted as the nodal point.

We shared our knowledge and respected one another's expertise and willingness to learn from one another. Together we searched for solutions by negotiating conflicting arguments and by considering what would work and what would not work in this rural environment. Through collaboration, we came to conclusions as the research unfolded.

4.10.3 Reflective journals

Reflective journals are very useful and can provide evidence that cannot always be achieved by other means of data generation (Bashan & Holblat, 2017). The reflective journals gave details of the research questions on which the data was collected, and this was used as a strategy that facilitates reflexivity.

During the first ALG meeting, the co-researchers were exposed to the idea of a reflective journal and what it entails. The reflective journals, where the co-researchers would document their findings, reflected on their findings and later in the ALG meeting co-researchers referred to them as a source of information. Written and visual reflective journals (Creswell, 2012) were used by all the co-researchers, and they utilised their cell phones to capture and record events and discussions. These reflective journals captured the co-researchers' thoughts, feelings and observations in notes, drawings, sketches and photos. This data is of particular importance in research where the purpose is to make changes in practice (Neethling, 2015). The more the co-researchers reflect upon in the journal, the more the journal serves its purpose of professional, as well as scholarly, development (Neethling, 2015; Zuber-Skerritt, 2011). Data generated in the reflective journals contributed to the ALG meetings as it allowed the co-researchers to present their findings to the ALG in a structured and reflected manner.

In the reflective journals the thoughts and perceptions of the co-researchers as well as their respondents were recorded (Roulston, 2020). In this study, the reflective journals involved a written and visual art recording of data. It was utilised throughout the research process (Biggs & Tang, 2007; Bosman, 2022; Travers, 2011; Zuber-Skerritt, 2011).

4.10.4 Fishbone diagram

The Ishikawa diagram, or better known as the "fishbone diagram", was invented by Kaoru Ishikawa in the 1960s (Wong, 2011). The fishbone diagram is usually used as a vehicle to investigate cause and effect (Arp, 2020; Ciocoiu, 2010; Shinde et al., 2018). For this research, the fishbone diagram was adjusted for the research context to combine the data generated when addressing the first three research sub-questions. The data enabled the co-researchers to identify, plan, integrate and reflect on strategies to implement in the classroom context. The data was generated over three cycles, as discussed below.

4.10.5 Data generation in the three cycles

Data was generated in three interlinking cycles. The three cycles were not static, but we went backwards and forward as the research unfolded. We revisited, revised, reconsidered and reflected on the research through each cycle.

4.10.5.1 Cycle 1

The first step in Cycle 1 was to obtain informed consent from all co-researchers and then establish the ALG. The relationship-building exercise that followed, provided us with our strengths and what we can contribute to the research as co-researchers. This activity did not form part of the data generation but contributed to the roles and responsibilities each member of the ALG fulfilled. I also used this opportunity to guide the co-researchers in the process of analysing data. Through identifying themes, reflecting on them and then making a collaborative decision on the way forward, we could establish our roles in the ALG.

In the first ALG meeting, the application of the use of the reflective journal (cf. 4.10.3) was explained. We also decided on the electronic mediums that will be used to communicate. Different co-researchers preferred different mediums because of religion or availability of resources. This is the reason for the wide variety of electronic mediums to be used. The first two research sub-questions were posed to the co-researchers for investigation:

- What challenges and barriers do FP mathematics teachers in rural school's experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?

Notes, photos and drawings in the reflective journals as well as mental notes and video recordings were made by all co-researchers. After each round of data generation, an ALG meeting was held where we discussed, reflected on and plan the actions to be taken. This collaboration and reflection to learn from one another, is one of the characteristics of PALAR (Zuber-Skerritt, 2011). Audio recordings of the ALG meetings were transcribed verbatim by me and verified by the co-researchers and used as additional data. In Cycle 1 of the research there was one theme in the data that emerged in almost each meeting, namely the lack of resources, especially the lack of LTSM. We decided to start a photo bank with photos of recycled and natural materials. These photos would later form part of the short learning programme that we developed. The findings of our data formed the basis for the actions and discussions in Cycle 2.

4.10.5.2 Cycle 2

The primary focus of this cycle was to transform or disturb (Mezirow, 2011) the co-researchers' way of approaching the teaching of mathematics. To achieve this, the co-researcher's role was to pilot and implement strategies to improve mathematics teaching to learners who experience barriers to learning. The first steps in this process were to answer the third research question:

- What strategies can they develop to improve their teaching of mathematics to minimise these challenges?

All the data from the first three research questions were amalgamated and interpreted on a fishbone diagram (cf. 4.10.4). As one of the possible solutions to the problem at hand, I suggested that we implement the DCAPS (DBE, 2018). From the feedback of the co-researchers, I realised that they have no knowledge of the existence of the DCAPS (DBE, 2018). As the trainer for the Department of Basic Education (DBE) on the DCAPS (DBE, 2018) mathematics, I presented the DCAPS (DBE, 2018) to the co-researchers in an ALG meeting. Collaboratively, a decision was made to implement the DCAPS (DBE, 2018).

The co-researchers did the piloting of the DCAPS (DBE, 2018), and evaluation and reflection followed. Through constant and cyclical reflection and communication, data was generated by the co-researchers and documented in their reflective journals as well as through electronic platforms. Transformation or disturbances (Mezirow, 2011) of the co-researchers' way of approaching mathematics was the intention when alternative ways were introduced to enhance their mathematical teaching skills. This was a trial-and-error process of moving backwards and forward between the cycles.

The co-researchers presented the DCAPS (DBE, 2018) to the secondary participants at their respective schools. The co-researchers were able to evaluate their own action through self-reflection as well as observe the secondary participant presenting the DCAPS (DBE, 2018). By documenting this data in their reflective journals, the co-researchers generated data on the secondary objectives of the research:

- To evaluate the effectiveness of the strategies that were developed, for improving mathematics instruction.
- How to amend the developed strategies to ensure efficiency.

This was the ideal time for the co-researcher to observe other teachers and how they perceive the DCAPS (DBE, 2018). In the ALG meeting that followed, we analysed and reflected on the data. By collaboratively analysing the data, the co-researchers took ownership of the data as well as the developing agency of the research. It was noted by the co-researchers that there was a need to address the lack of LTSM in mathematics. The problem with the LTSM was noticed in the first cycle and the co-researchers already started a bank of photos of natural and recycled LTSM. The second problem with the implementation of the DCAPS (DBE, 2018) was that the teacher's manual was very difficult to understand for teachers who are not fluent in English. These findings were then addressed in Cycle 3.

4.10.5.3 Cycle 3

During Cycle 3, the last research question was addressed:

- What guidelines can be derived from their learning to improve the teaching of mathematics in the FP in rural contexts?

The guidelines derived from the research were that the DCAPS was a very effective tool to use for assisting learners who experience barriers to learning mathematics, but it was not user-friendly for teachers in rural areas with limited resources, and teachers who are not fluent in English. For that reason, the co-researchers developed LTSM from natural and recycled material to integrate into the teacher's manual and translating the teacher's manual from English to isiZulu. This was done to improve FP mathematics teaching in rural schools. The co-researchers worked in groups of two per grade to translate the teacher's manual into isiZulu and to simplify the language. I integrated the photos of the LTSM into the teacher's manual. The co-researchers then later presented their SLP, which consisted of a DCAPS document as well as the amended teacher's manual to other schools in the community to improve the mathematics teaching of the FP teachers in the specific rural community.

4.11 DATA ANALYSIS

Interpretation of qualitative data endeavours to answer the "why", "how" and "what" questions (Wood, 2020; Zuber-Skerritt, 2011). Data generated via transcriptions of the ALG meetings (cf. 4.10.1) and reflective journals (cf. 4.10.3) were analysed, reflected u[on and interpreted to facilitate a deeper understanding of the research question:

- How can FP teachers in rural contexts improve their teaching of mathematics?

The data analysis process was guided by the dialectic epistemology (cf. 4.7.1.1), relational ontology (cf. 4.7.1.2) and axiology (cf. 4.7.1.3) of this research (Wood, 2020). The themes that emerged through the analysis process related to the theoretical literature to answer the primary research question (Neethling, 2015).

The first set of data was collaboratively analysed by co-researchers but did not form part of the actual study. This data was used to establish each member of the ALG's role in the research. At the art workshop held to build relationships between the co-researchers, I assisted with the analysing of the first set of data. As a group we worked together to identify themes in the data, listened to the other co-researchers and reflected and evaluate the data. Only thereafter a collaborative decision could be taken on the problem at hand and agency could be developed.

In the first cycle, thematic analysis (Braun & Clarke, 2006) was utilised to analyse data generated from the reflective journals, and the transcriptions from the ALG meetings. The themes that emerged through the analysis process were further explored as the research continued. Data was generated through discussions with the teachers at the respective rural schools by the co-researchers. The data was evaluated and reflected upon by each member of the ALG and then presented to the other members at an ALG meeting. Co-researchers listened to all participants' feedback and then reflect on the plan forward. All the co-researchers formed part of the analysing process to reach a unanimous decision on the plan forward.

In Cycle 2, the themes that emerged from the first three research questions were joined on a fishbone diagram to analyse all the data together. This was done to determine the strategies to be implemented in their classes. An ALG meeting was held where the co-researchers were introduced to the DCAPS (DBE, 2018), before implementing it in their classes. The co-researchers evaluated and reflected on the data that was generated and on the effectiveness of the implementation of the DCAPS (DBE, 2018). At an ALG meeting a collaborative decision was made to have the DCAPS (DBE, 2018) implemented at the respective schools. This was done to determine the amendments that are needed to be made to the teacher's manual, to improve FP mathematics teaching in rural contexts.

In the third cycle, the aim was to determine what guidelines could be derived from their learning to improve FP mathematics teaching in rural schools. I acted as the nodal point. The co-researchers sent their simplification and translation of the teacher's manual into isiZulu to me via the different electronic platforms, to be incorporated into the teacher's manual. Photos and descriptions of the natural and recycled LTSM were also forwarded to me. I incorporated the photos into the teacher's manual. I then compiled the data into a preliminary teacher's manual and forwarded it to the co-researchers for comments and amendments. Amendments were made and the co-researchers had the opportunity to present the DCAPS (DBE, 2018) and the amended teachers manual to the schools in the community.

Continued communication took place between the co-researchers throughout the study. The ALG meetings were transcribed rigorously to ensure trustworthiness. It also gave all of us insight into the problems teachers face on a day-to-day base, and this strengthened our relationship. During the research, the trustworthiness of the research and all co-researchers play a significant role.

4.11.1 Trustworthiness

Rigour and validity are of vital importance in educational research. An assortment of scholarly sources was reviewed, and Herr and Anderson (2005) were found to be the most appropriate for this study. Herr and Anderson (2005) presented criteria for validity that is applicable across the whole continuum of action research. The criteria are linked to a goal in the research as seen in Table 4.3.

Table 4.3: Criteria for validity

RESEARCH GOAL	VALIDITY CRITERIA	IN THIS RESEARCH
The generation of new knowledge	Dialogic validity	Collaborative reflection and discussions with co-researchers
The achievement of an action-oriented outcome	Outcome validity	Was the critically informed action plan successful?
The education of both researcher and co-researchers	Catalytic validity	The researcher formed part of the ALG that reflected on the progress of the research. Through this process both the co-researchers and me experience personal and professional growth.
Results that are relevant to the local setting	Democratic validity	Data was collected and interpreted in collaboration with the ALG. A constant reflective dialogue led to addressing the problem.

(Adapted from Herr & Anderson, 2005)

Herr and Anderson (2005) describe dialogic validity as the goal to generate new knowledge through collaborative dialogue. This study incorporates teachers from rural schools as co-researchers to form an ALG. The constant reflection and discussions contributed to dialogic validity.

In outcome validity, the success of the research or project is tested. It is through outcome validity that the actions occur that lead to the resolution of the research problem. Outcome validity recognises the fact that during the research process the outcome of the actions in the action plan may lead the study to develop an alternative or amended action plan that seems more suitable to solve the problem. In PALAR this is an ongoing spiralling dynamic to achieve the goal (Herr & Anderson 2005). This study adhered to outcome validity, as it will set the goal of supporting FP teachers at rural schools, to improve teaching skills in mathematics by amending the teacher's guide by translating it into isiZulu and incorporating natural and recycled resources into the manual.

Catalytic validity describes how the co-researchers and the secondary participants are willing to rethink and redefine their roles. This may differ from the traditional roles of the researcher facilitator and co-researchers. It may lead to a spiralling change in both the researcher and the co-researchers (Herr & Anderson 2005). All co-researchers made use of reflective journals. Constant dialogue via electronic media and ALG meetings ensured catalytic validity.

To ensure democratic validity, collaboration with all parties involved is important (Herr & Anderson, 2005). Herr and Anderson (2005) further refer to democratic validity as "the extent to which research is done in collaboration with all parties who have a stake in the problem under investigation" (p. 56). Different authors use different terminology to refer to democratic validity: Cunningham (1983) named it "local" validity"; Watkins (1991:15) referred to it as "relevancy" or "applicability" of validity; and Bronfenbrenner (1979) preferred to use the term "ecological validity". In this PALAR study, constant reflective dialogue to collect and interpret data took place between the co-researchers. This democratic process contributed to supporting teaching skills in FP mathematics.

Process validity refers to the extent to which the problems were solved in a manner that permits ongoing learning of the individual and the system (Herr & Anderson, 2005). To ensure process validity, triangulation via the inclusion of multiple perspectives was taken into consideration. Data was obtained from a range of sources (Herr & Anderson, 2005). To ensure process validity, the data for this study was generated from discussion and observations by the co-researchers that reflected on it in their reflective journals (cf.4.10.3), transcriptions from the ALG meetings (cf. 4.10.1) as well as the fishbone diagram (cf. 4.10.4).

4.11.2 Ethical considerations

Ethics may be defined as a method, procedure or perspective for deciding how to act when complex problems and issues are analysed (Gajjar, 2013). Permission for the research was obtained from the Ethics Committee of the Faculty of Education at the North-West University (NWU) and the Provincial Department of Education in KZN. The ethical considerations were communicated to the participants in a letter as well as in person by an independent gatekeeper who is not involved in the project. The ethical considerations are described below.

Voluntary participation: The researcher must always strive for honesty in any scientific research and inform co-researchers about the nature of the study in advance. A choice was given of participation or non-participation. I made it clear that there were no rewards or payments for participation and that participation is strictly voluntary. Co-researchers were given the right to withdraw from the study at any time (Gajjar, 2013).

No harm to participants: I ensured that procedures were put in place to ensure that the participants were not harmed during the process. This study mainly required that co-researchers should respect one another, and that no information could be used to put another person in jeopardy. To ensure this, I emphasised the use of a positive solution-focused approach and the importance of maintaining respectful relationships (Gajjar, 2013).

Anonymity and confidentiality: I explained the difference between anonymity and confidentiality to the co-researchers. Anonymity implies that an individual will not be identified as a co-researcher (Gajjar, 2013). Due to the positions of the co-researchers, it was only possible to commit to partial anonymity and confidentiality in this study. To maintain this partial anonymity and confidentiality, co-researchers' names were not linked to their contributions to the process, and all co-researchers were requested to maintain confidentiality when they participated in ALG meetings as well as discussions with the secondary participants. In the report on the findings, pseudonyms were used to refer to co-researchers (Gajjar, 2013). The co-researchers trusted and respected one another's privacy as well as the privacy of the teachers at the rural schools with whom they engage in discussions. The WhatsApp group was an open discussion group and the right to an opinion was acknowledged. Care was taken to adhere to the Protection of Personal Information Act (POPIA) (RSA, 2013) always. The co-researchers were free to leave the group at any time. Some of the co-researchers preferred to use e-mail and not to join the WhatsApp group, because of religious reasons.

Deception: There was no need for me to hide the true nature of the study to prevent the co-researchers from altering their natural behaviour (Gajjar, 2013). All data was generated and analysed by the co-researcher. By doing the analysis of the data collaboratively, the co-researchers not only learn from one another but can also take ownership of the data. Data generated from co-researchers will be kept under secure conditions and the information received will only be used for research purposes.

Storing of data: All data (electronic and hard copy versions) will be stored in a Google document in the cloud and on a USB with password protection in the office of the promotor / co-promotor at NWU for five years and then destroyed.

Feedback on findings: The co-researchers are aware of the findings as they analysed the data collaboratively. The teacher's manual is thus owned by all and will be implemented to improve the FP teacher's teaching of mathematics in rural contexts. All co-researchers have a copy of the DCAPS (DBE, 2018) and the teacher's manual to implement in their classes. It will also be available to the principals of the schools on request and other schools in the community on request.

4.12 CONCLUSION

With this study, the PALAR research design was used, through which the teachers from the local schools and I form an ALG. Through collaboration, the co-researchers identified the specific problem with teaching mathematics to learners who experience barriers to learning. The co-researchers decided unanimously to implement the DCAPS (DBE, 2018) at their respective schools and classes. From the data generated, it became clear that amendments were necessary to make the teacher's manual more user-friendly for teachers in the rural community of KZN. The teacher's manual was thus translated into isiZulu, and an LTSM from natural and recycled material was incorporated into the teacher's manual to assist teachers with limited educational resources in their class. The co-researchers presented the DCAPS (DBE, 2018) to the schools in the uMzinyathi district.

Chapter 5 will discuss the first cycle in the PALAR process.

CHAPTER 5
RELATIONSHIP BUILDING AND NEGOTIATION OF THE RESEARCH PROCESS

5.1 INTRODUCTION

In Chapter 4 the methodology and conceptual framework of the research were discussed. The focal point of this chapter was to describe the Participatory Action Learning and Action Research (PALAR) approach (cf. 4.8.1). The research paradigm and epistemology (cf. 4.7.2.1), ontology (cf. 4.7.2.2) and axiology (cf. 4.7.2.3) guided this study. A variety of methods were used to generate data and the analyses process were described. The PALAR process consists of three iterative cycles of data generation.

Chapter 5 will investigate how the data was generated and analysed in Cycle 1. A schematic analysis of the cycle (Figure 5.1) will guide the discussion.

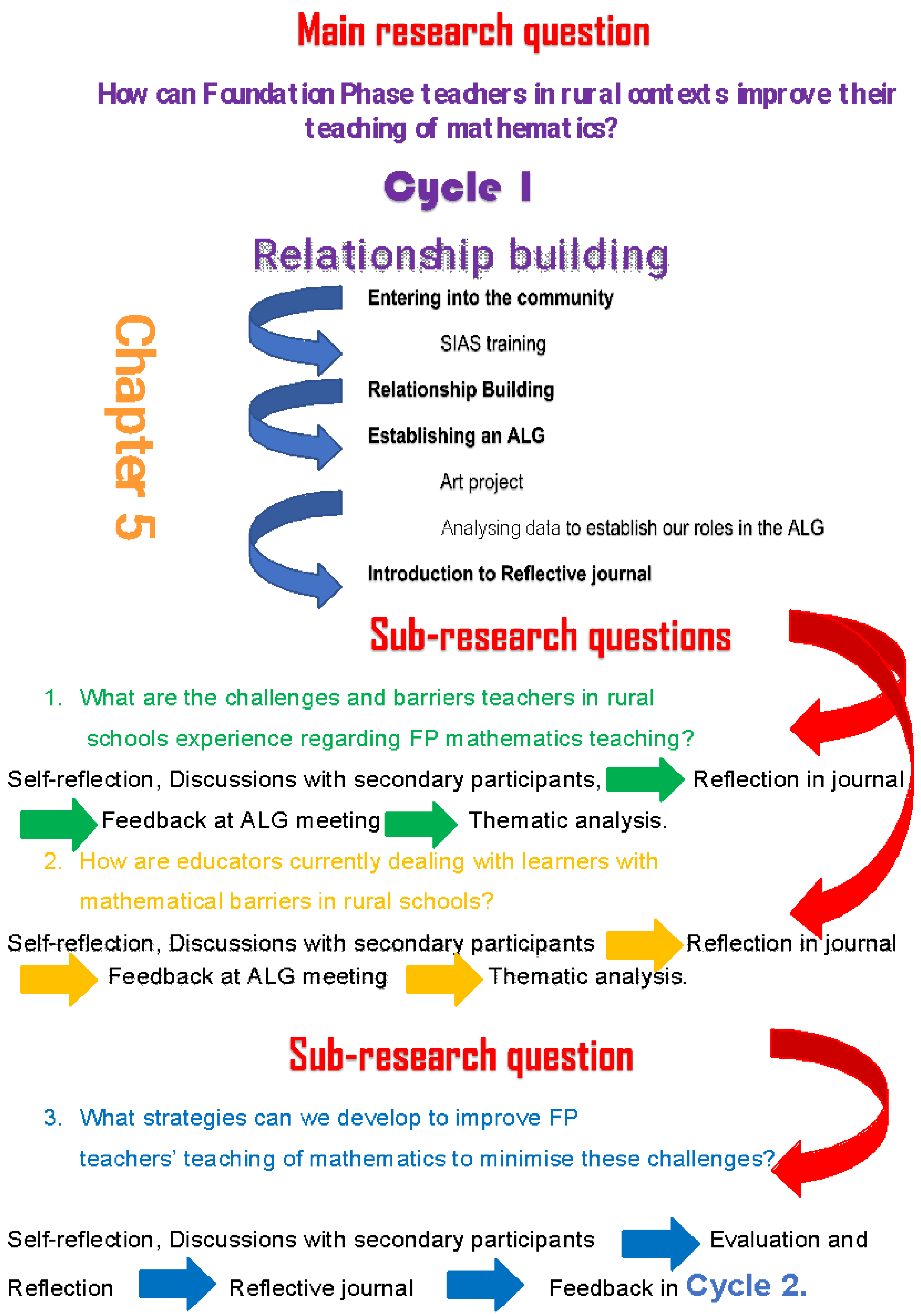

Figure 5.1: **Schematic analysis of Cycle 1**

5.2 CYCLE 1

The primary goal of Cycle 1 was to establish a relationship between the co-researchers in the action learning group (ALG) planning the research journey, and to find strategies for answering the first two secondary research questions, which were formulated as follows:

- What challenges and barriers do Foundation Phase (FP) mathematics teachers in rural school's experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?

The data generated regarding the above questions were evaluated and reflected upon, and they ultimately guided the research in terms of determining what strategies to follow in the next cycle.

Cycle 1 started when the uMzinyathi District in KwaZulu Natal (KZN) in South Africa (cf. 3.8) was entered. In my capacity as a teacher at a special school and an educationalist of the Screening, Identification, Assessment and Support (SIAS) policy (DBE, 2014) on behalf of the Department of Basic Education (DBE), I presented a workshop at different schools in the district. During these workshops, the teachers voiced their frustrations and challenges with the situation in rural areas. The gatekeeper and I considered the possibility of research on how to improve teaching in the rural community.

The gatekeeper contacted a few schools to find out whether they would be interested in participating in the project. Two schools were in favour of participating and a meeting with the principals was arranged. Both principals were very enthusiastic about the project and took the responsibility of motivating their staff to participate. The selection criteria relied on the teachers and principals who were interested in improving their teaching of mathematics, provided that they were teaching in the Foundation Phase (FP) at the time and were in daily contact with learners who experience barriers to learning.

On my first visit to the uMzinyathi District, time was spent in the rural community and a "meet and greet" activity was held with the principals of the two identified schools. We were all enthusiastic about the project and the principals started recruiting possible members for the Action Learning Group (ALG).

5.3 ESTABLISHING THE ACTION LEARNING GROUP

Wood (2020) describes an action learning group as a small group of people who work collaboratively to address a problem of mutual interest (Scott, 2022). This core project group act as co-researchers to plan, evaluate and reflect on their own actions as well as on the way forward in the research. This is done to foster individual and professional development (Wood, 2020).

The first meeting with each of the two schools was held separately. The gatekeeper discussed the project with the principals to identify volunteer teachers to act as co-researchers and form the ALG (cf. 4.10.5), with me. The discussions were merely to give them more information on the project. Spending time in the district gave me the opportunity to experience the authentic challenges teachers in rural areas are facing (cf. 3.7). Even though the principal at GP was enthusiastic about the project, his FP Departmental Head (HOD) was not in favour of the project and the staff were thus not included in the study. In the rural area with its close-knit community, a teacher from a nearby independent school heard from GP teachers about the proposed project and asked her deputy principal to contact the gatekeeper for an appointment, and thus became part of the project.

Cycle 1 commenced with two FP teachers from KP school and four FP teachers from CP school. Both schools are situated in the deep rural area of the uMzinyathi District. The ALG consisted of the co-researchers and me as the research facilitator. These teachers were selected because of their specific knowledge of this topic; therefore, their responses may be viewed as reliable and relevant (Eloff & Kriel, 2003). The ALG was a conglomerate of cultures, along with experience and knowledge. The teachers were from different ethnic groups, spoke different languages, and ranged from young newly appointed teachers to senior teachers. The teachers also received their teaching qualifications in different countries and at a variety of tertiary institutions. For the purpose of this study and for confidentiality, the teachers will be referred to as T1-T7.

The gatekeeper planned the first meeting with the above-mentioned six teachers and me as the research facilitator, and the ALG was formed. The ethical working agreement was discussed by the ALG before the necessary ethics consent forms were completed.

Data generation methods in Cycle 1 included minutes from the ALG meetings, as well as reflective journals and will be discussed.

The first ALG meeting was very informal and included an arts-based activity (Latz & Mulvihil, 2017) in which we explored our respective skills, values and knowledge on the research topic at hand and addressed the following questions:

- Who are we?
- Why do we want to take part in the research project?

- What do we want to learn from this project?
- What do we want to achieve in this project?
- What do we each bring to this project?
- What role would each like to take on?

The art-based project was done to reflect on the above questions but also to decorate our **reflective journals** (cf. 4.10.3). We discussed how the reflective journals would be utilised and which method of communication would be used to share information. Figure 5.2 illustrates the artwork the co-researchers made on their reflective journals while discussing the above-mentioned questions.

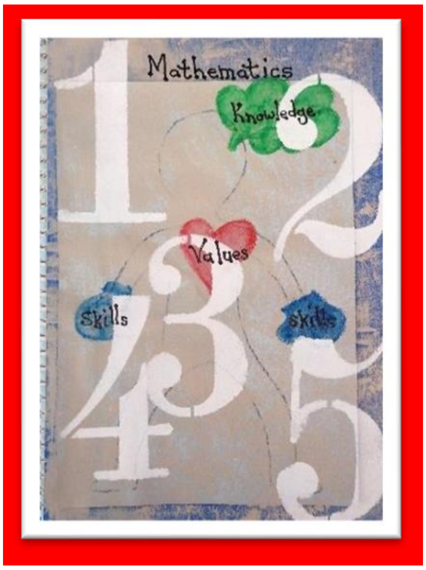

Figure 5.2: **Reflective journal**

While working together on our art-based project, the co-researchers had the opportunity to get to know one another and build a relationship (Wood, 2020). The meeting was mainly to plan the research and determine how to work together. The co-researchers informally discussed relevant education issues and challenges they experienced daily in rural areas, schools and classrooms (cf. 3.7). We then proceeded to more mathematical related challenges which the teachers are currently experiencing. It also became apparent that some of these challenges are universal and national challenges (cf. 2.3; cf. 2.4). I mentioned to the co-researchers that some of the challenges that were discussed are the same challenges that we are faced with at schools in the city. I also used this opportunity to guide the co-researchers in the process of analysing data. We used a simple coding method to identify themes. Through a process of evaluation and reflection, we collaboratively made decisions on the way forward. At the end of this meeting, our roles in the ALG were naturally defined as they developed through our discussion.

Ultimately, we could establish the aim of the research, which was to develop a short learning programme (SLP) to improve FP mathematics teaching to learners who experience barriers to learning. From the onset of the research, the co-researchers decided that the new knowledge that they were going to gain from this project should be shared with the greater educational community in the district. The challenges that the co-researchers are experiencing are not restricted to this area but are national and universally aligned. This made the co-researchers feel less isolated. As the relationship sessions continued, we addressed the first secondary research questions:

- What challenges and barriers do FP mathematics teachers in rural school's experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?

These questions were also sent to co-researchers as homework so data could be generated, evaluated and reflected upon. The co-researchers returned to their schools, reflected on the question and discussed it with their colleagues as secondary participants. After discussing the challenges, the co-researchers were made aware of the challenges that they were facing. Working in this difficult environment and dealing with the challenges on a daily basis, had discouraged them over time and prevented them from recognising the challenges. One of the schools decided to have this as a regular point on the agenda of their planning meetings. This was not just done to generate data but also to give the teachers that acted as secondary participants the opportunity to debrief their frustrations and to realise that we all struggle with the same problems in the same situations.

The themes generated from these meetings contributed rich and authentic data. It gave us an insight into the current situation in the teaching of mathematics in the FP in this specific area. This data was then the first inscription in co-researchers' reflective journals and thus present the first round of data generated. Visual and written data was used by the co-researchers to document their findings in their reflective journals but also as voice notes, videos and photos. The outcomes or answers to these two questions formed the framework of the next ALG meeting.

The next face-to-face ALG meeting started with a relationship-building activity. Because the co-researchers knew one another better by this time, the activity was intended to motivate each member. The co-researchers had to write something about one another and stick the note on the back of the relevant person. It was a revelation for me to see how the co-researchers could identify a characteristic in one another that was positive and motivating to them.

The discussion was audio-recorded and transcribed verbatim afterwards. The findings of the research regarding the two research questions posed to the co-researchers, were investigated and the data from their mental notes, reflective journals, photos and interview notes were then used to reflect on and analyse. Specific themes emerged from the data.

5.4 DATA ANALYSIS

Data analysis is a process of taking large quantities of data and breaking them down into smaller parts. Coding is when the data is categorised or classified into themes. The data thus became more manageable (Turner, 2019).

In the relationship building activity that we did in the first ALG meeting, I assisted the co-researchers in identifying themes from the data that we generated ourselves to identify our roles in the ALG. We used thematic analysis (Turner, 2019) and coded the data. This activity prepared the co-researchers for the larger amount of data that we had to code and analyse later in the research.

For this research, we used a nominal group analysis technique, where we discussed the data on a practical level (Wood, 2020). The participants had the opportunity to discuss their findings and illustrate their points by showing short interviews and videos, drawings and pictures from their reflective journals. The co-researchers had to listen to the different points of view of the others, reflect on their findings and then identify the most important themes through a discussion process, in order to answer the research question.

We had to work through a large quantity of data that was gathered from the co-researchers and the secondary participants in the schools, but the collaborative approach of PALAR (cf. 4.8.1) made this a less daunting task. By sitting together, we could apply dialectic epistemology (cf. 4.7.1) and discuss the different points of view of the co-researchers as well as the data each co-researcher generated. Thematic data analysis was applied. As we collaboratively worked through the data, specific themes emerged. After reflecting on the data and discussing it in the ALG, specific themes also emanated from the data. The themes are illustrated in Table 5.1 and will be individually discussed below.

Table 5.1: Themes from the first research question

RESEARCH QUESTION	THEMES
What are the challenges Foundation Phase teachers in rural school's experience when instructing mathematics?	1. Poverty 2. Overcrowded classes 3. Language of learning and teaching 4. Lack of parental involvement 5. Lack of support structures 6. Lack of resources 7. Curriculum challenges 8. Lack of knowledge regarding learners who experience barriers to learning

5.5 FINDINGS FROM THE FIRST RESEARCH QUESTION

These findings will now be individually discussed.

5.5.1 Poverty

Upon entering the community of the uMzinyathi district (cf. 3.8; 4.9.1), poverty (cf. 3.7.2) was clearly visible. Schools and school infrastructure were in a bad state. It was also clear from the people and the housing in the area that this was indeed a very poor socio-economic community. This most certainly has an influence on the learner's academic performance (DBE 2014; DoE, 2001; Lomofsky & Lazarus, 2014; Neethling, 2015; Prinsloo, 2011; Swart & Pettipher, 2016). Swart & Pettipher (2016) list a number of contextual factors in rural, poverty-stricken areas, that may contribute to barriers to learning, such as the education system, society, the economy, politics, lack of access to basic services, poverty, underdevelopment of children, HIV and AIDS epidemic, inflexibility of the curriculum, lack of appropriate communication, diverse ethnic and language groups, poor physical facilities, negative attitudes and lack of parental involvement (Neethling, 2015). These contextual factors fall within the bio-ecological system theory of Bronfenbrenner (cf. 3.3).

To contextualise Bronfenbrenner's model (cf. 3.3) for the research, and confirming my observation, T3 mentioned that it is not possible to send homework home because there is no electricity and the learners struggle to do the work by candlelight. T6 asserted that "if we send the books home they don't come back, because the parents use the paper for fire". From the feedback, the one remark that was the most concerning for me, was "How can you teach children that are hungry" (T4).

Poverty (cf. 3.7.2) was one of the key elements that contributed to the learners who experience barriers to learning and was mentioned by all the co-researchers. This extrinsic barrier (cf. 3.4.1) to learning has a big influence on the teaching of mathematics. Co-researcher T2 reiterated that all the teachers as secondary participants with whom she had discussions, were concerned about the state of poverty in their community. According to T1, the teachers are trying to address this from their own pockets. Even though the school has a feeding scheme for the learners during the term, the teachers are sending non-perishable food home for the school holidays. The poverty in the community also contributes to overcrowded classes in the schools.

5.5.2 Overcrowded classes

It became evident from our ALG meeting that overcrowded classes are a great problem. T1 disclosed that at one time she had 94 learners in her Gr1 class. She (T1) further mentioned that it is impossible to attend to the specific needs of all the learners if you have that many learners in your class. T2 reported that teachers are feeling overwhelmed by the number of learners in the class. She reiterated that "It is impossible to teach in our small classes with over 50 learners in one class". T3 added that "the classes are so small and we do not have enough desks for all 50 learners, some learners are working on their laps".

Although co-researchers can identify this problem, they are not always in a position to rectify it. The teachers as secondary participants can be assisted to handle large classes, but this support should come from the department (DOE, 2014). In-service training for these teachers will be vvaluable (Neethling, 2015). With the current budget cuts in education, as well as a limited number of staff, the support from the District Base Support Team (DBST) seems to be ideal, but difficult to execute (Hay, 2018).

5.5.3 Language of learning and teaching

The teachers need to be aware of the different teaching methods and strategies (cf. 3.5.1) that can be applied in the classroom. Teachers must be able to apply a variety of teaching theories (cf. 2.11) according to the learners' specific needs, especially in this situation where the learners are not familiar with the language of instruction. South Africa is a country with 11 official languages and sign language (cf. 3.7.4) (Makoelle, 2011). It was noted that the learners in the study were all educated in English, whereas their home language is predominantly isiZulu. Amongst the co-researchers, five different languages are spoken as a mother tongue and all are multilingual, but no co-researcher speaks English as a mother tongue. From the feedback it emerged that neither the secondary participants nor the teachers in the community are fluent in English. This was noted as a contributing factor to the barriers to learning which learners experience. It was put forward by T6 that "the learners enter the FP with no knowledge of English", and it was affirmed by T7 that the teachers must teach the learners the learning content as well as a new language, and then cover the curriculum. T6 observed that "this is almost impossible".

The above correlates with the findings by Jojo (2019), Molteno (2017) and Neethling (2015) that learners might experience barriers to learning when they are taught in an unfamiliar language (cf. 3.7.4). Learners who enter the school from an English school are often not able to understand and speak English properly because their teacher at the previous school was not proficient in English. Molteno (2017) reiterates that teacher training institutions in South Africa do not equip non-English speaking students with the correct tools to enter the practice. This theme was discussed and some participants suggested that we should address this through the SLP that we intend to develop. One of the co-researchers mentioned that the FP teachers at her school were mostly isiZulu-speaking and struggle to comprehend written English, which may result in the wrong transmission of content. The teachers struggle to speak English and when they do speak English, it is with an almost incomprehensible pronunciation (Nel & Muller, 2010). T2 mentioned that they have to translate the meetings for some of the teachers, or the meetings need to be conducted in isiZulu. T7 affirms that this is a real problem, considering that the learners actually need to be taught in English. Language barriers (cf. 2.9.1; 3.4; 3.7.4) thus emerged early in the research as a prominent aspect that had to be addressed through the research.

English is only spoken at school and many of the parents are also not able to speak English. There is thus no parental support at home for learners' linguistic challenges (T5). According to Sterne (2021), only 8% of learners in South Africa speak English as their mother tongue.

5.5.4 Lack of parental involvement

T3 remarked that "parents are nowhere, we feed them, we clothe them, we teach them manners". This profound statement describes the role of the teacher in the community (cf. 3.7.1). It also indicates the problem of discipline, which became one of the themes of the research.

Some parents are not staying in the community and the learners are in the care of grandparents, or are in child-headed households. Yet, parental involvement (cf. 3.7.5) in learner education is of vital importance (McKenzie et al., 2018). T1 made the following suggestion:

> *We have to think of innovative ideas to get the parents at the school for example to make the learners perform on stage so that the parents can come and look at their kids and then have a Parents' Day where we can consult with the parents.*

After discussing and reflecting on the matter of parental involvement, we came to the conclusion that this is a national phenomenon and that ways need to be developed to get parents more involved in their children’s education. The problem is aggravated by the fact that parents in most cases are illiterate and thus cannot support learners with homework either.

5.5.5 Lack of support structures

Participants agreed that there is very limited support from parents, but they found the lack of support from the education department even more frustrating (cf. 2.9; 3.7.6). They all agreed that the teachers are in urgent need of support, especially for handling learners who experience barriers to learning. This confirms findings in literature that support to teachers in rural areas is limited (Hay, 2012; Hay, 2018; Payne-van Staden, 2021). In the uMzinyathi district, there is very little support from the department because of the distance from the district office (P4). In rural areas teachers also have fewer opportunities to attend professional development to improve their skills and expand their knowledge (Du Plessis & Mestry, 2019). It was emphasised by T5 that the teachers are currently trying to support one another, but she describes these efforts as “the blind leading the blind”. The co-researchers were all in agreement that they receive no support whatsoever from the department (T4, T5, T6). T3 described their situation as that “it feels as if we are sitting on an island all alone and need to help ourselves or fail at the job”.

Bosman (2022) confirmed that support services in rural areas are limited and teachers are reliant on themselves and peer support for information (Hay, 2012; Hay, 2018; Payne-van Staden, 2021). A collaborative decision was made that this should be one of the areas where the ALG would try to make a difference.

5.5.6 Lack of resources

In light of the current economic state of South Africa, the provision of resources to schools by the department is a challenge (c.f. 2.10; 3.7.3). The teacher’s great concern was that they do not have the appropriate resources to teach mathematics to the learners. The quintile 1 rural school struggles financially to supply Learning and Teaching Support Material (LTSM) to the teachers. The independent school, on the other hand, is well-resourced. Quality education cannot take place if the learners do not have the correct LTSM.

T2 noted that “the departmental textbooks are not enough for all the learners and different prints have different page numbers that are very confusing for the learners”. Even though the department provides the schools with some LTSM, the teachers are not trained in using them in class, and in the multiple uses of some of the resources. Even the teachers at CP school were not aware of the multiple uses of the available LTSM, as pointed out by T7.

The co-researchers emphasised that the teachers not only need training in the use of resources in mathematics but also need to be able to make their resources. What was concerning for me, is that the teachers are not optimally using the available resources. According to T5, the schools all have blocks [Unifix], but the teachers only use them as counters and are not aware that they can be used in all the content areas as well as in other subjects.

From the feedback from the ALG, it became clear that teachers are trying their best to cope with the limited resources that are available (cf. 3.6), but “it is just such a daunting task when you are working in overcrowded classes, without the appropriate LTSM” (T3).

Gous et al*.* (2014), Krishnaratne et al*.* (2013), Neethling (2015), Quane and Glanz (2011), Sayed and Ahmed (2015), as well as Wildeman and Nomdo (2007), emphasise that quality education cannot take place amidst a lack of resources, but in this case the teachers are not able to optimally use the resources that are available. Adler (2016) points out that teachers must know how to use the available resource material and be able to think innovatively and use natural materials that are readily available. Hlalele (2014), like Adler (2016), suggests that the teaching of mathematics may improve if teachers utilise recycled and natural resources in their mathematics classes.

We decided to start an LTSM photo bank which should later form part of the SLP that we w develop. The photo bank would consist of photos of LTSM for mathematics, made from natural and recycled material. The co-researchers would take photos of appropriate LTSM in the FP classes at their schools and forward them to me, as I acted as the nodal point for the project. This idea came from one of the secondary participants and was then presented to the ALG by T7.

5.5.7 Curriculum challenges

Numerous general curriculum challenges were identified and discussed, of which a few will be mentioned below.

Curriculum coverage (cf. 3.4) seems to be a major problem, and along with it also assessment. Xhalisa (2011:12) describes this phenomenon as a “disjuncture between policy and practice” and focuses attention on the extent of the discrepancy between the two. This discrepancy between the policy and the practice was pointed out by the co-researchers as one of the primary problems the teachers experience:

> *Teaching mass classes and then expecting the learners to be disciplined and sit down while you are assisting one learner or translating for some of the learners takes so much time that it is not possible to get through the curriculum content in the prescribed time (T2).*

This is in line with Neethling's (2015) argument that the inflexibility of the curriculum (cf. 2.8; 3.4) limits the functional independence of mathematics teachers (also see Ramatlapana & Makonye, 2012). Furthermore, the pressure on the teachers to do content coverage does not allow time for an adequate adaptation of the curriculum to accommodate learners who are experiencing barriers to learning (Adewumi et al*.*, 2017, Laurillard, 2013; Neethling, 2015). Laurillard (2013) further notes that no curriculum is suitable for all learners, as all curricula need to be adaptable to the learners' specific needs.

Departmental schools seem to experience most problems with curriculum coverage. The independent school (CP) apparently has less of a problem with this because the smaller numbers of learners make it easier to cover the total content of the curriculum. At CP school the problem was more focused on the inflexibility of the curriculum to address barriers towards learning that the learners experience.

5.5.8 Lack of knowledge regarding learners who experience barriers to learning

The majority of the co-researchers had very limited knowledge regarding learners who experience barriers to learning and how to handle these learners in the class. The co-researchers were very open about this from the onset. They ascribed this to the lack of support from the district (cf. 2.9) and to the fact that inclusion was not properly addressed in their initial training as teachers (cf. 2.9; 3.7.6). Significantly, all the co-researchers had this experience although not all of them received their training in South Africa:

> *… we see these learners underperforming and are trying to address it, but we do not know why or what the reason for this is (T5).*
>
> *I would like to know why the learner is unable to do the work … If you know the cause of the problem you can address it ... (T6).*
>
> *We were trained in addressing barriers to learning in our studies but it was a very short module and not sufficient to address the problems the learners are having. The module primarily focused on what inclusion is. I only heard about the SIAS from you (T4).*
>
> *But still, we do not know how to help these kids (T5).*

Kempen and Steyn (2016) confirm the co-researcher's findings. Lessing and Dreyer (2007) further stressed that the teachers' limited training on strategies to support learners who experience barriers to learning, contributes to the barriers towards learning. Du Plessis & Mestry (2019), Jojo (2019) and Lessing and De Witt (2011) all found that if teachers did not receive adequate training in identifying and addressing barriers to learning in their classes, it may lead to creating even bigger barriers to learning. The Education White Paper 6 (EWP6) (DBE, 2001) stipulates that learners who experience barriers to learning, must attend schools in their community in spite of the barriers the learners are experiencing (Joubert, 2012). In EWP6 (DBE, 2001) the Department of Basic Education (DBE) undertakes to support the learners; but it is equally important to support the teacher to support the learner (DBE, 2014; DBE, 2017). In rural areas, this support is very limited (cf. 2.9; 3.7.6).

In view of the above the co-researchers decided to specifically address this problem by improving their teaching of mathematics to learners who experience barriers to learning. The co-researchers decided that the SLP would be written in a way that addresses the specific needs of the teachers to deal with barriers to learning in their classes.

In the ALG meeting, it was decided that we need to investigate what some teachers are doing address this specific problem. This led to the second research question on which the co-researchers' generated data:

- How are educators currently dealing with learners with mathematical barriers in rural schools?

5.6 FINDINGS FROM THE SECOND RESEARCH QUESTION

Data was generated by the co-researchers with the help of the secondary participants at their schools. The data was then evaluated and reflected upon in their reflective journals. At the next face-to-face ALG meeting, the data was discussed and collaboratively analysed. The themes in Table 5.2 below were identified. The co-researchers were astonished at what the secondary participants at their schools were doing. It was mentioned in the meeting that although some teachers were trying their utmost best, there were also teachers move simply had no time to spend on learners who were experiencing barriers to learning. Through the reflections and discussions, the themes in Table 5.2 were identified.

Table 5.2: Findings from the second research question

Research question	Themes
How are educators currently dealing with learners with barriers in mathematics in rural schools?	1. Alternative activities 2. Adaptation of the activities 3. Code-switching 4. Curriculum differentiation

5.6.1 Alternative activities

We had a large amount of data on this specific theme. The co-researchers also did some observations in the classes of their secondary participants. Even though the teachers mentioned that the learners were doing alternative activities, these were considered as time-wasting activities, in correlation with Langhan et al*.* (2012). The co-researchers wanted to observe what the secondary participants were doing in practice with the learners in their classes. This was possible because the teachers were busy with Quality Management System (QMS) class visits at the time. This gave them the opportunity to observe the participants in practice and how they dealt with learners who experienced barriers to learning in mathematics.

According to T1, the teachers handed out magazines to the learners to page through when she was teaching the rest of the class. In some cases, teachers would put the learners on the carpet with blocks, but with no activity to do with the blocks (T3). It was also mentioned that learners who experience barriers to learning were getting worksheets to colour in (T7). Some learners were actually sent out of the class to go and play outside while the rest of the class was doing mathematics, so that they would not disturb the other learners. These findings confirm the findings of other authors (Aydin & Ok, 2022; Langhan et al*.* 2012; Ramos, 2021), that teachers' practice in respect of learners who experience barriers to learning are time-wasting activities.

We came to the conclusion that even though teachers give alternative activities to the learners, these opportunities are not optimally used to enhance the mathematical skills of learners who experience barriers to learning.

5.6.2 Adaptation of the activities

The data reflect that some of the teachers are trying their best to address the barriers learners are experiencing in mathematics, with the limited knowledge and experience they have. The worksheets given to these learners were adapted, with less work and to a lower number range (T7). The teacher will also omit some of the work that they feel the learners are unable to comprehend. However, this leads to limited content coverage. One of the co-researchers (T3) mentioned that some teachers are teaching the same adapted content to learners in different grades. The teachers also have very low expectations of learners who experience barriers to learning. This data concurs with the findings of the research done by other authors (Aydin & Ok, 2022; Langhan et al*.* 2012; Ramos, 2021).

The data also reflected very positive suggestions. One teacher who was interviewed and observed by T7, was using the Straddling technique (cf.3.5.2.2) to support a learner in her class. She was still doing Grade 1 work with the learner who was in Grade 2 at the time. Another teacher let the whole class work on a more concrete level (cf. 2.11.3) to support the learners who experience barriers in mathematics (T1). She has a large number of learners with different intrinsic (cf. 3.4.2) as well as learners with extrinsic (cf. 3.4.1) barriers to learning, in her class.

From the data of T3, it was clear that the teachers at the KP school with limited resources find it even more difficult to adapt activities. They mainly use the department books but one teacher (T2) takes the learners outside the class for some mathematics lessons. She then let them use movement as well as natural resources to play out the mathematics before working in the books.

The data reflect that the teachers need in-service training on how to address learners who experience barriers to learning in mathematics. To be able to teach mathematics effectively in the FP the teachers must be able to apply an array of teaching styles and methods (cf. 2.11.3) and be able to accommodate all learners including learners who experience barriers to learning (Naude & Meier, 2014).

5.6.3 Code-switching

The data of the co-researchers as well as the data of the video and voice recordings showed that it is not uncommon for the teachers to use code-switching (cf. 3.5.2.1) in their teaching to support the learners that are struggling. Most of the teachers in this study are fluent in isiZulu, and the learners are entering the school with limited or no knowledge of English. The language spoken in the community is isiZulu. Except for myself, all the members of the ALG were fluent in isiZulu.

The teachers will switch between English and isiZulu as they teach. Some learners will pick the language up more quickly than others. The teacher will continue to address the learners that are struggling in isiZulu, even though the language of learning and teaching is English (T5). The learners are allowed to address the teacher in isiZulu if they struggle to speak English. When it comes to the explanation of new terminology, the teacher will also revert to isiZulu and then continue in English (T7). Some of the teachers are not able to speak English and their understanding of the language is very limited. The curriculum is in English, and it is therefore a problem for those teachers to understand exactly what is expected of them and thus the curriculum may be misinterpreted (T2).

Kaschula (2019) and Mudau (2019) described code-switching as a process. One of the co-researchers (T1) described the same process, where the teacher will initially start in the first term by mainly speaking isiZulu and as the year progresses, she will speak more English, until by the end of the year – when the learners are more confident in speaking English – the lesson is mainly in English.

Code-switching as a technique to address barriers to learning is also recommended by Mudau (2019), as it can encourage learners to participate in the class (Tejano, 2021). The data is thus in correspondence with the findings by Kashchula (2019) as well as King and Chatty (2014), who recommend code-switching as a suitable method of curriculum differentiation.

5.6.4 Curriculum differentiation

Almost all the teachers that were interviewed by the co-researchers mentioned that they were doing *differentiation of the curriculum* (cf. 2.11; 3.5.2) in mathematics. On further investigation, the teachers were unsure of what exactly they were doing to differentiate (T1). Teachers often have limited knowledge on how to do curriculum differentiation (Donohue & Bornman, 2014; Kempen & Steyn, 2016). The co-researchers themselves were not exactly sure about what was expected of them by the department when they had to do differentiation of the curriculum. T3 mentioned that “we can’t do the mathematics in the curriculum with the children [learners]”. She explained that the learners do not understand the work and cannot do the work, which begs the question, “What does the department expect from us to do with the kids?”

On interviewing an HOD on how differentiation is done in the class, she literally just pulled up her shoulders. Her answer was that “we are trying our best, they just can’t do the work, that we just leave them to fail” (T4). T6 explained, “I spend hours after school with him, but nothing seems to sink in – tomorrow there is nothing.”

We, as the ALG, concluded that even though the teachers may know the term *differentiation*, they are not able to do curriculum differentiation in their classes. Amaro (2022) also confirmed that this may be one of the most challenging tasks for a teacher when dealing with learners who experience barriers to learning. Poor differentiation may widen the gap and worsen the barriers the learners already experience (Anikumar, 2022).

T1 pointed out that the Head of Department at their school mentioned in her interview that she is aware of the teachers differentiating the curriculum, but her concern was that when the learner moves to another teacher or grade, there is no continuity. Because the schools do not apply the SIAS (DBE, 2014) process (cf. 2.9; 3.4; 3.6; 3.7), no record is kept of the specific adaptations made for a specific learner. This is often seen in rural areas where the teachers do not have the necessary support from the Department (Kempen & Steyn, 2016).

It is evident from the data and the transcripts of the ALG meetings that the co-researchers are in dire need of support to assist learners who experience barriers to learning. The co-researchers were speaking from their hearts and did a lot of self-reflection on this aspect.

5.7 SUMMARY OF DISCUSSIONS OF SECONDARY RESEARCH QUESTIONS 1 AND 2

The first research question posed to the co-researchers for investigation was formulated as follows:

- What challenges and barriers do FP mathematics teachers in rural school's experience?

The primary themes that emanated from the data and reflection upon the data in the ALG, were identified as poverty, overcrowded classes, the language of learning and teaching, lack of parental involvement, a lack of support structures and curriculum challenges. Findings that were reported in literature were confirmed by what the teachers actually experienced in the classes (DBE 2014; DoE, 2001; Lomofsky & Lazarus, 2014; Neethling, 2015, Prinsloo, 2011; Swart & Pettipher, 2016). The data reflect that the teachers are working under very difficult circumstances that may lead to learners experiencing barriers to learning (Kempen & Steyn, 2016). Some of the challenges and barriers the teachers are experiencing are beyond our ability to address. However, early in the study we already identified areas that we as an ALG would like to address. The teachers are trying their best, but without the correct support, it is a mammoth task. We decided that further investigation is needed, and this led us to the second research question:

- How are educators currently dealing with learners with mathematical barriers in rural schools?

With the second round of data generation, evaluation and reflection, the data indicated that even though some of the teachers are trying to help learners who experience barriers to learning, they do not have the knowledge for dealing with these learners and are in dire need of support. We generated some information on what is actually working in the class, but this topic needed further investigation and thus led to the follow-up data generation for the third research question:

What strategies can we develop to improve Foundation Phase teachers' teaching of mathematics to minimise these challenges?

What we have learned in Cycle 1 will guide the next cycle of strategies (Wood, 2020). The data generated with regard to the third research question formed the foundation of the next cycle in the research.

5.8 FEEDBACK TO THE CO-RESEARCHERS

The co-researchers, as part of the ALG, collaboratively worked on the reflection and the thematic analysis of the data. The findings of this cycle were owned by all the co-researchers, and therefore no specific feedback was given to the co-researchers. Appreciation was, however, expressed in various ways for their input and well-resourced and reflected data.

5.9 LIMITATION OF THIS CHAPTER

The first setback was when one of the schools decided not to participate in the project. The principal and some of the staff were very eager to participate, but the HOD was adamant about the withdrawal of her staff.

The distance between myself and the co-researchers could have hampered the relationship because we would have liked to have more face-to-face meetings. To overcome this barrier, we were in constant communication via WhatsApp and e-mail.

Using a reflective journal takes time, and this was discussed with the co-researchers at the first ALG meeting. With new technology being so readily available, the co-researchers relied more on WhatsApp, voice notes and short videos to capture data. It took some motivation from my side to get them to reflect on the data in their reflective journals before the ALG meeting.

5.10 CONTRIBUTION OF THIS CHAPTER

The co-researchers formed a close-knit team through relationship building. They trusted one another and respected one another’s opinions. The fact that we had such a diverse group with different opinions and expertise created a strong bond among the ALG members. The co-researchers were enthusiastic to be part of this project. Very early in Cycle 1 the co-researchers already incorporated some of their colleagues as secondary participants. The secondary participants made a huge contribution by making the data that was generated, rich and authentic. Feedback from the co-researchers indicated that the secondary participants were as excited to be part of the project as they themselves. It was also one of the secondary participants who requested support in LTSM, and from there the idea evolved of compiling of an LTSM bank with photos from recycled and natural materials. The secondary participants wanted to improve their teaching of mathematics as well as the skills of the teachers in their community. That was one of the reasons the co-researchers decided to take the SLP to the community schools.

With the first round of data generated, we could identify specific problems in the community. The second round was two-folded, as we could identify what strategies were being used to assist learners who experience barriers to learning as well as which of these strategies were indeed effective. This topic needed further investigation in the next cycle.

5.11 CONCLUSION

The focal point of this cycle was first to negotiate entrance into the community. Secondly, the focus was primarily on building a relationship between myself and the co-researchers. We determined how we, as the ALG, were going to work together and how we were going to plan the research. The first cycle was to establish a relationship between the co-researchers. Secondly, data was generated on the first two research sub-questions.

The first research question that was posed to the co-researchers for investigation was:

- What challenges and barriers do FP mathematics teachers in rural school's experience?

The themes that emerged from this data was poverty, overcrowded classes, the language of learning and teaching, lack of parental involvement, lack of support structures lack of resources curriculum challenges and lack of knowledge regarding learners who experience barriers to learning. Two of the themes in the data already stand out as problems that we would consider addressing in the short learning programme that we intend to develop. We also realise that further investigation needs to be done to establish *how educators are currently dealing with learners with mathematical barriers to learning in rural schools*.

The data from this second research sub-question reflect the following: *Alternative activities* are given to the learners, but they seem to be time wasting activities. *Adaptations are made to the activities,* but the teachers are uncertain what to do. *Curriculum differentiation* may be a buzz word but the teachers, including the members of the ALG, do not know what is expected of them. *Code-switching* is happening on a daily basis in classes, with reasonable success. From the data, it became evident that the teachers have limited knowledge of how to support learners who experience barriers to learning in mathematics.

The data on the above questions were collaboratively evaluated a reflected upon, and then ultimately guided the research to determine what strategies to follow in the next cycle. In chapter 6, the second and third cycles of the research will be discussed.

CHAPTER 6

DISCUSSION AND REFLECTION ON CYCLES 2 AND 3 TO DISSEMINATE THE TEACHER'S MANUAL FOR THE WIDER TEACHER COMMUNITY IN THE UMZINYATHI DISTRICT

6.1 INTRODUCTION

Chapter 5 offered a discussion of the data generated in Cycle 1. The primary focus of Cycle 1 was to negotiate entrance into the rural community of the uMzinyathi district (cf. 3.8). The action learning group (ALG) (cf. 4.10.1) and relationships were established between the members, which were of critical importance in a participatory action research design. Collaboratively we established our roles in the ALG and discussed the research process including the planning, actions, reflections and interventions. Data was generated on the first two research sub-questions focusing on challenges the teachers are currently experiencing in mathematics and what the teachers are doing to address learners with barriers to learning in their classes.

This chapter will report on data generation and analyse the data from the third and fourth research sub-questions, addressed in Cycles 2 and 3 of the research project. Figure 6.1 illustrates the schematic analysis of Cycle 2 and will be discussed below.

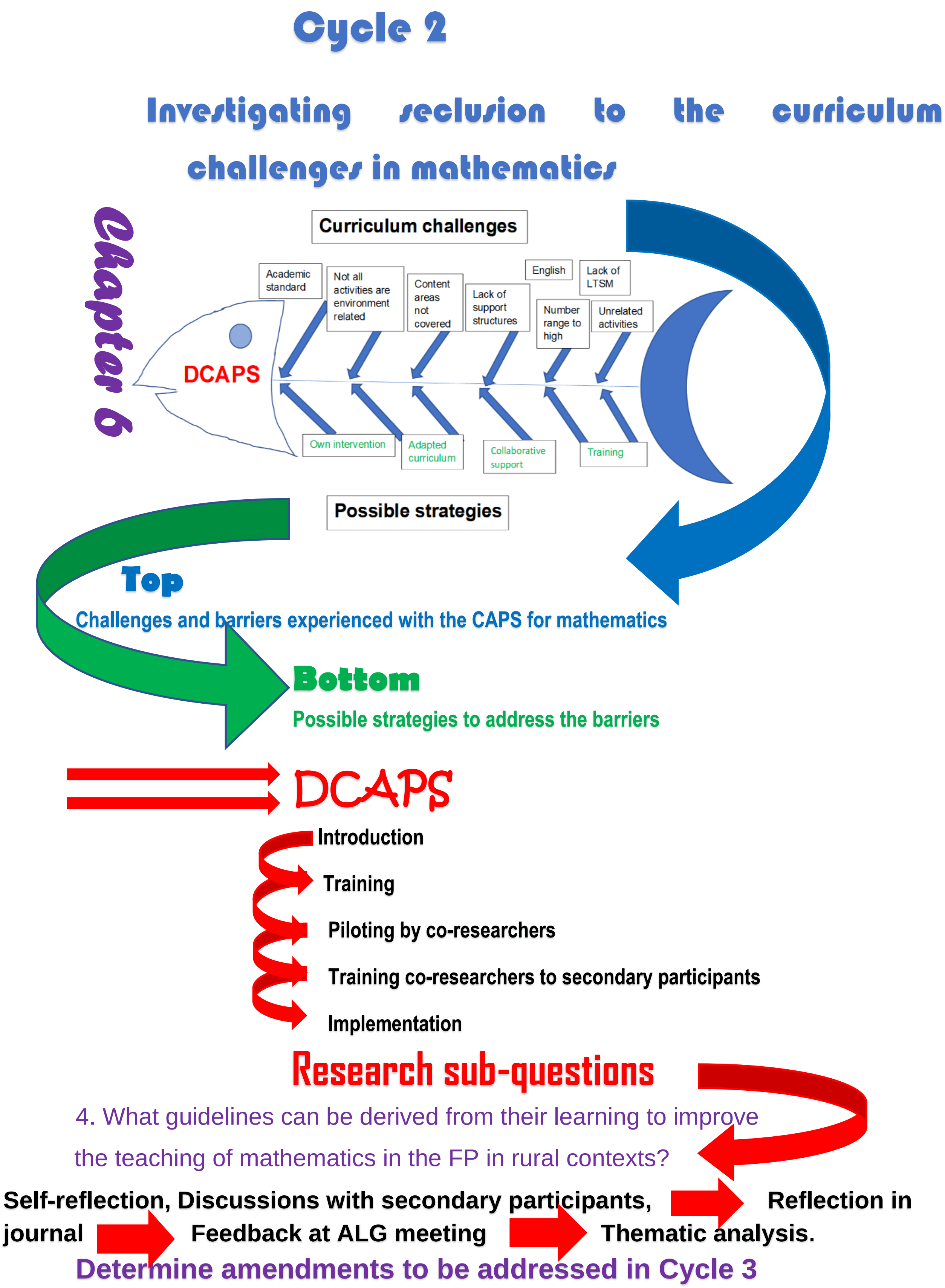

Figure 6.1: **Schematic analysis of Cycle 2**

6.2 CYCLE 2

The aim of Cycle 2, happening in several ALG meetings, was to develop strategies for improving the teaching of mathematics to learners who experience barriers to learning and implement these strategies to minimise the challenges Foundation Phase (FP) teachers are currently dealing with in their classes. Findings of the first research question in Cycle 1 indicated the following as problem areas: poverty, overcrowded classes, the language of learning and teaching, lack of parental involvement, lack of support structures, lack of resources, curriculum challenges and lack of knowledge regarding learners who experience barriers to learning, as the primary problems the teachers are currently dealing with.

Most of the ALG meetings were face-to-face although a few were done virtually because of the distance between me and the rest of the co-researchers. Each meeting commences with a relationship-building session to negotiate needs and reflect on the data collected. The primary focus of this cycle was to transform or disturb (Mezirow, 2011) the participants' way of approaching the teaching of mathematics. The focus in this cycle was to implement strategies to improve mathematics teaching to learners who experience barriers to learning.

To enable the co-researchers to find a strategy to implement that will improve the teaching of mathematics, we had to revisit the findings as stated in Cycle 1 (cf. 5.6). As co-researchers, we also had to revisit our notes in our reflective journals (cf. 4.10.3) to recollect which of these themes identified in cycle 1 were the greatest need to address. Collaboratively, we decided on *curriculum challenges* as the ideal problem area to address in this research, because, by addressing one of the problems identified teachers experience in teaching mathematics, we can address the research problem.

We realised in Cycle 1 already that there was a gap in knowledge on curriculum challenges. To address the gap in our research additional data needed to be collected on the specific challenges and barriers the teachers are experiencing with implementing the curriculum and assessment policy statement (CAPS) (DBE, 2011a) mathematics curriculum. We collaboratively generated, analysed and reflected on the data on the challenges the teachers experienced with the implementation of the CAPS (2011a) in the ALG meeting. When we identified the challenges, we had to look for ways to address these challenges. Thus, from the previous research sub-questions aroused the third research sub-question:

What strategies can we develop to improve Foundation Phase teachers' teaching of mathematics to minimise these challenges?

The co-researchers returned to their schools and had discussions with the secondary participants to generate data on the mentioned questions. Short videos and notes were made. After evaluating the data, we used our reflective journals to document our personal reflections to present them at the next ALG meeting. All the findings from the first three research sub-questions as well as the additional question were presented and reflected on at the meeting on a fishbone diagram (cf. 4.10.4). The following findings were generated at the ALG meeting and helped us to establish the way forward in the research.

The Ishikawa diagram or better known as the fishbone diagram (Figure 6.2) was developed by Kaoru Ishikawa in the 1960s (Wong, 2011) (cf. 4.10.4). The idea was that it be used to establish causes and effects (Arp, 2020; Ciocoiu, 2010; Shinde et al., 2018). For this research, it was adapted to amalgamate all the data generated from the first three research questions addressed in chapters 5 and 6. The curriculum challenges and barriers the teachers are experiencing when teaching mathematics in the FP were reflected upon and analysed by the co-researchers to establish the primary problems. These were put on one side of the fishbone diagram. On the other side were possible strategies to address the problem under investigation. Collaboratively, a decision was made to Implement the Differentiated Curriculum and Assessment Policy Statement (DCAPS) (DBE, 2018).

6.3 FINDINGS FROM THE FIRST THREE RESEARCH QUESTIONS

6.3.1 Themes that emerged as curriculum challenges

Several challenges with the current CAPS (DBE, 2011a) mathematics curriculum were presented at the ALG meeting. The co-researchers decided on the following challenges, in Table 6.1 as the ones that we as a group can address.

Table 6.1: Curriculum challenges

ADDITIONAL RESEARCH QUESTION	THEMES
What challenges and barriers are teachers currently experiencing with the CAPS?	1. Academic standard
	2. Not all activities are contextualised
	3. Content areas are not all covered
	4. Lack of support structures
	5. Number range to high
	6. Lack of knowledge on addressing barriers to learning
	7. English as the language of learning and teaching
	8. Lack of learning and teaching material

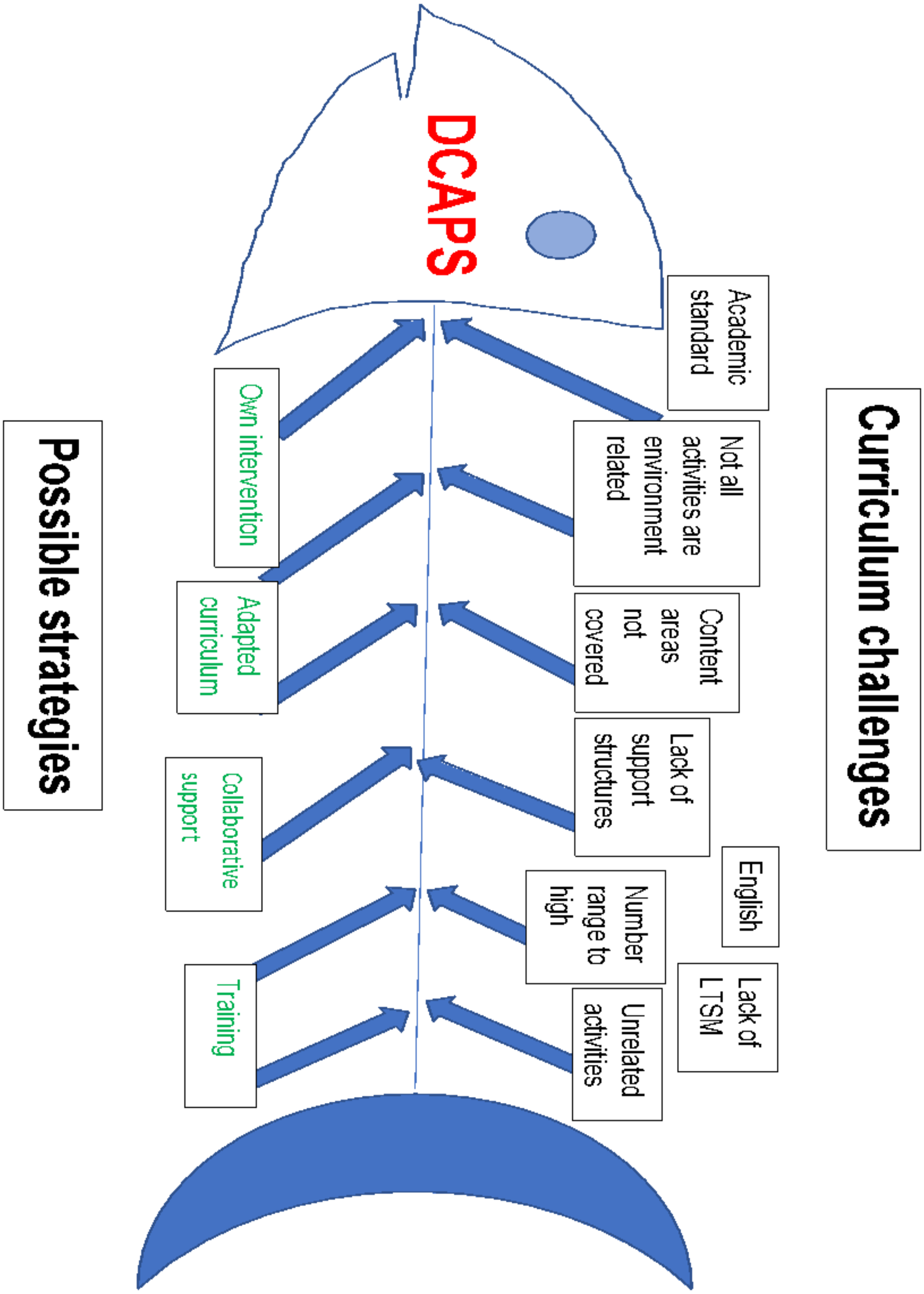

Figure 6.2: Fishbone diagram as amended form

(Arp, 2020; Ciocoiu, 2010; Shinde et al., 2018.)

These themes that arise from the fishbone diagram will be individually discussed.

6.3.1.1 Academic standard

Some of the secondary participants find the current curriculum too difficult for some learners to achieve all the outcomes. Since 1994, South Africa has never had a curriculum to adequately address the specific needs of learners who experience barriers to learning (Donohue & Bornman, 2014; Kempen & Steyn, 2016). The co-researchers reported that, learners who experience barriers to learning are struggling to reach the desired outcomes in the time frame provided.

The learners just can't do all the work." (T5) "I give them extra classes but still the children do not understand" (T6) "A couple of the teachers I had discussions with said exactly the same thing, that they can't get all the work done the department expects from them. This is not possible in one term… (T3).

As indicated by the co-researchers and echoed by Roberts et al*.* (2019) the total academic standard of the curriculum is too high for all learners to reach the required outcomes. This is even more difficult for learners that are experiencing intrinsic barriers like dyscalculia or specific problems with mathematics (cf. 3.4.2) as well as extrinsic barriers to learning for example contextual restraints, lack of resources, poverty and many challenges related to poverty (cf. 3.4.1) This aligns with Reddy et al*.* (2015); Spaull (2019) and Van der Berg et al*.* (2019) stating that some changes need to be made to the curriculum to accommodate all learners. The co-researcher's data correlates with the findings of Xhalisa (2011), that stated that there is a "disjunction between the policies and the practice" (p. 25) within the South African environment.

The teachers are experiencing challenges with the curriculum as a whole and not just with specific content areas. This is emphasised by the co-researchers who observed that "the learners that are struggling, struggles with everything, not just maths or a part of it" (T1), "… just some of my children struggle with maths, but with almost all the mathematics" (T4). Most of the learner's basic mathematics competencies are of a lower standard than that required by the CAPS (DBE, 2011a). The comments of the co-researchers illustrate that this phenomenon is evident in rural areas:

For some of the learners counting to 5 is a challenge, this does not come close to what CAPS expect of me [teachers]" (T2).

"There are parts in the CAPS that my children will never grasp" (T6).

"I can't even start with multiplication if [the learners] still struggle with subtraction and addition" (T4).

"How can you work with numbers up to 100 if [the learners] are having trouble grasping the concept of 10 or 20? (T3).

These findings directly link with the DBE Annual performance plan (DBE, 2020) which states that "… large proportions of South African children reach grade 5 without achieving basic numeracy proficiency." (p. 28). Attending a rural school should not affect the quality of education learners receive (Hlalele, 2014), but in reality, the rural environment in which these learners are raised may contribute to them experiencing barriers to learning (cf.3.7.2) (Lessing & De Witt, 2011; Gilili, 2020).

6.3.1.2 Not all activities are contextualised

The CAPS (DBE, 2011a) is not flexible (cf. 2.8) for adapting the activities to the rural environment (Neethling, 2015). In South Africa and specifically in the uMzinyathi district, attending a preschool before formal schooling is not a given. The co-researchers state that this may "contribute to the learners who experience barriers to learning" (T4) and "we [the FP teachers] find the activities not all appropriate to the living and schooling environment and further it is very difficult to adapt the activities because of overcrowded classes, where we have no space" (T7). T2 added that "The LTSM [Learning and Teaching Support Material] that is available does not allow for the activities set out in the CAPS" (cf. 2.10.1.3) T2 elaborated by saying that:

> *Learners from rural areas come to the classes with limited vocabulary and the CAPS does not allow for learners to have enough time to master a specific concept or activity before I have to move on to the next activity (T2).*

They experience extrinsic (cf. 3.4.1) barriers to learning and the T5 dovetailed when stating that "We have to jump from number concepts to time and then next week back or even later in the term come back to previous concepts, by then the learners totally forgot what you have taught then earlier".

Mkhabela (2016), reiterates that teachers are finding it difficult to address the requirements of the CAPS (DBE, 2011a). She blamed this on the lack of appropriate training, but the data indicated that environmental factors may be the biggest contribution to this. Roberts et al*.* (2019) blame the mass classes, the language of learning and teaching (LoLT) being English as well as the lack of LTSM as contextual factors influencing learning and teaching.

According to T5, it would have been in the learner's interest if some parts of the CAPS (DBE, 2011a) is covered and completed and then move on to the next concept. This contributes to some learning areas not covered in the year. According to Mkhabela (2016:) "the Department of Basic

Education is too busy concentrating on improving basic capacity" that they neglect environmental factors that may influence the implementation of the CAPS (DBE, 2011a).

6.3.1.3 Not all content areas are covered

During the ALS meetings, co-researchers agreed that the secondary participants are not covering all the content areas, as prescribed in the CAPS (DBE, 2011a). "The teachers do not have time to cover all the content, so data handling is usually the one content area that is not addressed during the year" (T7). T2 affirmed that "Most teachers see it as a waste of time". Data handling is important because it encompasses real-world situations and develops critical thinking skills (Naidoo & Mkhabela, 2017). Adu (2022) on the other hand, blames the teachers not doing data handling with their learners, on the lack of qualified teachers to teach data handling especially in rural schools. He is of the opinion that teachers should teach more and not fewer data handling in FP (Adu, 2014), as what is prescribed in CAPS (DBE, 2011a). T7 confirmed that Measurement is one of the areas that will also receive less attention from the teachers because of overcrowded classes and time limitations. Research done by Langhan et al*.* (2012) supported these statements and emphasise that one of the primary challenges that teachers experience is that the time allocation in the CAPS (DBE, 2011a) is inflexible, and the teachers must cover specific content within a specific time frame. To enable teachers to do so, certain content areas are not covered or less attention is given to those areas. Kempen and Steyn's (2016), findings correlate with the co-researchers in that it is challenging for learners and teachers in rural areas and learners who experience barriers to learning to cover all the content areas in the CAPS (DBE, 2011a), especially with limited support.

6.3.1.4 Lack of support structures

Aligned with the statement of Kempen and Steyn (2016); Taylor (2021) as well as Venkat and Spaull (2015), T2 confirms that "we [teachers] did not all receive training in the implementation of the CAPS" (cf. 2.10.1.1). "We also do not receive support from the district office because they say it is too far from the district office to the rurality of the uMzinyathi district." The co-researchers echoed the need for support on the implementation of the curriculum as well as support with teaching mathematics as a subject. Adu (2022) requested, in the conclusion of his findings, that this support for teachers in rural areas from the education departments and from the government. During our reflections, we agreed that the lack of support by educational role players was alarming and we agreed that this is one of the primary concerns contributing to the poor performance and progress of the FP learners. This data emphasis the findings of Taylor (2020), who stated that teachers that do not receive in-service training, pose a problem to the delivery of proper teaching.

A major change is needed to develop all our learners to their full potential and not just the most talented (Adu, 2022).

"Teachers are reliant on support from their peers [colleagues] and teachers from other schools in the district…this is a matter of the blind leading the blind…" (T5). It was said (T2) that the teachers find it particularly difficult to support learners who experience barriers to learning with very little support from the department. Hay et al*.* (2021) and Kempen and Steyn (2016) in their research had very similar findings. They continued by stating that teachers feel that they do not receive sustainable and efficient support from the School Based Support Team (SBST) and District Based Support Team (DBST). In the ALG meeting, support from the SBST and DBST was not mentioned because of the absence of these teams from their schools and district. If teachers do not understand the learners' disabilities or their barriers, it is understandable that they find it difficult to modify and adapt the curriculum to address these unique learning needs (Kempen & Steyn, 2016). This may also be one of the reasons the teachers feel so overburdened and stressed (Nkambule & Amsterdam, 2018).

6.3.1.5 Number range too high

According to the co-researchers, several teachers complained that the number range on the CAPS (DBE, 2011a) is set so high that the learners find it difficult to reach the outcomes as set in the curriculum. In the content area numbers, operations and relationships the learners cannot all count to the number range in the respective grades. The number range, for example in counting, as well as in addition and subtraction is in grade R: 1-10; grade 1: 0-100; grade 2: 0-200 and in grade 3: 0-1 000. The co-researchers agreed that,

> *Some kids [learners] struggle to count to 3 and 5 and then they must count to 10 and 100" (T6). "There are only a few children [learners] that will be able to achieve the outcomes [as] the rest of the class are really struggling" (T7). "We as teachers need to bring the outcomes down [reduce] to a level that it is achievable for the learners [in this context]. Then, when they go to the next teacher, [grade or phase] the teachers think we did not do our work (T3).*

As seen from the comments of the co-researchers, the learners are struggling with the number range especially numbers, operations and relationships. Measurement is one of the areas where the learners find it difficult to convert centimetres into meters because of the number range and the conversion from 1000cm to 1m. Learners who experience barriers to learning not only find it difficult to count but also experience barriers with abstract concepts (Du Plessis & Mestry, 2019). Roberts's et al*.* (2019) findings correlate with that of the co-researchers by categorising these specific challenges that the learners are experiencing, into the following six criteria "1. counting, 2. applying basic mathematical processes, 3. evaluating quantity, size, length, and contents, 4. in understanding of relational terms, 5. spatial ordering and 6. relatively concrete mathematical reasoning ability” (p. 12).

From the feedback of the co-researchers, the secondary participant seems to be exhausted in catching up on the work the learners have mist in the previous year with the COVID-19 pandemic and still must complete the outcomes of the curriculum. T4 mentioned that she is concerned about the secondary participants, she is working with because of the heavy workload and stress levels at school. Davids (2021) echoed this in an article with the name that says it all “Supporting SA’s overburdened and mentally fatigued teachers”. The high pitching of the CAPS (DBE, 2011a) and the inflexibility of the curriculum demotivate the teachers (Mkhabela, 2016).

6.3.1.6 English as language of learning and teaching

The phenomenon of the LoLT of the schools being English, tends to pop up in all discussions (cf. 3.7.4). This is one of the main barriers for both the teachers and the learners (Adu, 2021; Jojo, 2019; Makoelle, 2012; Neethling, 2015; Roberts et al., 2019). The learners find it difficult to understand English especially when the teacher is not fluent in English (Nel & Muller, 2010; Shayne, 2020). All the members of the ALG had this as one of the aspects that are hampering the teaching of mathematics.

T7’s statement correlated with Langhan et al*.* (2012) (cf. 2.6) that The CAPS (DBE, 2011a) is well written but in academic language that is not within the comprehension of a person that is non-English speaking (Cronje, 2021). Prinsloo (2011) asserts that the learners are only exposed to English during school hours and cannot develop an English academic language. Cronje (2021) as well as Marais and Wessels (2020) explained that this sometimes leads to teachers presenting activities that are unrelated to the specific content areas. There is a direct link between these findings and that of (Langhan et al., 2012) who also name these activities as time-wasting activities. “The teachers are handing out magazines to the learners but are not giving the learners an activity to do with them” (T1). She (T1) further explained that the secondary participants will let the learners do a lot of paperwork that is mainly colouring in and not focus on the learners mastering the mathematic concepts. Douglas (2019) underlines those learners who experience barriers to learning find it difficult to work on an abstract level and still need to work on a concrete level.

T5 emphasised that the learners have a specific number concept that comes from home, this is either thought in isiZulu at home or they picked some mathematical concepts up while watching television in English. T4 posed that “This prior knowledge does not always correlate with what we [teachers] are teaching them in class, because of the language barrier”.

According to T6, the teachers will constantly switch between English and isiZulu in the class to assist the learners. Makhwathana et al. (2021) agree with this and continued by emphasising that teachers use code-switching (cf. 3.5.2.1) to overcome their inability to teach in English. He further suggests that teachers should strengthen their knowledge of English and consistently speak English in classes.

It is thus important for the teachers to have the necessary LTSM to enable them to teach mathematics.

6.3.1.7 Lack of learning and teaching support material

The uMzinyathi district is one of the very rural areas in South Africa where poverty is hempen (cf. 3.8) (DoCG&TA, 2020). The report further states that the average annual household income is R14 600. There is an overall lack of water, electricity, refuge removal services, and ablution facilities (DoCG&TA, 2020). This has serious consequences for learners (Du Plessis & Mestry 2019). Schools in rural areas are often negatively impacted by a lack of physical resources, basic infrastructure, and information (Du Plessis & Mestry, 2019). From the findings of the study done by Adu (2022), 78% of the schools partaking in the study had a lack of LTSM in the school. T6 claims that the curriculum is not compiled in a matter that always keeps into consideration that the teachers in the rural areas do not have access to all the necessary LTSM required to teach mathematics properly. This comment resonates with Makhwathana et al. (2021) and Douglas (2019) extended this by stating that learners who experience barriers to learning, also require a larger variety of concrete material to enable them to do mathematics.

Very early in the research, the lack of LTSM was a primary discussion point (cf. 5.6.6). The topic of LTSM features in almost all discussions and all the co-researchers reported that the secondary participants were complaining about the lack of resources. In Cycle 1 the co-researchers decided to start an LTSM bank of photos of natural and recycled material to be used later in the study. This was at the request of one of the secondary participants. All these photos were sent to me via different electronic platforms because the co-researchers voted me in to act as the nodal point during the research project.

6.3.1.8 Knowledge on addressing barriers to learning

All the co-researchers as well as the secondary participants mentioned that they have learners who experience barriers to learning in their classes and they are trying their best to address the barriers. “We see them struggling but don’t know what is wrong and how to fix it, Without the necessary knowledge and support, this is quite a daunting task” (T6). Jojo (2019), Du Plessis, and Mestry (2019), Lessing, and De Witt (2011) all argued that if teachers do not receive adequate training in identifying and addressing barriers to learning in their classes, this may lead to creating even bigger barriers to learning. This theme is also one that featured in almost all discussions and the co-researchers as well as the secondary participants, via the co-researchers, upper these points as one of the major contributing factors that influence the optimal implementation of the curriculum.

This then brings us to the opposite side of the fishbone diagram (cf. 4.10.4) (Figure 6.1).

6.3.2 Themes that emerged as possible solutions to the curriculum challenges

Through evaluating and reflecting on our actions, along with discussions with the secondary participants, we collaborate in seeking possible strategies to improve the teaching skills in mathematics to learners who experience barriers to learning.

By applying dialectic epistemology (cf. 4.7.1.1) to the research, we engaged in creative and collaborative dialogue to identify specific themes from the data (Wood, 2020). These themes were discussed individually from the data generated from the transcripts of the discussion and deliberations in the ALG meetings as well as from the sticky notes on the fishbone diagram (Figure 6.1).

The themes that emanated from the data was categorised under the following headings as illustrated in Table 6.2. These themes will be individually discussed below.

Table 6.2: Possible solutions to the curriculum challenges

RESEARCH QUESTION	THEMES
What strategies can we develop to improve FP teachers' teaching of mathematics to minimise these challenges?	1. Training
	2. Collaborative support
	3. Own intervention
	4. Adapted Curriculum

6.3.2.1 Training

Teachers are seen as the most important asset in the school (Hlalele, 2014). When taking this into consideration, the teachers should receive ample support to fulfil this important task. This is not happening at the rural schools (cf. 6.3.1.4) and was echoed by all the co-researchers. The co-researchers further resonated with Kempen and Steyn (2016) that teachers must make their own plans in addressing the lack of support they are receiving from the SBST and DBST (Kempen & Steyn, 2016). When there is limited support for the teachers most of the time also extend the teachers' roles to that of counsellors for the families, addressor of socio-economic issues and giving emotional support, related to the learners' barriers to learning (Bosman, 2022; Georgiana, 2015, Payne-van Staden & Van der Merwe, 2021)

With the limited support, the co-researchers suggested that teachers must find solutions to do their own training. This underlined the value of the ALG where we as co-researchers do research and conduct in-service training and workshops on specific topics such as appropriate teaching techniques, methods and strategies, and on addressing the needs of learners who experience barriers to learning. The co-researchers then take this newly acquired knowledge to the secondary participants in the community. T7 elaborated and suggested that YouTube videos should be sauced on differentiation, straddling, and scaffolding and presented to the secondary participants as in-service training. The co-researchers indicated that even though the teachers in general are familiar with the terminology they do not know how to apply these strategies in their classes. In the ALG meeting, the co-researchers indicated that they wanted to provide the secondary participants and the teachers in the community with a hands-on manual to improve the provision of mathematics to the learners who experience barriers to learning.

6.3.2.2 Collaborative support

The co-researchers all agreed that most teachers at school need collaborative support to make up for the lack of support from the department (cf. 6.3.1.4). This is in line with Adu (2021) and Hay et al*.* (2022) state that teachers may benefit from receiving collaborative support. T5, a newly appointed teacher at one of the schools suggested that:

> *We must all make it gospel to ask experienced teachers for advice when we are experiencing challenges with the curriculum or with learners who experience barriers to learning in mathematics and we lack knowledge. We must stop being shy to ask (T5).*

Providing training on the CAPS (DBE, 2011a) is primarily the responsibility of the Department of Basic Education (DoE, 2001; DBE, 2011a; DBE, 2011d; DBE, 2017) (cf.2.10; 3.7.3), this was the reason for the suggestion by all co-researchers that the DBE will [again] be requested curriculum training for all teacher that feels a need to attend. The co-researchers stated that "training can be virtual and for schools lacking these kinds of resources, can attend [the training] at schools in the position of the facilities. T3 said, "this is collaboration in practice."

6.3.2.3 Own intervention

Suggestions for interventions were not only expected from outside the school, some of the suggestions that were made were of activities that the teachers themselves can do to improve their teaching of mathematics.

The co-researchers were all excited when T7 suggested that "we develop our own workbooks". T1 reminded us of "the limited number of departmental books that are available at our [the] schools", as well as the problem the teacher experience with the "different prints, that have different [variating] page numbers. The co-researchers came to the fore with suggestions like "we can develop our own workbooks with activities that are on a level that is within the learner's ability, and which are environmental related". T2 suggested that "The teachers adapt the curriculum" (T3), meaning that teachers from neighbouring schools collaborate according to grades to adapt and differentiate the curriculum to enhance its practicality. This was also one of the recommendations from Agarwal et al*.* (2010).

To bring about change in a community the teachers need to collaborate and learn from one another (Adu, 2021; Hay et al*.*, 2022). Hlalele (2014) supports this endeavour because in his opinion, "teachers navigate the curriculum" (p. 464) and thus can make the necessary changes to the curriculum as required by the learners.

T6 suggested that all teachers should "Spend more time learning Zulu to break the teaching barrier". This means that the teachers can do code-switching (cf. 3.5.2.1) when needed. Teachers use code-switching as a process and alternate between languages to assist the learners in understanding the learning content (Kaschula, 2019; Mudau, 2019). According to Kaschula (2019) as well as King and Chetty (2014), code-switching is a suitable method of differentiation and a valuable tool to use when learners experience barriers to learning (Mudau, 2019) because through code-switching the learners can participate in class discussions without feeling insecure (Tejano, 2021).

6.3.2.4 Adapted curriculum

As the facilitator of the ALG, I suggested the Differentiated Curriculum and Assessment Policy Statement (DCAPS) (DBE, 2018) learning programme as an option to address the barriers the teachers are currently experiencing when teaching mathematics in the FP. To my surprise, none of the co-researchers had knowledge of the existence of the DCAPS (DBE, 2018).

6.4 TRAINING ON THE DIFFERENTIATED CURRICULUM AND ASSESSMENT POLICY STATEMENT

When listening to the teachers' frustrations on the current situation of teaching mathematics in rural areas and with my prior knowledge of the DCAPS (DBE, 2018), I realise that the content of the DCAPS (DBE, 2018) a line with the challenges that the secondary participants and co-researchers are experiencing.

Being one of the national trainers of the DCAPS (DBE, 2018) in mathematics, for the Department of Basic Education (DBE), I presented the DCAPS (DBE, 2018) to the co-researchers during one of our ALG meetings. The co-researchers requested this training because we believed the DCAPS (DBE, 2018) may be an option to investigate as a strategy to consider for addressing the research question.

After introducing the DCAPS (DBE, 2018) to the co-researchers, we evaluated all options and unanimously decided on piloting the DCAPS (DBE, 2018) in our classes. The reason being the DCAPS (DBE, 2018), adheres to the typical FP learner in a rural area. Data on the piloting of the DCAPS (DBE, 2018) were generated by the co-researchers, evaluated and reflected on their own actions, in their reflective journals.

After the piloting of the DCAPS (DBE, 2018), the feedback from the co-researchers at an ALG meeting, was very positive. T2 remarked that she found the teacher's manual a handy tool to use in her class as she was able to accommodate the learners who experience barriers to learning with her other learners simultaneously. This was echoed by T7 when mentioning that "I now actually know what to do with those learners".

There were however concerns about the confusing headings in the teacher's manual. All the co-researchers agreed that it took them some time in figuring out what was expected of them and what were activities and what were outcomes and what was supposed to be assessed. Both T2 and T3 were concerned about the language used in the policy as well as in the teacher's manual. They mentioned that both the documents were only available in English and the secondary participants and the teachers in the community are not all provisioned enough in English to grasp the concepts in the teacher's manual. The LTSM described in the teacher's manual was not available in rural schools, according to T6.

A collaborative decision was made that the DCAPS (DBE, 2018) was an appropriate tool to use in the rural community, but it was clear that some amendments need adjustment to make the teacher's manual more user friendly for teachers in rural areas. The co-researchers then included the secondary participants in the implementation of the DCAPS (DBE, 2018).

The themes that emanated from the data generated on the implementation of the DCAPS (DBE, 2018) will now be discussed.

6.5 THEMES THAT ARISE FROM THE DATA COLLECTED ON THE IMPLEMENTATION OF THE DCAPS

All the co-researchers presented training at their respective schools to the secondary participants to enable them to implement the DCAPS (DBE, 2018) in their classes. The implementation was well monitored, and the co-researchers observe and had discussions with the secondary participants to generate data.

The co-researcher's receptiveness to change and how they perceived the DCAPS (DBE, 2018) and accompanying teachers' manual along with their own authentic experiences, were reflected upon. This was done so that the necessary adaptations could be made, to ensure its practicality. By implementing, reflecting on their own actions, and then documenting the data generated in their reflective journals (cf.4.10.3) rich data could be generated.

The co-researchers generated data on the secondary objectives of the research:

To evaluate the effectiveness of the strategies that were developed for improving mathematics instruction.

How to amend the developed strategies to ensure efficiency.

Data was generated by implementing the DCAPS (DBE, 2018) in our own classes, as well as by the secondary participants but also by observing the teachers at the respective schools in their classes. Discussions with some of the teachers were held by the co-researchers on their perspective on how the DCAPS (DBE, 2018) contributes to their improvement in teaching mathematics. These findings were presented and deliberated at an ALG meeting.

In the ALG meeting that followed, these data were analysed and reflected on and are now presented in Table 6.3. and will be discussed below.

Table 6.3: Amendments to the teacher's manual

RESEARCH SUB-QUESTION	AMENDMENTS TO BE MADE
How to amend the developed strategies to ensure efficiency?	1. Lack of resources
	2. English in the teacher's manual
	3. The teacher's manual

6.5.1 Lack of resources

As mentioned in the study, a lack of resources is one of the major barriers to the teaching of mathematics (cf.2.10.1.3; 3.7.3; 4.10.5.1; 5.6.6; 6.3.1.7). Maharajh et al*.* (2016), mentioned that a lack of LTSM as the greatest challenge in teaching mathematics in South Africa. In the rural areas where there is a lack of LTSM, this was a real concern. The teachers were initially hesitant to implement the DCAPS (DBE, 2018) because of the lack of LTSM according to T1. From the discussions throughout the research, the co-researchers were concerned about the lack of LTSM in the classes. T3 noted that the secondary participants from her school requested that we, the ALG support them in making LTSM. In a follow-up ALG meeting, it thus became clear that we would have to address this challenge through this research. The LTSM photo bank that we started in Cycle 1 will contribute to this matter. T4 suggested, "why not add our photo bank and methods to the teacher's manual?"

The next challenges that we identified were that the teachers struggle with the English in the DCAPS (DBE, 2018) and the teacher's manual.

6.5.2 English in the teacher's manual

In the uMzinyathi district, isiZulu is the primary language spoken. The teachers are all teaching in English but to a certain degree, lack comprehension of English. Molteno (2017) and Shayne (2020) proposed that it is very difficult for effective teaching and learning to take place in a language where the teachers lack comprehension (Adu, 2021). According to Molteno (2017) and Nowicki (2019), if neither the teacher nor the learners are comfortable with the LoLT, this might lead to a lack of confidence and disinterest in learning in general. This often results, in learners who experience barriers to learning (Adu, 2021; Jojo, 2019; Makoelle, 2011; Neethling, 2015; Roberts et al*.*, 2019).

The teacher's manual for the DCAPS (DBE, 2018) was written in English. This posed a problem for the non-English speaking teachers at the rural schools. Some of the activities were miss interpreted which led to incorrect content transfer. One of the co-researchers mentioned that "I had to explain the activities over and over to the teacher for her to grasp the concept" (T3). The activities had to be translated into isiZulu and code-switching had to take place for the learners to understand what is expected of them. "If we do code-switching in the class, why not code-switch the DCAPS?" was a question posed by T4. The rest of the co-researchers thought this a great idea. We collaboratively decided that the teacher's manual need to be translated into isiZulu.

6.5.3 The teacher's manual

Another major problem was the teacher's manual itself. There were a few complaints from the co-researchers (T3; T4; T5) about the headings that were very confusing. What is called **Content Areas** in the DCAPS policy document (DBE, 2018) is called *Topics* in the teacher's manual. The manual then has **Activities** as a heading, but it reflects the *Outcomes* for the specific week. The next heading is **Recommended resources,** but it was written for schools with the appropriate resources. Under the heading **Clarification note** was the *Suggested activities* that could be done to reach the outcomes.

The layout of the manual is also not described in the teacher's manual and the co-researchers had to explain that over and over to the secondary participants (T3).

From the feedback of the co-researchers, there need to be amendments made to the teacher's manual for the teachers to fully interpret the content and to optimise the teaching of mathematics to learners who experience barriers to learning. The co-researchers addressed this in an ALG meeting and decided that the necessary amendments will be made in Cycle 3 of the research, in order to enhance its practicality.

6.6 FEEDBACK FROM THE CO-RESEARCHERS AND SECONDARY PARTICIPANTS

The DCAPS (DBE, 2018) was well received by the secondary participants and implementation went well as seen in their feedback.

> *For the first time, I didn't need to worry about the learners that were struggling. I can just give the learner his work and continue with the rest of the class" (T5). "It made my preparation so much easier when you can just open the manual and know exactly what to do for the week" (T7). "The initial part, when I did the baseline assessment to, determine on what grade to start the learner, was time-consuming but after that, it was smooth sailing (T6).*

Overall, the feedback was very positive and the co-researchers and secondary participants were comfortable presenting the learning content from the DCAPS (DBE, 2018) to the learners that experience barriers to learning. The co-researchers were proud to have achieved their main objective being *to improve FP mathematics teaching in rural contexts*.

The co-researchers thought that presenting the DCAPS (DBE, 2018) to the secondary participants, assists them in addressing barriers to learning but not all secondary participants could benefit from the DCAPS (DBE, 2018) and teacher's manual. There was a little negativity on the side of the secondary participants because they did not have all the LTSM, to present the DCAPS (DBE, 2018). Before looking into the teacher's manual, the secondary participants already made up their minds that they do not have the LTSM to present it. This was to me an indication of how deprived the teachers and people from the rural community are. The LoLT of the schools is mainly English but the secondary participants are not all fluent in English. This also poses a problem for the secondary participants and these phenomena had to be addressed in Cycle 3.

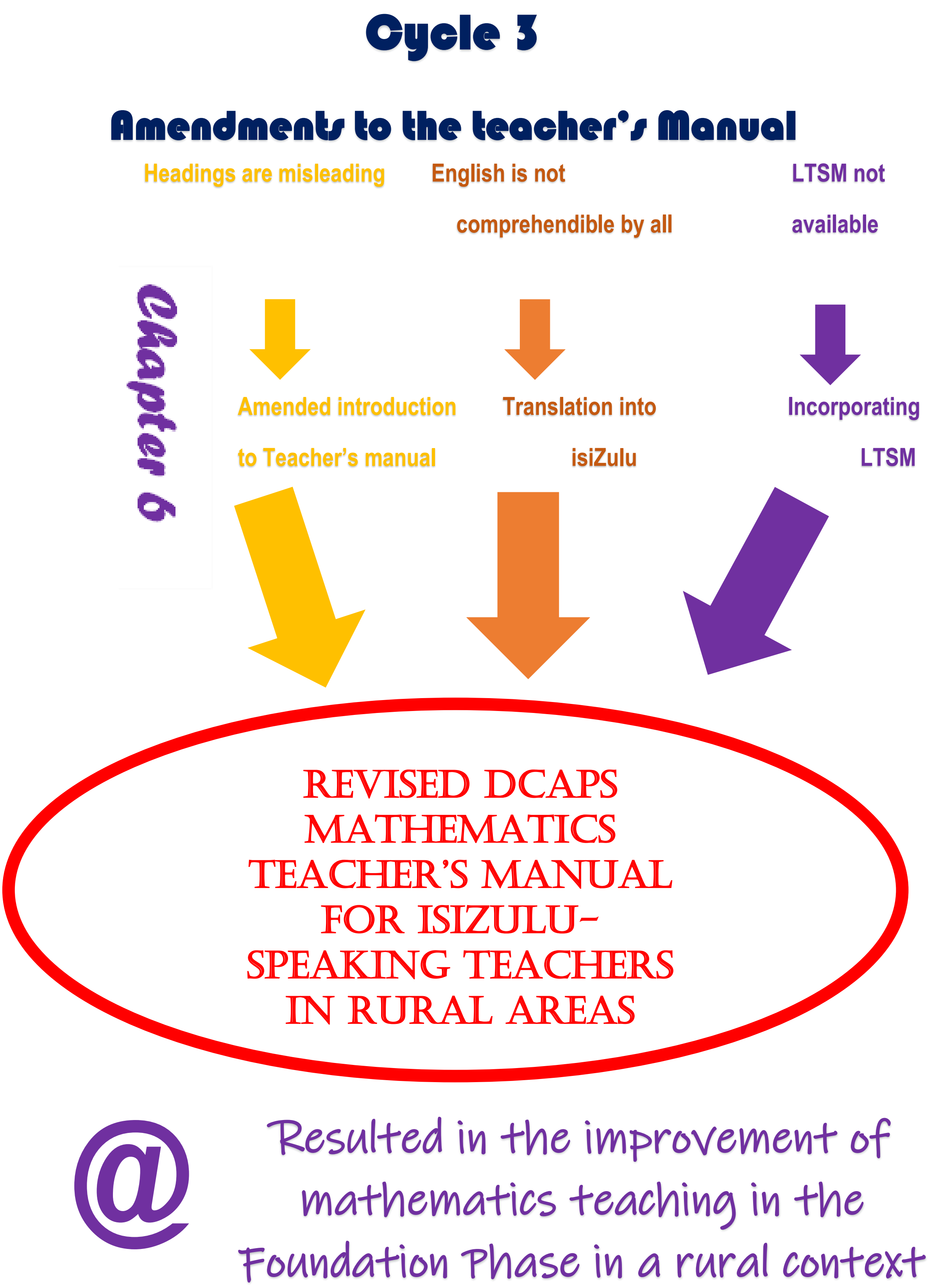

Figure 6.3: **Schematic analysis of Cycle 3**

6.7 CYCLE 3

Cycle 3 initially centred around the guidelines to be developed to improve the teaching of mathematics in the FP. After the amendments to the teacher’s manual were done, the dissemination of the teacher’s manual to the wider teacher community in the uMzinyathi district commenced.

We wanted to develop a hands-on teacher’s manual that was user-friendly and appropriate for teachers in rural communities. Our main aim with Cycle 3 was to answer the last research sub-question being: *What guidelines can be derived from their learning to improve the teaching of mathematics in the Foundation Phase in rural contexts?*

To optimise the use of the teacher’s manual we had to investigate what could be done to enhance its practicality.

At the next ALG meeting, we had a work session on the problems identified by the co-researchers as well as the secondary participants at their respective schools that were implementing the DCAPS (DBE, 2018) in their classes. Besides the main challenges that were identified, there was one additional challenge that we also wanted to address in the revised teacher’s manual. The description of the activities was not always clear enough for the teachers to grasp what exactly is expected of them.

6.7.1 Amendments made to the teacher’s manual

Collaboratively the co-researchers had to revise the list of problems identified with the teacher’s manual from their reflective journals and from the transcripts from the previous ALG meetings. The data was again analysed and reflected upon to decide on which of these problems they are able to address and how the teacher’s manual can be adapted to contextualise it for the rural environment of the uMzinyathi district.

Three major changes were made, namely the translation of the teacher’s manual into isiZulu and simplifying the context, writing an introduction to the manual to explain how to use the manual and the incorporation of LTSM from natural and recycled materials into the manual.

6.7.1.1 Translating the teacher’s manual into isiZulu

Seeing that all the co-researchers, except myself, were all fluent in isiZulu, we worked in groups of two per grade and translated the teacher’s manual of the DCAPS (DBE, 2018) into isiZulu. The content of the teacher’s manual was simplified for better understanding. After doing the translations, it was circulated amongst the secondary participants for approval. By doing this, it was possible for the teachers from the rural community in the uMzinyathi district to understand the activities, because they struggled to understand English. This also ensured that the right learning content was conveyed to all the learners. The translations were e-mailed to me, as the nodal point for amalgamating.

6.7.1.2 Introduction to manual

There was no proper introduction to the teacher's manual to explain how the teachers should use the manual or to explain the meaning of each heading and section. The headings were confusing and we as co-researchers decided to change them in the translated version, to guide the teachers through the manual. I was nominated to write the introduction and one of the secondary participants translated the introduction into isiZulu.

Below is an extract from the teacher's manual, to indicate the changes that were made.

BACKGROUND

According to *The Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System* (DoE, 2001), all learners can learn and have the right to education. The *Curriculum and Assessment Policy Statement* (DBE, 2011a) (CAPS) provides the teachers with the knowledge, skills and values, the learners should be able to master in a specific grade. This is, however, not always possible for learners who experience barriers to learning and learners in the rural environment. There are learners in ordinary schools who have an aptitude and interest in applied knowledge and vocational skills, for whom the CAPS needs to be differentiated to make it more accessible. For these learners and learners that experience barriers to learning, the curriculum should be presented in a more functional manner and at a reduced depth and breadth.

INTRODUCTION

This *Differentiated Curriculum and Assessment Policy Statement* (DCAPS) (DBE, 2018) provides a CAPS-aligned alternative, that promotes local contexts and is sensitive to global imperatives (DBE, 2018). The DCAPS aims to equip all learners with the knowledge, skills and necessary values needed for self-fulfilment and meaningful participation in society as citizens.

The mathematics programme was adapted to accommodate learners who experience barriers to learning. The content areas in the DCAPS mathematics cover all five content areas as set out in the CAPS. Each content area contributes to the acquisition of specific skills. The content areas are Numbers, Operations and Relationships; Patterns, Functions and Algebra; Space and Shapes; Measurement and Data handling.

OVERVIEW OF THE DCAPS

The DCAPS consists of a grade overview and term overview. These documents should be read in conjunction with the teacher's manual which is a separate document. In this document, we only focus on the teacher's manual. Some changes were made to the original document, and it was translated into isiZulu for the specific use of isiZulu-speaking teachers and to enhance its practicality.

6.7.1.3 Explanation of the teacher's manual

The teacher's manual was originally named the **lesson plan**. The grades are colour-coded to make it user-friendly. The teacher's manual will provide teachers with a weekly overview of the content that needs to be instructed in that specific week. In the heading that is repeated on each page, the grade and term are indicated.

GRADE R WITH DIFFERENTIATION TEACHER'S MANUAL TERM 1
GRADE R UKUFUNDISA NGOKWEHLUKA UMHLAHLANDLELA KATHISHA ITHEMU 1

Figure 6.4: Teacher's manual with the isiZulu translation

Weekly planning

The row in the lighter shade indicates the week and what should be done every day during that week.

Week 2 Continue with the following daily	• Counting objects • Mental Mathematics	• Solve problems in the context • Time	• Patterns, functions and algebra • Measurement • Data handling
Isinto 2 Qhubeka nokulandelayo usuku nosuku	• Ukubala izinto • IziBalo zomqondo	• Xazulula isibalo ngokwendikimb a • Isikhathi	• Amaphethini, functions ne- algebra • Ukukala • Cwaninga izinombolo

Figure 6.5: Weekly planning in English and isiZulu

Topic

The **topic** describes the specific *content area* that should be addressed in that week.

TOPIC		ISIKHATHI
Count objects		Bala izinto
Time		Isihloko

Figure 6.6: Topic in English and isiZulu

Outcomes

The outcomes, previously described as **activities**, are the outcomes to be reached at the end of the week. The outcomes printed in **bold** are the outcomes to be assessed in that specific week. This will align with the assessment overview in the DCAPS document (DBE, 2018).

OUTCOMES	IMIPHUMELA
• Number range: • 1 to 2: counting in ones • **Sequence recurring events in own daily life**	• Ukulandelana kwezinombolo: • 1kuya 2: bala ngakunye • **Uhlu kuyaqhubeka izigameko empilweni yakho yosuku**

Figure 6.7: Outcomes in English and isiZulu

Recommended resources (LTSM)

The **recommended resources (LTSM)** will assist the teacher in the preparations for the week. The learning and teaching support material (LTSM) is developed especially for schools with limited resources. All LTSM are from natural or recycled materials and are readily available. The teachers can let the learners assist in the making and collecting, of their LTSM for the lessons.

RECOMMENDED RESOURCES (LTSM)

UMTHOMBO WOLWAZI ONCONYWAYO (LTSM)

- Concrete objects for measurement
  (Izinto eziphathekayo zokubala)

- Count and compare objects.
  (Bala uqhathanise
  izinto)

- Learners (Abafundi)
- Action song/rhyme
  (Okuzokwenziwa iculo/umlalazelo)

Figure 6.8: Recommended resources (LTSM) in English with the isiZulu inserted

Suggested activities

Suggested activities, previously known as **clarification notes**, provide the teacher with suggested activities to reach the desired outcomes. These activities can be used as is, or the teacher can use her initiative in designing activities that will be appropriate to reach the outcomes. Mathematics can be integrated into all Creative Art activities, and several mathematical concepts can be addressed through art activities e.g., using geometric shapes such as circles and squares to make a collage, or designing a pattern to frame a picture.

> *The weather chart, calendar and birthday charts provide opportunities for exploring mathematical concepts. It is the teacher's knowledge and initiative that can maximise learning potential. Routines where children participate actively, such as snack time, arrival, home time and toilet routines, can also be given a mathematics focus (DBE, 2018, p18).*

SUGGESTED ACTIVITIES		
• Counting concrete objects: **Number range: 1 to 2** - One-to-one correspondence - Count in ones the same number of different objects e.g., 2 beads, 2 girls, 2 boys, 2 hands, 2 legs etc. - Clap hands - Stamp feet - Climb stairs - Count body parts - Rote counting using number rhymes and songs		• Ukubala izinto eziphathekayo: **Uhlu lwezinombolo: 1 kuya ku- 2** - Okukodwa okuhambisana nokunye okukodwa - Bala ngakunye izinombolo ezifanayo usebenzisa izinto Isib., 2 ubuhlalu, 2 amantombazane, 2 abafana, 2 izandla, 2 izitho njll. - Shaya izandla - Gxoba ngezinyawo - Nyuka izitebhisi - Bala izitho zomzimba - Ukubala ngokuphindaphinda usebenzisa inamba line okusamlolozelo nokucula

Figure 6.9: Suggested activities

By inserting an introduction to the teacher's manual, the DCAPS (DBE, 2018) and with it the teacher's manual is more tailor-made for the rural environment. In the teacher's manual, we also inserted the LTSM to use with most of the activities.

6.7.1.4 Incorporating LTSM

Because I, as the research facilitator, acted as the nodal point for the LTSM, photos, methods, and videos of natural and recycled LTSM were sent to me to integrate into the teacher's manual. An electronic version of the preliminary teacher's manual with the LTSM integrated into the manual was sent to the co-researchers to reflect on and make the necessary adjustments.

After the teacher's manual was amended, we all agreed that the ideal way of disseminating the teacher's manual to the wider community of the uMzinyathi district would be through the co-researchers. Each co-researcher then identified a school in the district where she would present the DCAPS (DBE, 2018) and the amended teacher's manual.

6.8 CONTEXTUALISED THEORETICAL FRAMEWORK

By doing the research, some perspective changes took place. The critical transformative learning theory (CTLT), according to Mezirow (2011), is a metacognitive epistemology of evidential (instrumental) and dialogical (communicative) reasoning. This reasoning and reflection will ultimately lead to a transformation of the current situation. Wood (2020) describes CTLT in participatory action learning and action research (PALAR) as a process of learning from the experience of others via critical self-reflection. Learning must culminate in action (Ravans, 1998; Wood, 2020). In this study, the CTLC was one of the theories applied.

The co-researchers had the opportunity to observe the teachers at their schools and gained first-hand experience in the implementation of the DCAPS (DBE, 2018). Their perspective on teaching learners that experience barriers to learning mathematics, changed. T5, for example, noted: "I started looking at what the learner can do and not just at what he is not able to do." The teacher's perspective of mathematics and the teaching of mathematics to learners who experience barriers to learning also transformed. In the co-researcher's feedback, I picked up that they were very proud of the teacher's manual and remarked that "we did a good job" (T7, T3, T2). The co-researchers felt as if it was their personal work when they received a printed copy of the teacher's manual. When they experienced the results first-hand in their respective schools, T1 wanted to know "and when do we start with the rest of the DCAPS?", with reference to translating the other learning areas in FP and making it more accessible as well.

My personal perspective of teaching mathematics to learners who experience barriers to learning underwent a total transformation. Coming from a well-resourced special school, barriers to learning for me were mainly intrinsic and we had to adapt the curriculum to cater to the specific needs of these children. This was done on a one-to-one basis because of the small number of learners in the class. I thus had a specific profile in mind of learners who experience barriers to learning.

When I was working in the rural environment of the uMzinyathi district, I came across large, overcrowded classes with learners who experience extrinsic (cf. 3.4.1) as well as intrinsic barriers to learning (cf. 3.4.2). In addition, the teacher has no training or support to assist these learners (cf. 2.9). I experienced teachers as being "hungry for knowledge and help" (T1). I had to make a total paradigm shift to also consider the contextual barriers these learners and teachers are facing when teaching mathematics.

We utilised a learning programme that was initially developed for a learner with a different profile in a different context. The DCAPS (DBE, 2018) was written for learners with severe intellectual disabilities, and we applied it in rural schools to address their contextual barriers to learning in specific mathematics. By implementing the DCAPS (DBE, 2018) for these learners, we could overcome the contextual as well as intrinsic barriers that these learners are experiencing.

6.9 LIMITATIONS OF THIS CHAPTER

The initial negative attitude of the co-researchers as well as the secondary participant towards the DCAPS (DBE, 2018) and the teacher's manual may have influenced their implementation of the DCAPS (DBE, 2018). The same teachers' feedback after implementation was very positive and they were thankful for the assistance they received.

There were several teachers at the rural schools who found the English in the teacher's manual too difficult to understand, and the confusing headings contributed to their struggle at first. The co-researchers tried their best to translate the manual and to explain the working and layout of the teacher's manual to the secondary participants.

I do not understand isiZulu and thus had to rely on the co-researchers and secondary participants for the translation. This personal limitation allowed me some insight into the challenges that the teachers face, however. The teacher's manual forms a large part of the study and without knowledge of the language, I could put myself in the shoes of the teachers in rural areas who are unable to speak or understand English. The relationship between the co-researchers and myself enabled me to trust their knowledge and expertise to translate the content. The co-researchers now took ownership of the teacher's manual.

6.10 CONTRIBUTION OF CHAPTER

By implementing the DCAPS (DBE, 2018), a significant contribution was made in terms of supporting teachers to address barriers to learning in mathematics. The teachers' feedback was positive. Some amendments had to be made to the teacher's manual to make it more user-friendly, especially for teachers in rural areas. By translating the teacher's manual into isiZulu and simplifying the concepts, it was made more accessible to the teachers in the uMzinyathi district, and also throughout KwaZulu-Natal where isiZulu is the most spoken language. This ensured that the correct learning content was conveyed to the learners and that the teachers had some idea of the LTSM they could make from recycled and natural materials to use in the classes. By inserting an introduction to explain how to use the teacher's manual, its practicality was enhanced to suit the needs of the rural community.

Through the PALAR process fruitful relations were built, and we instilled a collaborative working relationship between the co-researchers, secondary participants as well as teachers from the community. Hopefully, the relationships that were built and the collaborative working agreement will have a sustainable impact on the community and the teachers can now address some of the other challenges in their community.

6.11 CONCLUSION

The focus of this chapter was on Cycles 2 and 3 of the research project. The data from the first three research questions were merged on a fishbone diagram (Figure. 6.1) to find a possible solution to the curriculum challenges experienced by the FP teachers when teaching mathematics.

Some challenges with the current CAPS (DBE, 2011a) mathematics curriculum (cf. 6.3.1) were presented at the ALG meeting. These include the *academic standard* (6.3.1.1), and the *number range which is too high* (cf. 6.3.1.5) for all learners to achieve the prescribed outcomes. Since there is not enough class time for all learning areas, teachers cannot cover all the content areas in mathematics. It was also mentioned that *not all activities* in the curriculum *are contextualised* (cf. 6.3.1.3) in the rural uMzinyathi district. The teachers believed that there is a *lack of support structures* (cf. 6.3.1.4) in place to assist the teachers, especially with *knowledge on addressing barriers to learning* (cf. 6.3.1.8). *English as the language of teaching and learning* (cf. 6.3.1.6) is probably one of the contributing factors to the learners experiencing barriers to learning. A *lack of LTSM* (cf. 6.3.1.7) creates a challenge for teachers when teaching mathematics. These challenges formed one side of the fishbone diagram (Figure 6.2). On the opposite side were possible solutions that were considered by the co-researchers to address these challenges.

The themes that emanated from the data was categorised under the headings of *Training* (cf. 6.3.2.1), *Collaborative support* (cf. 6.3.2.2), *Own intervention* (cf. 6.3.2.3), and *Adapted Curriculum* (cf. 6.3.2.4). Through collaboration, the co-researchers agreed to implement the DCAPS (DBE, 2018) with the teacher's manual to improve FP mathematics teaching in rural contexts.

The co-researchers collaboratively decided to first pilot the DCAPS (DBE, 2018) in their classes, after they had received training. Feedback on the piloting was positive, and the co-researchers therefore decided to train the secondary participants at their schools to implement the DCAPS (DBE, 2018).

Data that was generated on the implementation of the DCAPS (DBE, 2018) were evaluated, reflected upon and documented in the co-researcher's reflective journals. This data was analysed at the ALG meeting and used to investigate the amendments that can be made to enhance its practicality. The challenges that emerged from the data were addressed in Cycle 3 (cf. 6.7) of the research.

In Cycle 3 the co-researchers translated and simplified the content of the teacher's manual into isiZulu and I integrated the LTSM photos and methods from natural and recycled materials (cf.6.7.1). An introduction was written to explain the content and functionality of the teacher's manual to contextualise the content to the rural environment, and this was also translated into isiZulu. The preliminary teacher's manual was circulated via e-mail to all the co-researchers for their input and amendments. To ensure sustainability the co-researchers decided to disseminate the DCAPS (DBE, 2018) and with it the translated teacher's manual to the wider uMzinyathi district.

In Chapter 7 the conclusions of the research will be presented and recommendations for further research will be made.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

My primary aim with this research was to answer the main research question:

How can Foundation Phase (FP) teachers in rural contexts improve their teaching of mathematics?

I applied the Participatory Action Learning and Action Research (PALAR) approach to enable us to come to the conclusions that will be discussed in this chapter.

Chapters 5 and 6 describe the analyses of the research data, as well as the feedback after the *Differentiated Curriculum and Assessment Policy Statement* (DCAPS) (DBE, 2018) was implemented. The generated data at our disposal enabled us to develop a Short Learning Programme (SLP). This chapter will provide an overview of research findings, the limitations and contributions of the research and recommendations for future research.

7.2 REASON FOR THIS RESEARCH

With the publication of the *Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System* (DoE, 2001) (EWP 6) came significant curriculum changes (Magagula, 2015; Neethling, 2015) but for teachers in rural areas and classes with limited resources, this turned out to be a challenge (Langhan et al., 2012; Simelane in Gina, 2018). The possibility of developing a curriculum to suit the specific needs of learners who experience barriers to learning, was never considered (Donohue & Bornman, 2014; Magagula, 2015; Kempen & Steyn, 2016). Literature indicated that teachers find it difficult to adapt the curriculum in a manner to accommodate the specific needs of a diverse learner population, especially those experiencing barriers to learning in mathematics (Jojo, 2019; Kempen & Steyn, 2016; Langhan et al., 2012; Moosa, 2014).

This study focused on improving the teaching of mathematics in rural schools through a collaborative professional development initiative. The PALAR design, which was used in this research, provides the co-researchers as well as the secondary participants the opportunity to develop personally as well as professionally. This ultimately leads to the improvement of the teaching of mathematics in the FP.

7.3 BRIEF OUTLINE OF THIS RESEARCH

7.3.1 Chapter 1

Chapter 1 presented an orientation of the research. Through the PALAR design, U investigated how to improve FP teaching in rural contexts. The primary focus was to support teachers in assisting learners who experience barriers to learning in mathematics. I provided a brief background and rationale for the research and then presented the problem statement and the purpose of the study. Some concepts were clarified to contextualise the research. This was followed by the theoretical and conceptual framework that would guide this research, the research methodology as well as measures to ensure trustworthiness and ethical considerations. I concluded the chapter with the possible contribution and structure of the research.

7.3.2 Chapter 2

Chapter 2 gave a background of mathematics (cf. 2.2) and a comparison of the curricula of Brazil, Russia, India, China, and South Africa (BRICS countries) (cf. 2.3) (Wolhuter, 2020). Since this study focused on improving FP mathematics teaching in rural contexts, it was important to also investigate the advantages of the *Curriculum and Assessment Policy Statement* (CAPS) (DBE, 2011a), as well as the *Differentiated Curriculum and Assessment Policy Statement* (DCAPS) (DBE, 2018), which were recently implemented in South Africa. I focused on curriculum changes that were needed to address and support learning and teaching. The current state of mathematics in South Africa (cf. 2.7) and the unpacking of the mathematics curriculum and assessment policies were explored to centre the study. It became obvious that the CAPS poses specific challenges (Xhalisa, 2011) for learners who experience barriers to learning (cf. 2.10).

7.3.3 Chapter 3

In Chapter 3 the focus shifted from perspectives on the teaching of mathematics in general to how mathematics should be taught to FP learners who experience barriers to learning in a rural context. The chapter started with an explanation of how inclusive education is implemented in South Africa (cf. 3.2) and then moved to its implementation in rural areas (cf. 3.7). When mathematics is taught in a rural context, it is important to consider all the barriers, intrinsic (cf. 3.4.2) as well as extrinsic (cf. 3.4.1), that may influence teaching and learning. Teachers must have a holistic approach to teaching these learners and realise the bio-ecological (cf. 3.3) influence that these barriers have on the learner's academic performance. To address these barriers to learning, several specific teaching methods can be used, including differentiation of the curriculum (cf. 3.5.2), code-switching (cf. 3.5.2.1), scaffolding (cf.3.5.2.2), and adapting the curriculum and assessment (cf. 3.5.2.3). This is a daunting task for teachers in rural areas with limited resources and support. The uMzinyathi district where this study was done, is a rural area with poor socio-economic resources (cf. 3.8). Parent involvement (cf. 3.7.5) is limited, and support structures (cf. 3.7.6) are virtually non-existing.

7.3.4 Chapter 4

The primary focus of Chapter 4 was to discuss the theoretical and conceptual framework guiding this research methodology. In this chapter, the study was contextualised, and the research paradigm and methodology of choice were discussed in detail. *Participatory Action Learning and Action Research* (PALAR) (cf.4.8.1) was discussed as the applicable research design for this community-based research (Wood, 2020). The participatory paradigm, along with dialectic epistemology (cf.4.7.2.1), relational ontology (cf. 4.7.2.2) and axiology (cf. 4.7.2.3), guided this study (Brydon-Miller et al., 2003; Wood, 2020). In the next sections, the data generation (cf. 4.10) and data analysis methods (cf. 4.11), ethical considerations (cf. 4.11.2), validity, and trustworthiness (cf. 4.11.1), and the contributions to the authenticity of the research were dealt with. The chapter concluded with a summary of the content focusing on collaboration and support between all co-researchers to improve the FP teaching skills in mathematics.

7.3.5 Chapter 5

The PALAR design in this study consists of three iterative cycles of data generation and analysis. In Chapter 5 paid attention to how the data was generated and analysed (cf. 5.5) in Cycle 1.

My primary focus in Cycle 1 was the establishment of a relationship between the co-researchers in the action learning group (ALG). A few ALG meetings were held in this cycle and each meeting commenced with a relationship-building activity following a planning session for the action to be taken to address the research aims and objectives. This was followed by a reflection session and intervention of the actions. The first two research sub-questions were addressed:

- What challenges and barriers do FP mathematics teachers in rural school’s experience?
- How are educators currently dealing with learners with mathematical barriers in rural schools?

These findings were dealt with in (cf. 5.6) Tables 7.1 and 7.2 (cf. 5.7).

The answers to these questions were documented as data in the reflective journals. Most of the meetings were face-to-face, but a communication system was put in place where some of the findings were also communicated. Through e-mail, WhatsApp and voice notes, continuous communication was established, because of the distance between the research facilitator and the co-researchers. These answers to the first two research questions were reflected upon and formed the basis for the second cycle, to be discussed in Chapter 6.

7.3.6 Chapter 6

In Chapter 6 the second and third cycles of the PALAR were reported on. In Cycle 2, the co-researchers generated data on the third research question:

What strategies can they develop to improve their teaching of mathematics to minimise these challenges?

The data was evaluated and reflected upon by the co-researchers at an ALG meeting and the findings were reflected upon in Tables 7.3 and 7.4. The data from the three research questions were reflected upon and analysed in a fishbone diagram (cf. 4.10.4; Figure 6.2). This analysis culminated in a critically informed action plan. A collaborative decision was taken to implement the DCAPS (DBE, 2018), along with the teacher's manual for mathematics. The DCAPS (DBE, 2018) was implemented, evaluated and reflected upon in the co-researcher's reflective journals. Adaptations were made to ensure its practicality in the rural environment. This was done by tailor-making the DCAPS (DBE, 2018) teacher's manual for the rural environment. The teacher's manual was translated into isiZulu, LTSM was integrated into the teacher's manual and a new introduction was written for the teacher's manual to ensure that the teachers understand how to apply the teacher's manual in their classes.

Through these actions, the co-researchers were able to answer the last research question:

What guidelines can be derived from their learning to improve the teaching of mathematics in the Foundation Phase in rural contexts?

The main research question for this research was as follows:

How can Foundation Phase teachers in rural contexts improve their teaching of mathematics?

This research question will thus be addressed by the implementation of the DCAPS (DBE, 2018) and teacher's manual, which will be introduced to the community in the uMzinyathi district, to improve their teaching of mathematics.

7.3.7 Chapter 7

The concluding chapter consists of a brief summary of the findings as well as the conclusion and the recommendation for further research.

7.4 FINDINGS OF THE RESEARCH

Data from the research questions were generated by the co-researchers through observations, personal experience, interviews and discussions with their colleagues as secondary participants. These findings were first evaluated and reflected upon in their reflective journals before presenting the findings to the other co-researchers at an ALG meeting. The key findings were extracted from the data collaboratively at the ALG meetings and will be presented as a synopsis below.

7.4.1 Synopsis of the key findings of the first research sub-question

The first research sub-question was:

- What challenges and barriers do FP mathematics teachers in rural school's experience?

The key findings will be presented in Table 7.1 and will be dealt with under the headings. Key findings, Reference to empirical data, Quotes of co-researchers and Reference to literature review. The findings were triangulated with the literature and the quotes of co-researchers to ensure the authenticity of the data.

Table 7.1: Key findings of the first research sub-question

Key findings	Reference to empirical data	Quotes of co-researchers	Reference to literature review
Poverty	(cf. 3.3; 3.8; 3.7.2; 4.9.1; 5.6.1)	"How can you teach children, that are hungry ..."(T4). "We can't send homework home because there is no electricity and the learners struggle to do the work with candles" (T3). "If we send the books home they don't come back, because the parents use the paper for fire" (T6) "All the teachers I had discussions with, were concerned about the state of poverty in our area" (T2).	DBE 2014; DoE, 2001; Lomofsky & Lazarus, 2014; Neethling, 2015; Prinsloo, 2011; Swart & Pettipher, 2016
Overcrowded classes	(cf. 2.11; 3.5.1; 5.6.2)	"I know of a teacher that had 94 learners in her Gr1 class" (T1) "The teachers are feeling overwhelmed with the number of learners in the class" (T2). "It is impossible to teach in our small classes with over 50 learners in one class" (T2). "The classes are so small and we do not have enough desks for all 50 learners, some learners are working on their laps" (T3).	DOE, 2014; Hay, 2018; Neethling, 2015
Language of learning and teaching	(cf. 2.9.1; 3.4; 3.7.4; 5.6.3)	"The learners enter the FP with no knowledge of English" (T6) "The teachers must teach them the learning content as well as a new language and then cover the curriculum" (T7) "This is almost impossible" (T6). "We must translate for them or have the total meeting in Zulu" (T2). "This is a real problem if you think that the learners must actually be taught in English" (T7). "Parents do not linguistically support the learners at all" (T5).	Jojo, 2019; Makoelle, 2011; Molteno, 2017; Neethling, 2015; Nel & Muller, 2010; Sterne, 2021
Lack of parental involvement	(cf. 3.7.1; 3.7.5, 5.6.4)	"Parents are nowhere, we feed them, we clothe them, we teach them manners …" (T3). "We have to think of innovative ideas to get the parents at the school for example to make the learners perform on stage so that the parents can come and look at their kids and then have a parent's day where we can consult with the parents" (T1).	Abrahams, 2013; Bosman, 2022; Davids, 2009; Davids & Gouws, 2013; Karibayeva & Bŏgar, 2014; McKenzie et al., 2018
Lack of support structures	(cf. 2.9; 3.7.6; 5.6.5)	"Currently the teachers are trying to support one another but it is as if the blind are leading the blind" (T5). "We have none, whatsoever, support from the department. It feels as if we are sitting on an island all alone and need	Bosman 2022; Du Plessis & Mestry, 2019; Hay, 2012; Hay, 2018; Payne-van Staden, 2021

Key findings	Reference to empirical data	Quotes of co-researchers	Reference to literature review
		to help ourselves or fail at the job" (T3). "We have none, whatsoever support from the department" (T4, T5, T6)	
Lack of resources	(cf. 2.10; 3.6; 3.7.3; 5.6.6)	"The departmental textbooks are not enough for all the learners and different prints have different page numbers that are very confusing for the learners" (T2). "The schools all have blocks (Unifix), but the teachers only use them as counters and are not aware that they can be used in all the content areas" (T5). "Our teachers also don't actually know how to optimally use those blocks" (T7). "It is just such a daunting task when you are working in overcrowded classes, without the appropriate LTSM" (T3).	Adler, 2016; Gous et al., 2014; Hlalele, 2014; Nomdo, 2007; Wildeman & Krishnaratne et al., 2013; Neethling, 2015; Quane & Glanz, 2011; Sayed & Ahmed, 2015
Curriculum challenges	(cf. 2.8; 3.4; 5.6.7)	"Teaching mass classes and then expect the learners to be disciplined and sit down while you are assisting one learner or translating for some of the learners takes so much time that it is not possible to get through the curriculum content in the prescribed time" (T2).	Adewumi et al., 2017; Laurillard, 2013; Neethling, 2015; Ramatlapana & Makonye, 2012; Xhalisa, 2011
Lack of knowledge learners who experience barriers to learning	(cf. 2.9; 3.7.6; 5.6.8)	"… we see these learners underperforming and are trying to address it, but we do not know why or what the reason for this is" (T5). "I would like to know why the learner is unable to do the work … If you know the cause of the problem you can address it ..." (T6). "We were trained in addressing barriers to learning in our studies but it was a very short module and not sufficient to address the problems the learners are having. The module primarily focused on what inclusion is. I only heard about the SIAS from you. But still, we do not know how to help these kids" (T5).	DBE, 2014; DBE, 2017; DoE, 2001; Dreyer, 2007; Du Plessis & Mestry, 2019; Jojo, 2019; Joubert, 2012; Kempen & Steyn, 2016; Lessing & De Witt, 2011

7.4.2 Synopsis of the key findings of the second research sub-question

The second research sub-question was:

How are educators currently dealing with learners with mathematics barriers in rural schools?

This question was asked with the objective to research and develop strategies to support these educators to deal with barriers to learning in mathematics. The question was initially intended to shed some light on what the teachers are doing in practice when dealing with learners who experience barriers to learning in mathematics. The themes that were identified in this second research question need some explanation which is why an additional column is inserted to explain the findings. These findings formed a crucial part of the next cycle and eventually the development of the short learning programme (SLP).

Table 7.2: Key findings of the second research sub-question

Key findings	Reference to empirical data	Quotes of co-researchers	Explanation of findings	Reference to literature review
1. Alternative activities	(cf. 5.7.1)	"… teachers are handing out magazines …" (T1) "Learners are given worksheets to colour in, when she [Teacher] is busy with the rest of the class" (T7) "… give them blocks and nothing to do with them …" (T3) "… learners are sent out of the class not to disturb the rest of the class…" (T2, T3)	We came to the conclusion that even though giving alternative activities to the learners, these opportunities are not optimally used to enhance the mathematical skills of learners who experience barriers to learning.	Douglas, 2019; Langhan et al., 2012; Linde, 2021
2. Adaptation of the activities	(cf.2.11.3; 3.4.1; 3.4.2; 3.5.2.2; 5.7.2)	"… some worksheets are adapted with smaller numbers and less work …" (T7) "… some content areas are not done …" (T) "The teacher is presenting the same *adapted* activities to learners from multiple grades" (T3) "… they [the teacher] think they [the learners] can do nothing …" (T3) "She is doing grade 1 mathematics with him in her grade 2 class" (T7) "… her whole class was working on a lover grade …"(T1) "The one teacher takes the learners outside to do the maths practically … before working in the books" (T2) "… with limited resources it is difficult to adapt the CAPS" (T3)	Some teachers are trying their best and are doing an adaptation of the curriculum but with limited knowledge on how to do it. Teachers have very low expectations for the learners and no progression of the work content is taking place. Some content areas are omitted. Teachers are applying the scaffolding technique. Some teachers are utilising the natural resources to their availability to do mathematics. It was clear from the findings that the teachers need support in adapting the activities to address the learners' specific needs.	Langhan et al., 2012; Naude & Meier, 2014

Key findings	Reference to empirical data	Quotes of co-researchers	Explanation of findings	Reference to literature review
2. Code-switching	(cf. 3.5.2.1; 5.4.3)	"… she will address the one child in Zulu and the rest in English" (T5). "Some terminology is just too difficult to translate in Zulu so the teacher will switch to English and other terminology needs explanation in Zulu to assist the kids in understanding what it means" (T7). "… some of them cannot speak a word of English, they can't understand the work in the curriculum" (T2) "She will start in the first term to only use the African language … in the last term she only speaks English in the class and most of the learners as well …" (T1).	Code-switching is a common practice in classes, even if the language of learning and teaching (LoLT) is English. A lack of understanding and speaking of English may lead to miss interpretation of the curriculum. There were teachers that correctly applied code-switching in the class with great success.	Kaschula, 2019; King & Chatty,2014; Mudau, 2019; Tejano, 2021
4. Curriculum differentiation	(cf. 2.9; 2.11;3.4; 3.5.2; 3.6; 3.7; 5.4.4)	"It seems that the teachers always understand what is expected of them …" (T1) "We can't do the mathematics in the curriculum with the children. They do not understand the work and can't do the work. What does the department expect from us to do with the kids?" (T3). "We are trying our best, they just can't do the work, that we just leave then to fail" (T4). "I spend hours after school with him, but nothing seems to sink in – Tomorrow there is nothing" (T6). "… she said: "they are doing differentiation" then she just pulled up her shoulders" (T4).	Curriculum differentiation seems to be a buzz word. Almost all the co-researchers mentioned that they and the secondary participants are doing differentiation. On further investigation, the data reflect that the teachers are in need of support to do curriculum differentiation.	Amaro, 2022; Anikumar, 2022; DBE, 2014; DBE, 2018; Donohue & Bornman, 2014; Kempen & Steyn, 2016;

7.4.3 Synopsis of the key findings of the third research question

The third research question read as follows:

What strategies can we develop to improve Foundation Phase teachers' teaching of mathematics to minimise these challenges?

To enable the co-researchers to answer this question, we first had to decide on the specific focus of the research. Participatory action learning and action research (PALAR) (cf. 4.8.3) is non-static research and there is a constant moving between cycles as the research progresses (Wood, 2020). We thus had to revisit the topics in Cycle 1 and decide on a specific focus of the research. As co-researchers, we also had to revisit our notes in our reflective journals (cf. 4.10.3) to recollect which of these themes identified in Cycle 1 were the greatest need to address. Collaboratively, we decided on *curriculum challenges* as the ideal problem area to address in this research, because by addressing one of the problems identified teachers experience in teaching mathematics, we could address the research problem. This was done to develop guidelines to inform the teaching of mathematics in a rural context.

We used a fishbone diagram (cf. 4.10.4) (Ciocoiu, 2010; Wong, 2011; Shinde et al., 2018; Arp, 2020) to amalgamate the findings. When the specific challenges that teachers experience with the current CAPS were investigated, the following findings in Table 7.3 were identified. In the fishbone diagram, we could then also address the third research question. The key findings of the third research question are presented in Table 7.4. Based on these findings, a collaborative decision was made to implement the DCAPS (DBE, 2018) in the respective schools.

Table 7.3: Key findings of the third research sub-question

Key findings	Reference to empirical data	Quotes of co-researchers	Reference to literature review
Academic standard	(cf. 3.4.1; 3.4.2; 6.3.1.1)	"The learners just can't do all the work." (T5) "I give them extra classes but still the children do not understand" (T6) "A couple of the teachers I interviewed said exactly the same thing, that they can't get all the work done the department expects from them. This is not possible in one term …" (T3). "The learners that are struggling struggle with everything not just maths or a part of it" (T1), "… just some of my children struggle with maths, but with almost all the mathematics" (T4). For some of the learners counting to 5 is a challenge, this does not come close to what CAPS expect of me [teachers]" (T2). There are parts in the CAPS that my children will never grasp (T6). I can't even start with multiplication if still struggle with subtraction and addition (T4). How can you work with numbers up to 100 if they [the learners] are having trouble grasping the concept of 10 or 20? (T3).	DBE, 2011a; DBE, 2020; Donohue & Bornman, 2014; Gilili, 2020; Hlalele, 2014; Kempen & Steyn, 2016; Lessing & De Witt, 2011; Reddy et al., 2015; Roberts et al., 2019; Spaull, 2019; Van der Berg et al., 2019; Xhalisa, 2011
Not all activities are contextualised	(cf. 2.8; 2.10.1.3; 3.4.1;6.3.1.2)	"… contribute to the learners who experience barriers to learning" (T4). "We [the FP teachers] find the activities not all appropriate to the living and schooling environment and further it is very difficult to adapt the activities because of overcrowded classes, where we have no space" (T7). "The LTSM [Learning and Teaching Support Material] that is available does not allow for the activities set out in the CAPS" (T2). Learners from rural areas come to the classes with limited vocabulary and the CAPS does not allow for learners to have enough time to master a specific concept or activity before I have to move on to the next activity (T2). "We have to jump from number concepts to time and then next week back or even later in the term come back to previous concepts, by then the learners totally forgot what you have taught then earlier" (T5). "… the children did not attend pre-school and creche … they do not know anything …" (T4). "… overcrowded classes make it impossible to do the activities …" (T7).	DBE, 2011a; Mkhabela, 2016; Neethling, 2015; Roberts et al., 2019

Key findings	Reference to empirical data	Quotes of co-researchers	Reference to literature review
Content areas are not all covered	(cf. 6.3.1.3)	"The teachers do not have time to cover all the content so Data handling is usually the one content area that is not addressed during the year" (T7). "Most teachers see it as a waste of time" (T2). "… Measurement is also left out …" (T7).	Adu, 2014; Adu, 2022; DBE, 2011a; Kempen & Steyn, 2016; Langhan et al., 2012; Naidoo & Mkhabela, 2017
Lack of support structures	(cf. 2.10.1.1; 6.3.1.4)	"We [teachers] did not all receive training in the implementation of the CAPS" (T2). "We also do not receive support from the district office because they say it is too far from the district office to the rurality of the uMzinyathi district." "… this is a matter of the blind leading the blind …" (T5). "The teachers find it particularly difficult to support learners that struggle if they don't receive support from district" (T2).	Adu, 2022; Hay et al., 2021; Kempen & Steyn, 2016; Nkambule & Amsterdam, 2018; Taylor, 2020; Venkat and Spaull, 2015
Number range to high	(cf. 6.3.1.5)	"Some kids struggle to count to 3 and 5 and then they have to count to 35 and 100" (T6). "There are only a few children that will be able to achieve the outcomes the rest of the class are really struggling" (T7). "We as teachers need to bring the outcomes down to a level that it is achievable for the learners. Then when they go to the next teacher, the teachers think we did not do our work" (T3).	Davids, 2021; DBE, 2011a; Du Plessis & Mestry, 2019; Mkhabela, 2016; Roberts's et al., 2019
English	(cf. 3.7.1; 6.3.1.6)	"The CAPS is well written …" (T7) "They [the teachers] do not understand the content of the curriculum" (T7). "The teachers are handing out magazines to the learners but are not giving the learners an activity to do with them" (T1). "… the teachers let the learners do a lot of paperwork that is mainly colouring in and not focus on the learners mastering the mathematic concepts (T1). "The learners come with maths concepts from home that is different from what is taught in class" They get this from watching TV or what was picked up from their friends or parents" (T5). "This prior knowledge does not always correlate with what we [teachers] is teaching them in class, because of the language barrier" (T4). "… teachers are constantly switching between English and Zulu" (T6).	Adu, 2021; Cronje, 2021; DBE, 2011a; Douglas, 2019; Jojo, 2019; Langhan et al., 2012; Makhwathana et al., 2021; Makoelle, 2012; Marais & Wessels, 2020; Neethling, 2015; Nel & Muller, 2010; Prinsloo, 2011; Roberts et al., 2019

Key findings	Reference to empirical data	Quotes of co-researchers	Reference to literature review
Lack of LTSM	(cf. 6.3.1.8)	"… the teachers do not have the LTSM to teach mathematics" (T6).	Adu, 2022; Douglas, 2019; DoCG&TA,2020; Du Plessis & Mestry, 2019; Makhwathana et al., 2021
Lack of knowledge on addressing barriers to learning	(cf. 3.8; 5.6.6; 6.3.1.7)	"We see them struggling but don't know what is wrong and how to fix it. Without the necessary knowledge and support, this is quite a daunting task" (T6).	Du Plessis & Mestry, 2019; Jojo, 2019; Lessing & De Witt, 2011

Table 7.4: The key findings of the third research question

Key findings	Reference to empirical data	Quotes of co-researchers	Reference to literature review
Training	(cf. 6.3.1.4; 6.3.2.1)	"…YouTube videos should be sauced on differentiation, straddling, and scaffolding" (T7).	Bosman, 2022; Georgiana, 2015; Hlalele, 2014; Kempen & Steyn, 2016; Payne-van Staden & Van der Merwe, 2021
Collaborative support	(cf. 2.10; 3.7.3; 6.3.1.4; 6.3.2.2)	"We must all make it gospel to ask experienced teachers for advice when we are experiencing challenges with the curriculum or with learners who experience barriers to learning in mathematics and we lack knowledge. We must stop being shy to ask (T5). "…ask experienced teachers for advice" (T5) "…this is collaboration in practice. (T3).	Adu, 2021; DBE, 2011a; DBE, 2011d; DBE, 2017; DoE, 2001; Hay et al., 2022
Own intervention	(cf. 3.5.2.1; 6.3.2.3)	"Develop our own workbooks" (T7). "…the limited number of departmental books that are available at our [the] schools" (T1). "The different prints, that have different [variating] page numbers. (T1). "We can develop our own workbooks with activities that are on a level that is within the learner's ability, and which are environmental related" (T1). "The teachers can adapt the curriculum" (T3). should "Spend more time learning Zulu to break the teaching barrier" (T6).	Adu, 2021; Agarwal et al., 2010; Hay et al., 2022; Hlalele, 2014; Kaschula, 2019; Mudau, 2019; Tejano, 2021
Adapted curriculum	(cf. 6.3.2.4)	"What about introducing the Differentiated CAPS to support learners who experience barriers to learning" (T1).	DBE, 2018

7.4.4 Synopsis of the key findings of the fourth research question

After the implementation of the DCAPS (DBE, 2018), the data reflected that even though the teachers were finding the DCAPS useful for addressing barriers to learning which the learners experience in mathematics, some challenges with the teacher's manual were associated with the policy document. The following challenges were identified:

The teacher's manual needs to be explained to the teachers before they can implement the DCAPS.

The teachers do not have the necessary LTSM to optimise the implementation of the DCAPS.

The policy document, as well as the teacher's manual is written in English which is not the mother tongue of the teachers. they thus find it difficult to understand what is expected of them.

For these reasons, the following collaborative decisions were made in answer to the fourth research question, namely:

What guidelines can be derived from their learning to improve the teaching of mathematics in the Foundation Phase in rural contexts?

A collaborative decision was made to write an explanatory introduction to the teacher's manual and integrate the natural and recycled LTSM from the LTSM photo bank, which started in the first cycle of the research. The teacher's manual was translated into isiZulu by the co-researchers to enhance its practicality in the KwaZulu-Natal (KZN) region where it is the most commonly spoken language.

The DCAPS with the newly amended teacher's manual will be presented to the teachers in the wider community of the uMzinyathi district to improve their teaching of mathematics to learners who experience barriers to learning in mathematics.

7.5 RECOMMENDATIONS

Based on the findings, it is of the utmost importance for the department to take the following steps:

Provide teachers and schools with training on the Screening, Identifying, Assessment and Support (SIAS) document (DBE, 2014).

Provide teachers and schools with training on dealing with learners who experience barriers to learning in the class.

Provide teachers and schools with training on the implementation of the CAPS (DBE, 2011) and DCAPS (DBE, 2018).

Provide the necessary LTSM to all schools, including rural schools.

Provide the district offices with the means to provide the support that the teachers desperately need.

Translate the DCAPS teacher's manuals into all 11 official languages.

It will be to the teachers' advantage if they form action learning groups to support one another in terms of mutual challenges.

7.6 POSSIBLE CONTRIBUTIONS

A pivotal contribution of this study is that the teaching of mathematics in the FP in a rural context to learners who experience barriers to learning, was addressed through the implementation of the DCAPS (DBE, 2018). This study has demonstrated that a PALAR approach can be successfully utilised as an instrument to address a contextual need.

The co-researchers as well as the secondary participants who participated in this research gained knowledge on the teaching of mathematics but also shared their knowledge with the wider community of the uMzinyathi district. Through participating in the research, the co-researchers gained skills in the critical analyses of data by reflecting on their own actions, investigating the practices of other teachers and developing curiosity that led to acquiring problem-solving skills (Boyer, 1990; Shulman, 2011, Neethling, 2015; Wood, 2020). The co-researcher's perspective on teaching learners who experience barriers to learning changed. By focusing on what the learner is able to do, and not on the barrier itself, the framework of how they viewed the learner, also changed.

My personal perspectives had to transform. With my background in special education in a city with well-resourced schools, the impoverished rural community with such limited support transformed the conservative way in which I addressed barriers to learning. I had to move beyond my comfort zone to address the environmental barriers these teachers are facing daily. Being a co-researcher in this research gave me the opportunity to learn from the rest of the members of the ALG.

The DCAPS was originally compiled for learners with severe intellectual disabilities. In this research, it was utilised to address the barriers for teaching mathematics to learners with intrinsic as well as extrinsic barriers in a rural context. The DCAPS can thus be used in rural areas around South Africa to address the specific barriers these learners experience.

7.7 RECOMMENDATIONS FOR FURTHER RESEARCH

The DCAPS (DBE, 2018) mathematics was implemented with success in the schools in the uMzinyathi district. It is for this reason that the co-researchers recommended that its application in other subjects should also investigated.

This research focused on the implementation of the DCAPS (DBE, 2018) in the two schools incorporated in this research. Since the co-researchers are taking the DCAPS (DBE, 2018) and revised accompanying teacher's manual to the schools in the uMzinyathi district, it will be of value if follow-up research can be done on how the DCAPS (DBE, 2018) and revised teacher's manual was received in the community and to monitor the success in the wider community.

This research was done in the rural area of the uMzinyathi district in KZN, where isiZulu is the indigenous language. It is recommended that similar research be done in one of the other provinces in South Africa and that the other official languages and cultures be incorporated.

The PALAR design was used successfully in this research to support the teachers in rural areas. Teachers in rural areas are in desperate need of support in dealing with learners who experience barriers to learning. Alternative ways to support the teachers in rural areas will be of great help to these teachers.

It is also recommended that teachers in rural areas in greater South Africa receive support in curriculum implementation. Any research to support teachers with curriculum implementation will be well received.

7.8 CHALLENGES AND LIMITATIONS OF THE RESEARCH

The primary challenge of this research was the distance between the co-researchers and me. Even though I spent some time in the community, it would have been ideal to have all the ALG meetings face-to-face. This was, however, not possible and we had to communicate by using electronic platforms. A personal limitation was that because of my deteriorating health, a large part of this research was done from my bed or from hospital.

One of the challenges was that when we decided on implementing the DCAPS, the secondary participants were reluctant to try out the new curriculum because of the lack of LTSM. The lack of

LTSM was identified as a challenge by teachers in almost all the ALG meetings. This problem was addressed by integrating the natural and recycled LTSM into the teacher's manual.

The co-researchers were initially enthusiastic about using reflective journals. As the research continued, it took some motivation to get them to reflect in their reflective journals, since they preferred to use WhatsApp, voice notes and e-mail. Nevertheless, the reflection on the topic at hand had been done, and rich and trustworthy data was generated. Their input and well-thought-through answers to the research questions were presented at the ALG meetings.

7.9 EVALUATION OF PALAR AS A RESEARCH DESIGN

The PALAR research design was the most appropriate for this specific study because it brought about the transformation that we as co-researchers envisioned for this study (Zuber-Skerritt, 2011; Kemmis et al., 2014). We were able, through the PALAR design, to build relationships amongst the co-researchers as well as relationships within the community; we also had the opportunity to reflect on our own actions and share our views and findings and to be intellectually stimulated by the rest of the ALG (Wood, 2020).

Collaborative action research through the PALAR research design is a process of giving and taking, giving some of your own knowledge and expertise in exchange for the knowledge and expertise of co-researchers. I would recommend the PALAR design for research in education because it not only benefits the researcher but also co-researchers as well as the education community as a whole.

7.10 CONCLUSION

Teachers in the rural areas in South Africa are deprived of the support needed to help learners who experience barriers to learning, especially in the FP. It is of pivotal importance that these teachers are provided with the necessary skills and knowledge to improve the teaching of mathematics. It is deducted from this study that the department does not have the capacity to provide much-needed support. The teachers should take the lead to develop agency in their communities with the skills and expertise they acquired through years of teaching in rural areas for transformation to take place (Wood, 2020). This research was a journey of transformation for the co-researchers, secondary participants and me.

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ANNEXURE A: PARTICIPANTS INFORMED CONSENT

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South Africa 2520

Tel: 018 299-1111/2222
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Faculty of Education

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Tel: 018 111 1111
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NWU®
NORTH-WEST UNIVERSITY
NOORDWES-UNIVERSITEIT
YUNIBESITI YA BOKONE-BOPHIRIMA

_________________________________(Participants name)
____
____
(Recipient address)

Date

PARTICIPANT INFORMATION AND CONSENT FORM

I herewith wish to request your consent to participate in this research, which involves [enter information]. Before you give consent, please acquaint yourself with the information below.

The details of the research are as follows:

TITLE OF THE RESEARCH PROJECT:

Improving Foundation Phase mathematics teaching in rural contexts: A participatory action learning and action research approach

ETHICS APPLICATION NUMBER

PROJECT SUPERVISOR: Dr. M. Neethling
Dr D. Laubscher
ADDRESS: Marinda.neethling@nwu.ac.za
CONTACT NUMBER: 071 642 8943

FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
Contact person: Ms Erna Greyling, E-mail: Erna.Greyling@nwu.ac.za, Tel. (018) 299 4656

This study has been approved by the Research Ethics Committee of the Faculty of Education of the North-West University and will be conducted according to the ethical guidelines of this committee. Permission was also asked from the provincial Department of Basic Education as well as the school principal.

What is this research about?

The main aim of this study is to improve the teaching skills of Foundation Phase mathematics teachers at rural schools, to the benefit of all learners, but more specifically, those who experience barriers to learning. The study aims to generate knowledge on how the latter can be done.

The following objectives are set for the study:

- To investigate the challenges and barriers teachers in rural school's experience regarding Foundation Phase mathematics teaching.
- To research how educators are currently dealing with learners with mathematics barriers in rural schools
- To develop strategies to improve Foundation Phase teachers' teaching of mathematics to minimise these challenges
- To develop guidelines to improve the teaching of mathematics in the Foundation Phase in rural contexts

Participants

- 6-8 Teachers

What is expected of you as participant?

An Action Learning Group (ALG) of 6-8 Foundation Phase teachers, and the candidate as the research facilitator, will act as co-researchers. The current projection is to collaboratively decide to keep reflective journals in which the co-researchers can capture ideas and reflection on relevant aspects of the research. The ideal is to request that the co-researchers do evaluation and reflection once a week. They will further use the journals to positively critique and reflect on the suggestions made in the ALG on improving mathematical knowledge and skills to support learners experiencing barriers in their learning.

Regular communication via face-to-face meetings, when possible, emails, WhatsApp group discussions and voice messages. ALG meetings will be approximately 45min depending on the topic under discussion.

Benefits to you as participant

Co-researchers build self-awareness and develop agency and self-confidence in presenting the programme to other schools and their colleagues. All will gain knowledge on teaching mathematics to learners who experience barriers to learning. Guided by values of social justice the members of the ALG will share their knowledge with the teachers at their school as well as other schools in the community. By being part of an ALG creates a sense of collaboration to achieve a mutual goal.

The introduction of the short learning program (SLP) to the teachers in the district, learners who experience barriers to learning may reserve the necessary support.

Risks involved for participants

Very low risks

Confidentiality and protection of identity

Members of the ALS will sign a confidentiality agreement. The identity of the school will be kept confidential and only KP and CP will be used to identify the two schools. Teachers will be named T1-T6/8.

Dissemination of findings

The co-researchers will be aware of the findings as they do the analysis of the data collaboratively. The SLP will be owned by all and will be implemented to improve the Foundation Phase teachers teaching of mathematics in rural contexts

If you have any further questions or enquiries regarding your participation in this research, please contact the researchers for more information.

Yours sincerely
Karen Joubert

DECLARATION BY PARTICIPANT:

By signing below, I …………………………………….………… agree to take part in a research study entitled:

Improving Foundation Phase mathematics teaching in rural contexts for learner diversity: A participatory action learning and action research approach

I declare that:

- I have read this information and consent form and understand what is expected of me in the research.
- I have had a chance to ask questions to the researcher and all my questions have been adequately answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the research process before it has finished, if the researcher feels it is in my best interests, or if I do not follow the research procedures, as agreed to.

Signed at (place)___________________________on (date) ______/______/20____

_____________________ ____________________

Signature of participant **Researcher**

ANNEXURE B: EXTRACT FROM ISIZULU TEACHER'S MANUAL

Inkombandlela kathisha yeKharikhulamu efundisa ngokwaHlukana neSitatimende sePholisi yokuVivinya yeBanga le-Foundation yesiZulu

2022

OKUQUKETHWE

1 ISISEKELO SALOKHU

Ngokwe-*The Education White Paper 6 yabanesiDingo seMfundo eHlukile: Ukwakha uHlobo lwezeMfundo nokuQeqesha olufaka lonke uhlobo lwengane* (DoE, 2001), bonke abafundi bangafunda babe nelungelo lokuthola imfundo esezingeni elihle. Inkombandlela kathisha yeKharikhulamu efundisa ngokwaHlukana neSitatimende sePholisi yokuVivinya (DBE, 2011) (CAPS) inikeza uthisha ulwazi, uqeqesho kanye namagugu, okufanele ngabe umfundi useyalwazi eBangeni elithize. Kodwa-ke lokhu akulula ukwenzeka kumfundi ongabambi kalula kanye nakubafundi basezindaweni zasemakhaya. Kunabafundi abasezikoleni ezejwayelekile abanethalente lokubamba uma kufundwa ngendlela yokwenza izinto nabafundi abanethalente lemfundo yamakhono okufanele i-CAPS ibahlelele imfundo eyehlukile ukuze ibalungele bayizwe kalula nabo. Kulaba bafundi kanye nakulabo abangabambi kalula, kubo ikharikhulamu kumele yethulwe ngendlela yokwenza izinto nephathekayo futhi yenziwe ibe lula nangezinga elingasheshi.

2 ISINGENISO

Le Kharikhulamu efundisa ngoKwahlukana kanye nePholisi yeSitatimende sokuVivinya (DBE, 2011), isakhele uhlelo oluhambisana ne-CAPS oluzoletha umehluko, olugqugquzela ukusiza ezinkingeni ezitholakala ezindaweni esizakhele kodwa futhi ibe ihambisana nezinqubo ezamukelekile emhlabeni wonke jikelele. (DBE, 2018). I-DCAPS iqonde ukuhlomisa bonke abafundi ngolwazi, amakhono kanye namagugu adingeka ukuze bazethembe futhi bakwazi ukubamba iqhaza ngempumelelo emphakathini njengezakhamizi.

Uhlelo lweZibalo lwalungiswa kabusha ukuze lulungele ukufaka nabafundi abangabambi kalula ezifundweni. Imikhakha yokuqukethwe eyahlukene kwi-DCAPS ye-Zibalo (Mathematics) ifaka yonke imikhakha eyahlukene njengokulawula kokusetha kwe- CAPS. Uhlelo ngalunye lokuqukethwe lusiza ekubambeni amakhono athize. Amakhono ahlukene asohlwini yilawa: • Izinombolo, Okwenziwayo kanye noBudlelwano; • Ukulandelana kwezinto, Okusekelwe kokunye kanye ne-Aalgebra ; • Indawo kanye noKuma okwahlukene kwezinto; • Ukukala; • Ukusebenza ngezinombolo.

3 UKUBHEKA KAFUSHANE DCAPS

I- DCAPS iphethe ukubukeza okuqondene neBanga kanye nokwama temu. Le miqingo kumele ifundwe ihambisana noMhlahlandlela kathisha ewumqingo oseceleni. Kulo mqingo , siqondene nokubheka uMhlahlandlela kathisha. Olunye ushintsho lwenziwa emqingweni owedlule lwatolikelwa esiZulwini ukuze lukwazi ukusetshenziswa wothisha abakhuluma isiZulu nokuthi isebenziseke kalula.

3.1 Umhlahlandlela kathisha

Umhlahlandlela kathisha kuqala wabe ubizwa ngokuthi **wuhlelo lokufundisa isifundo.** AmaBanga abhalwe ngemibalabala ukuze alandeleke kahle. Umhlahlandlela kathisha uyosiza uthisha ngezisekelo zokuzokwenziwa okuqukethwe kwesonto ngalinye okuzofundiswa kulelo sonto. Esihlokweni esibhalwe saphindwa ekhasini ngalinye, iBanga nethemu libhaliwe.

GRADE R UKUFUNDISA NGOKWEHLUKA UMHLAHLANDLELA KATHISHA ITHEMU 1

3.2 Ukuhlelo kwesonto ngalinye

Umugqa onombala okhanyayo ukhomba isonto nokumele ukwenziwa usuku nosuku ngalelo sonto.

Isinto 2 Qhubeka nokulandelayo usuku nosuku	• Ukubala izinto • IziBalo zomqondo	• Xazulula isibalo ngokwendikimba • Isikhathi	• Amaphethini, functions ne- algebra • Ukukala • Cwaninga izinombolo

3.3 Isihloko

Isihloko sichaza *ingxenye ngqo yokuqukethwe* okusuke kuzokwenziwa ngalelo sonto.

Isikhathi
Bala izinto
Isihloko

3.4 Umphumela

Umphumela oqale wabizwa ngokuthi **okuzokwenziwa** yimiphumela yalokho okumele kube sekwenziwe kwaqedwa ngesonto. Imiphumela ebhalwe **ngokugqamile** yimiphumela yokumele kuhlolwe ngalelo sonto ngqo. Lokhu kuyohambisana nokumele kuhlolwe okuchazwe emqingweni okwi-DCAPS (DBE, 2018)

IMIPHUMELA
• Ukulandelana kwezinombolo: • 1 kuya 2: bala ngakunye
• Uhlu kuyaqhubeka izigameko empilweni yakho yosuku

3.5 Ulwazi olukhethekile ungaluthola kulo mthombo (LTSM)

Ulwazi olukhethekile ungaluthola kulo mthombo (LTSM) lzomsiza uthisha uma elungiselela umsebenzi wesonto. I-LTSM yakhelwe ikakhulukazi lezo zikole ezintulayo ezingenazo izinsiza ezanele. Wonke ama-LTSM asebenzisa izinto zemvelo noma izinto ezilahlwayo futhi atholakala kalula. Uthisha angagqugquzela izingane ukuthi zimelekelele ekwenzeni nasekuqoqeni izinto ze-LTSM asuke ezofundisa ngazo.

UMTHOMBO WOLWAZI ONCONYWAYO (LTSM)
• Izinto eziphathekayo zokubala  • Bala uqhathanise izinto   • Abafundi • Okuzokwenziwa iculo/umlolozelo

3.6 Izinto ongazenza

Izinto ongazenza, Ngokudlule bekwaziwa ngokuthi ***amanothi okuchaza***, zinikeza uthisha izinto angazenza ukuze kufikwe emphumeleni ohlosiwe. Lokhu okumele kwenziwe kungenziwa kunjengoba kunjalo, noma uthisha azisebenzisele okwakhe aziqambele khona okuzosiza ekufikeni emphumeleni oqondiwe. IziBalo (Mathematics) zingafakwa zihambisane nokwenziwa

GRADE R UKUFUNDISA NGOKWEHLUKANA
UHLELO LOKUFUNDISA ISIFUNDO
ITHEMU 1

ISIHLOKO	UMPHUMELA	IMITHOMBO YOLWAZI ENCOMEKAYO (LTSM)	IZINTO EZINGENZIWA
Isonto 3 Qhubeka nalokhu njalo ngosuku	• Ukubala izinto • IziBalo zezengqondo	• Xazulula iziBalo esimweni esithile • Isikhathi 	• Amaphethini amafankshini ne-Algebra • Ukukala • Ukusebenza ngezinombolo
Bala uye phambili nasemuva	Uhlu lwezinombolo: 1 kuya ku- 2 • Bala ngakunye	• Izinto eziphathekayo    • Izenzo amaculo/imilolozelo	• Qondanisa ukubala usebenzisa imilolozelo nomculo, izinto eziphathekayo, okokubala, ubala nangokunyakazisa umzimba. • Bala izinto ezejwayelekile ufike ku- 2 • Bala uye phambili nasemuva ufike ku- 2 • Phindaphinda ubala ngakunye, phambili usebenzisa imilolozelo, umculo, izinto eziphathekayo, nezingxenye zomzimba.
Ukuhlanganisa nokususa	• Sebenzisa izinto eziphathekayo ukuxazulula iziBalo ezifaka izinomolo 1-2	• Ukusebenzisa izinsiza eziphathekayo., okokubala  • Amatreyi amaqanda (Wasike ka- 2) 	• Xazulula izibalo zokuhlanganisa nokususa ezishiwo ngomlomo ezinezimpendulo ezifika ku-2 • Sebenzisa izinsiza eziphathekayo zokubala isb. Okokubala noma okunye okuphathekayo onakho • Isibonelo: ○ Uthisha ubiza ingane eyodwa ize phambili ekilasini. Bese ebiza omunye umfundi. Usebize abafundi abangaki? ○ Mangaki amaqanda azogcwala godi emi-2?
Uhlangothi,	Ulimi lokuma kwayo	• Izinto ezisetshenziswa phandle	Ulimi lokuqondana kwezinto

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GRADE R UKUFUNDISA NGOKWEHLUKANA UHLELO LOKUFUNDISA ISIFUNDO ITHEMU 1			
ISIHLOKO	**UMPHUMELA**	**IMITHOMBO YOLWAZI ENCOMEKAYO (LTSM)**	**IZINTO EZINGENZIWA**
Ibhekephi Nombono	• Ukuqondana kwezinto ezimbili mayelana nokuma komfundi	• Ifenisha yasekilasini • Ukugxuma    • Ikhwela • Ithamborini	• Isimo sokuqondana kwezinto ezi-2 noma ngaphezulu maqondana nomfundi • Ngaphambili nangemuva • Phakathi nangaphandle • Phansi naphezulu Ukudlala ngaphandle kubalulekile. • Esifundweni sokuzivocavoca ima ngaphambi ngemuva komfundi, ngababili shintsha ukuma uma uthisha eshaya indweba. • Phakamisa izandla/zehlise • Gxuma ngaphakathi/ngaphandle kwehuku
Amaphethini e-Geometry	**Kopisha wandise amaphethini usebenzisa izinto eziphathekayo** • Akazakhele awakhe amaphethini okuphinda • Kopisha wandise amaphethini	• Izinto eziphathekayo 	• Kopisha wandise amaphethini shaya iphekhushini (shay' izandla, gxoba) • Phinda wenze okufanayo ngama-cones, amabhlokhi nokokubala.

GRADE R UKUFUNDISA NGOKWEHLUKANA UHLELO LOKUFUNDISA ISIFUNDO ITHEMU 1			
ISIHLOKO	**UMPHUMELA**	**IMITHOMBO YOLWAZI ENCOMEKAYO (LTSM)**	**IZINTO EZINGENZIWA**
		• Bala izingxenye zomzimba • Okokubala 	

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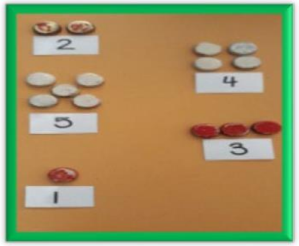
UHLELO LOSUKU OLUNGALANDELWA USUKU NOSUKU

8

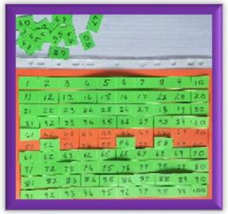
IBANGA 1 UKUFUNDISA NGOKWEHLUKANA UMHLAHLANDLELA KATHISHA ITHEMU 2			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI ENCOMEKAYO (LTSM)**	**IZINTO EZINGENZIWA**
Isonto 8 • Qhubeka nalokhu njalo ngosuku	• Ukubala izinto • Izibalo zezengqondo	• Xazulula izibalo esimweni esithile • Isikhathi 	• Amaphethini, amafankshini ne-Algebra • Ukukala • Ukusebenza ngezinombolo
• Ukusebenza ngezinombolo	• Qoqa uhlele izinto	• Izinto eziphathekayo   	• Qoqa uhlele izinto ezinobudlelwano • Usayizi • I-shape/ukuma kwento • Umbala
• Ukuxazulula inkinga	• Xazulula izibalo ezishiwoyo ngezimpendulo ezifika ku-7	• Izinto eziphathekayo   • Ubumba lokudlala 	• Xazulula izinkinga ngomlomo

IBANGA 1 UKUFUNDISA NGOKWEHLUKANA UMHLAHLANDLELA KATHISHA ITHEMU 2			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI ENCOMEKAYO (LTSM)**	**IZINTO EZINGENZIWA**
• Amasu okuxazulula izinkinga	• Ukuphinda kabili nokuhhafula	• Amapuleti ephepha  	• Sebenzisa izinsiza eziphathekayo isib. • Okokubala, izitebhisi ezinezinombolo nokunye okuphathekayo okusekilasini nangaphandle kwekilasi

IBANGA 2 UKUFUNDISA NGOKWEHLUKANA UHLELO LOKUFUNDISA ISIFUNDO ITHEMU 3			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
Isonto 6 Qhubeka nalokhu njalo ngosuku	• Ukubala izinto • Izibalo zekhanda	• Xazulula izibalo esimweni esithile • Isikhathi 	• Amaphethini, amafankshini ne-Algebra • Ukukala • Ukusebenza ngezinombolo
Ukuhlanganisa nokususa	• Hlanganisa ufike ku-18 • Susa usuke ku-18	• Izithombe zezinombolo ezingamagama  • Izithombe zezinombolo ezingamasimboli  • 100 chart  	• Sebenzisa amasimboli afanele (+, -, =) • Qeqesha amabhondi ezinamba kuya- 5

IBANGA 2 UKUFUNDISA NGOKWEHLUKANA UHLELO LOKUFUNDISA ISIFUNDO ITHEMU 3			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
Isikhathi	• Bukeza izikhathi zonyaka • Fundisa iziNsuku zeSonto ngeculo	• Ishadi lesimo sezulu  • Ishadi lezinsuku zokuzalwa • Ikhalenda	• F-undisa abafundi izinsuku zesonto ngomculo nomlolozelo • Gcizelela ukufundisa ishadi lamasizini • Faka izinsuku zokuzalwa eshadini
Yethula izinamba	• Yethula izinombolo	• Izithombe 	• Sebenzisa izithombe ukwethula ulwazi ngezithombe
2D wama-shape	• Chaza, hlela uqhathanise 2D izinto ngokosayizi, umbala, ne-shape	• Izinto eziphathekayo 	• Izinkomba zama-shape • Chaza, hlela uqhathanise 2D ama-shape ngokosayizi, nombala • Dweba ama-shapes: indilinga, isikwele, unxantathu

IBANGA 2 UKUFUNDISA NGOKWEHLUKANA UHLELO LOKUFUNDISA ISIFUNDO ITHEMU 3			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
		• 2 D ama-shape   	
Amasu okuxazulula izinkinga	• Ukuphindaphinda kuze kufike ku- 20	• Izinsiza eziphathekayo  • Ulayini wezinombolo 	• Sebenzisa iqhinga lokuphinda uma uhlanganisa noma ususa, uqoqa uhlanganisa uxazulula izinkinga

IBANGA 3 UKUFUNDISA NGOKWEHLUKANA UMHLAHLANDLELA KATHISHA ITHEMU 4			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
Week 7 Qhubeka nalokhu njalo ngosuku	• Ukubala izinto • Izibalo zengqondo	• Xazulula izibalo esimweni esithile • Isikhathi 	• Amaphethini, amafankshini ne-Algebra • Ukukala • Ukusebenza ngezinombolo
Ukuhlanganisa nokususa	• Hlanganisa ufike-80 • Susa usuka ku-800 • Sebenzisa amasimboli (+,-,=) • Ukuhlanganisa nokususa amaqiniso (ukuhambisana kwezinombolo) kufika ku- 20	• Izinto eziphathekayo • Izinsiza eziphathekayo • Imidwebo • Ulayini wezimombolo   • Ishadi lika-100 • Okokubala  	• Sebenzisa la masu ukuxazulula izibalo uchaze indlela oyisebenzisile ○ Imidwebo nezinsiza eziphathekayo Isib. okokubala ○ Ukwakha nokuhlakaza izinombolo ○ Olayini bezinombolo besekelwe yizinsiza eziphathekayo ○ Ishadi lika-100 ○ Okokubala

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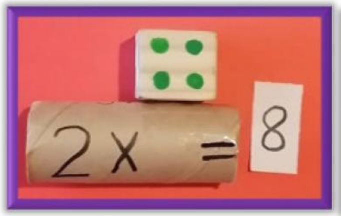
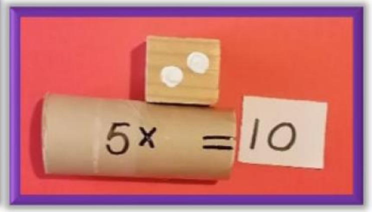
IBANGA 3 UKUFUNDISA NGOKWEHLUKANA UMHLAHLANDLELA KATHISHA ITHEMU 4			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
Ukuhlanganisa okuphindwayo okuholela ekuphindaphindeni	• Xazulula izibalo zamagama usichaze isixazululo senkinga yokuphindaphinda • Okuholela ekuphindaphindeni • Ukuhlanganisa uphinde kaningi izinombolo ezilandelayo u-10, 5 no-2 ngezimpendulo ezifika ku- 80 • Phindaphinda izinombolo 1-10 ngo 2, 5 no- 10	• Izinsiza eziphathekayo  • Izinto eziphathekayo  • Imidwebo • Olayini bezinombolo • Ishadi lika-100 	• Ulwazi lokuhlukanisa lwethulwa ngokufundisa abafundi izibalo eziphathekayo ukuhlukanisa nokuqoqela ndawonye • Yethula uphawu lokuhlukanisa • Ngezansi kunezinhlobo zezibalo zezinombolo zamagama ezingenziwa • Ukucozulula, ubeke eceleni okusele • Nika oswidi abahlanu umuntu ngamunye ukuze yilowo nalowo athole inamba efanayo yamaswidi. • Bhala imifanekiso yokuhlanganisa nokwabelana • Uma uchaza ngezibalo zokwabelana, abafundi bayokwabelana into ngayinye ngesikhathi • Kungenzeka abafundi babelane into eyodwa/ezimbili ngesikhathi • Okugxilwa kukho akukhona ukwazi ithebula ngekhanda kepha ukwazi ngokuphindaphinda. • Abafundi bafunda ngokufunda nokuqonda ngezinombolo emshweni • Kumele babone izinto eziningi ezisiza ukuphindaphinda babhale okuningi ezincwadini zabo • Isibonelo somsebenzi obhalwayo ○ Iqoqo eli-1 lika- 5 liwu 5 noma 1 umphinda ka- 2 = 2 noma 1 x 2 = 2 ○ Amaqoqo ama-2 ka- 2 ma- 4 noma 2 phinda ka- 2 wu- 4 noma 2 x 2 = 4

IBANGA 3 UKUFUNDISA NGOKWEHLUKANA UMHLAHLANDLELA KATHISHA ITHEMU 4			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
		• Ikhalkhuletha   	○ Amaqoqo ama-3 ka- 2 wu- 6 noma 3 phinda ka- 2 wu 6 noma 3 x 2 = 6
Iphethini yezimombolo	• Kopisha, nweba uchaze izinombolo ezilula ezilandelanayo okungenani ezifika ku-80 • Ukubala kumele kukhombise ukubala ubheke emuva naphambili ubala ngo 1, 2,10, no-5	• Inamba line  • Ubuhlalu nentambo  I-Abacus • Izinti zokubala 	• Ukulandelana kwezinombolo kungaxhunywa kusekele ukubala • Uma ikhono labafundi lokubala lishintsha futhi likhula nezinhlobo zokulandelana kwezinamba abazisebenzisayo zingakhula. • Ukubala kumele kukhombise ukubala uya phambili nasemuva kulokhu: • Oku-1 kusuka kunoma yiyiphi inamba esuka ku- 1 kuya ku- 80 • Abafundi bangamboza, umbala noma bazungelezele inamba lapho bebala kwi-namba line nakwinamba gridi. • Abafundi bangagcwalisa izinamba ezisele kwinamba line nakwinamba gridi,belandela uhlu neketanga lezinamba.

IBANGA 3 UKUFUNDISA NGOKWEHLUKANA UMHLAHLANDLELA KATHISHA ITHEMU 4			
ISIHLOKO	**IMIPHUMELA**	**IMITHOMBO YOLWAZI (LTSM)**	**IZINTO EZINGENZIWA**
		• Umentshisi  Okokubala **Izivalo zamabhodlela**  • Izindumbuluzi zamapentshisi • Amatshe  • Ama-unifix cubes   • Inamba grids • Iketanga lokubala	

IBANGA 3 UKUFUNDISA NGOKWEHLUKANA
UMHLAHLANDLELA KATHISHA
ITHEMU 4

ISIHLOKO	IMIPHUMELA	IMITHOMBO YOLWAZI (LTSM)	IZINTO EZINGENZIWA
2D shapes	• Chaza, hlela uqhathanise ama- 2D shapes ngoko: ○ Sayizi ○ UMbala	• Ama-shapes  	Ama-shapes ayizinhlobo ahlukahlukene • Bona, usho uhlobo lwe- 2D shape ○ Isikokela ○ Unxantathu ○ Isikwele Izinkomba zama-shapes • Chaza, hlela bese uqhathanisa 2D shapes ngoko: ○ Sayizi ○ Umbala Dweba ama-shapes • Indilinga • Unxantathu • Isikwele
Yethula ulwazi lwezinombolo	• Yethula ulwazi lwezinamba zihambisane enye nenye	• Izinto eziphathekayo 	• Qoqa ulwazi lwezinamba ngendikimba thizeni ulwethule ngesithombe.

ANNEXURE C: ETHICAL APPROVAL

Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: http://www.nwu.ac.za

Senate Committee for Research Ethics
Tel: 018 299-4849
Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Education Sciences Research Ethics Committee (EduREC)** on 29 September 2022, the Education Sciences Research Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Improving Foundation Phase mathematics teaching in rural contexts: A participatory action learning and action research approach

Study Leader/Supervisor (Principal Investigator)/Researcher: Dr M Neethling

Student / Team: K Joubert (PhD student – 24789933), Dr D Laubscher

Ethics number:

N	W	U	-	0	0	3	0	0	-	2	2	-	A	2
Institution				Study Number						Year			Status	

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type: Single study

Commencement date: 29/09/2022 **Risk:** Low

Expiry date: 29/09/2023

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable):

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the ES-REC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the ES-REC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-SCRC and ES-REC reserves the right to:*
  - *request access to any information or data at any time during the course or after completion of the study;*

- *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
- *withdraw or postpone approval if:*
  - *any unethical principles or practices of the study are revealed or suspected;*
  - *it becomes apparent that any relevant information was withheld from the ES-REC or that information has been false or misrepresented;*
  - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
  - *new institutional rules, national legislation or international conventions deem it necessary.*

The ES-REC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the ES-REC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely

Prof CP van der Vyver
Chairperson NWU Education Sciences Research Ethics Committee

Original details: (22351930) C:\Users\22351930\Desktop\ETHICS APPROVAL LETTER OF STUDY.docm
8 November 2018

Current details: (22351930) M:\DSS1\8533\Monitoring and Reporting Cluster\Ethics\Certificates\Templates\Research Ethics Approval Letters\9.1.5.4.1 ES-REC Ethical Approval Letter.docm
5 December 2018

File reference: 9.1.5.4.2

ANNEXURE D: GATEKEEPER CONSENT

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Faculty of Education

(Research entity details)

Tel: 018 111 1111
Email: Name.Surname@nwu.ac.za

(Dr Elsa Bosman)
(Cedar International Academy)

Date: January 2022

GATEKEEPER INFORMATION AND CONSENT FORM

I herewith wish to request your consent to participate in this research, which involves acting as a gatekeeper. Before you give consent, please acquaint yourself with the information below.

The details of the research are as follows:

TITLE OF THE RESEARCH PROJECT:

Improving Foundation Phase mathematics teaching in rural contexts: A participatory action learning and action research approach

ETHICS APPLICATION NUMBER

PROJECT SUPERVISOR: Dr M. Neethling
CO-SUPERVISOR: Dr D. Laubscher
ADDRESS: Marinda.neethling@nwu.ac.za
CONTACT NUMBER: 071 642 8943

FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
Contact person: Ms Erna Greyling, E-mail: Erna.Greyling@nwu.ac.za, Tel. (018) 299 4656

This study has been approved by the Research Ethics Committee of the Faculty of Education of the North-West University and will be conducted according to the ethical guidelines of this committee. Permission was also asked from the provincial Department of Basic Education as well as the school principal.

What is this research about?

The main aim of this study is to improve the teaching skills of Foundation Phase mathematics teachers at rural schools, to the benefit of all learners, but more specifically, those who experience barriers to learning. The study aims to generate knowledge on how the latter can be done.

The following objectives are set for the study:

- To investigate the challenges and barriers teachers in rural school's experience regarding Foundation Phase mathematics teaching.
- To research how educators are currently dealing with learners with mathematics barriers in rural schools
- To develop strategies to improve Foundation Phase teachers' teaching of mathematics to minimise these challenges
- To develop guidelines to improve the teaching of mathematics in the Foundation Phase in rural contexts.

Participants

- 6-8 Teachers

What is expected of you as the Gatekeeper?

To contact school principals in the uMzinyathi district and request permission for the research to be conducted. To introduce the research and researchers to the possible participants.

Benefits to you as gatekeeper

Self-awareness, build their self-confidence in presenting the program to school principals and possible participants. Gaining knowledge on teaching mathematics to learners who experience barriers to learning, if they are interested in the findings of the research.

Risks involved for gatekeeper

Very low risks

Confidentiality and protection of identity

The gatekeeper will sign a confidentiality agreement. The identity of the schools and teachers will be kept confidential.

Dissemination of findings

The findings of the research will be published and available on request after it was reviewed and amended by the co-researchers if need be.

If you have any further questions or enquiries regarding your participation in this research, please contact Karen Joubert at 083 730 7367 or k.j.studie@gmail.com for more information.

Yours sincerely
(Karen Joubert)

DECLARATION BY PARTICIPANT:

By signing below, I …**Elsa Bosman**…………………… agree to take part in a research study entitled:

Improving Foundation Phase mathematics teaching in rural contexts for learner diversity: A participatory action learning and action research approach

I declare that:

- I have read this information and consent form and understand what is expected of me in the research.
- I have had a chance to ask questions to the researcher and all my questions have been adequately answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the research process before it has finished, if the researcher feels it is in my best interests, or if I do not follow the research procedures, as agreed to.

Signed at (place)___Greytown____________________on (date) _26_/_08_/2022__

______________________ ______________________

Signature of gatekeeper **Researcher**

ANNEXURE E: SGB GOODWILL PERMISSION

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Faculty of Education

(Research entity details)

Tel: 018 111 1111
Email: Name.Surname@nwu.ac.za

________________________________(Participants name)
____
____
(Recipient address)

Date

GOODWILL PERMISSION: SCHOOL GOVERNING BODY/OTHER RELEVANT BODY

I herewith wish to request your permission for the school governing body to participate in this research, which involves your Foundation Phase teachers. Prior to granting permission, please acquaint yourself with the information below.

The details of the research are as follows:

TITLE OF THE RESEARCH PROJECT:

Improving Foundation Phase mathematics teaching in rural contexts: A participatory action learning and action research approach

ETHICS APPLICATION NUMBER

PROJECT SUPERVISOR: Dr M. Neethling
CO-SUPERVISOR: Dr D. Laubscher
ADDRESS: Marinda.neethling@nwu.ac.za
CONTACT NUMBER: 071 642 8943

FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
Contact person: Ms Erna Greyling, E-mail: Erna.Greyling@nwu.ac.za, Tel. (018) 299 4656

This study has been approved by the Research Ethics Committee of the Faculty of Education of the North-West University and will be conducted according to the ethical guidelines of this committee. Permission was also obtained from the provincial Department of Basic Education.

What is this research about?
The main aim of this study is to improve the teaching skills of Foundation Phase mathematics teachers at rural schools, to the benefit of all learners, but more specifically, those who experience barriers to learning. The study aims to generate knowledge on how the latter can be done.

The following objectives are set for the study:

- To investigate the challenges and barriers teachers in rural school's experience regarding Foundation Phase mathematics teaching.
- To research how educators are currently dealing with learners with mathematics barriers in rural schools
- To develop strategies to improve Foundation Phase teachers' teaching of mathematics to minimise these challenges

- To develop guidelines to improve the teaching of mathematics in the Foundation Phase in rural contexts.

Participants

- 6-8 Teachers

What is expected of the participants?

An Action Learning Group (ALG) of 6-8 Foundation Phase teachers, and the candidate as the research facilitator, will act as co-researchers. The current projection is to collaboratively decide to keep reflective journals in which the co-researchers can capture ideas and reflection on relevant aspects of the research. The idea is to request that the co-researchers do evaluation and reflection once a week. They will further use the journals to positively critique and reflect on the suggestions made in the ALG on improving mathematical knowledge and skills to support learners experiencing barriers in their learning.

Regular communication via face-to-face meetings, when possible, emails, WhatsApp group discussions and voice messages. ALG meetings will be approximately 45min depending on the topic under discussion.
All participants will collaboratively analyse the data of each cycle and plan for the next actions. The co-researchers will be required to implement the action plan, evaluate and reflect on it. An SLP will collaboratively be developed by all members of the ALG.
What is this research about?

Benefits to the participants

Co-researchers build self-awareness and develop agency and self-confidence in presenting the programme to other schools and their colleagues. All will gain knowledge on teaching mathematics to learners who experience barriers to learning. Guided by values of social justice the members of the ALG will share their knowledge with the teachers at their school as well as other schools in the community. By being part of an ALG creates a sense of collaboration to achieve a mutual goal.
The introduction of the SLP to the teachers in the district, learners who experience barriers to learning may reserve the necessary support.

Risks involved for participants

Very low risk.

Confidentiality and protection of identity

All possible measures will be taken to protect the participant's confidentiality.

Dissemination of findings

All participants will form part of the data analysis and the compiling of the Short Learning Program; thus, the information is owned by all participants. The findings of the research will be published and available on request after it was reviewed and amended by the co-researchers.

If you have any further questions or inquiries regarding your participation in this research, please contact the researchers for more information.

DECLARATION BY SGB CHAIRPERSON/RELEVANT RESPONSIBLE PERSON:

By signing below, I ……………………………….………… agree to give permission for the research to take place with the identified participants in the study entitled:

Improving Foundation Phase mathematics teaching in rural contexts for learner diversity: A participatory action learning and action research approach

I declare that:

- I have read this information and consent form and understand what is expected of the participants in the research.
- I have had a chance to ask questions to the researcher and all my questions have been adequately answered.
- I understand that taking part in this study is voluntary and participants will not be pressurised to take part.
- Participants may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- Participants may be asked to leave the research process before it is completed if the researcher feels it is in their best interests, or if they do not follow the research procedures, as agreed to.

Signed at (place)___________________________on (date) ______/______/20____

____

Signature of SGB Chairperson/Relevant responsible person

ANNEXURE F: SGB GOODWILL PERMISSION

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Phindile Duma Tel: 033 392 1063 Ref.:2/4/8/1824

Dr M Neethling
Private Bag X6001
North-West University
Potchefstroom
2520

Dear Dr Neethling

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: "A COMMUNITY ENGAGEMENT PROJECT TO SUPPORT TEACHERS IN THE UMZINYATHI DISTRICT TO IMPROVE THEIR TEACHING OF LEARNERS WITH DIVERSE EDUCATIONAL NEEDS AND DISABILITIES", in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended reseaæh and interviews are to be conducted.
6. The period of investigation is limited to the period from 10 June 2019 to 10 June 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full reportldissertationlthesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag)(9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

Dr. EV Nzama
Head of Department: Education
Date: 12/06/2019.

KWAZULU-NATAL DEPARTMENT OF EDUCATION ...Championing Quality Edution Creatng and Sewing a Brihbr Fut:re
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Physical Address: 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201
Tel.: +27 33 392 1063 • Fax.: +27 033 392 1203. Email:Phindile.Duma@kzndoe.gov.za •Web:w.w.kzneducation.gov.za
Facebook: KZNDOE....Twitter. @DBE_KZN....tnstagram: km education....youtube:kzndoe

ANNEXURE G: SCIENTIFIC COMMITTEE APPROVAL

Faculty Education:
Research & Innovation - M&D Administration

Private Bag X1290, Potchefstroom
South Africa 2520

Higher Degree Administrator:
Ms J Lion
Tel: 018 285 2102
Email: 13090895@nwu.ac.za

Web: http://www.nwu.ac.za

22 April 2021

To Whom It May Concern

RE: Student name: **Ms K Joubert**; Student number: **24789933**

(Phd – Special Needs Education)

I hereby confirm that the research proposal of the above-mentioned student was approved by the COMBER Scientific Committee on **14 April 2021.**

Risk Level: Low risk (Ethics application should be submitted to Edu-REC)

The Research title was served for approval at the Research and Innovation Committee and will serve for approval on 06 May 2021 as follows:

Supporting Foundation Phase teachers at rural schools to improve teaching skills in Mathematics for a diverse learner population

Should you have further enquiries in this regard, you are welcome to contact Ms Ronelle van Staden at 018 285 2101 or by email at Ronelle.vanStaden@nwu.ac.za, alternatively you may contact Prof L Wood at 018 299 4770 or by email at Lesley.Wood@nwu.ac.za.

Yours sincerely

COMBER Scientific Committee

Original details: C:\Users\20505957\Documents\Nextcloud\X-skyf\Faculty of Education\Letters\2021\Confirmation of proposal\COMBER\Confirmation of Proposal Approval.docm
22 April 2021

File reference: 9.4

ANNEXURE H: POPIA

WhatsApp Group – POPIA compliance message posted

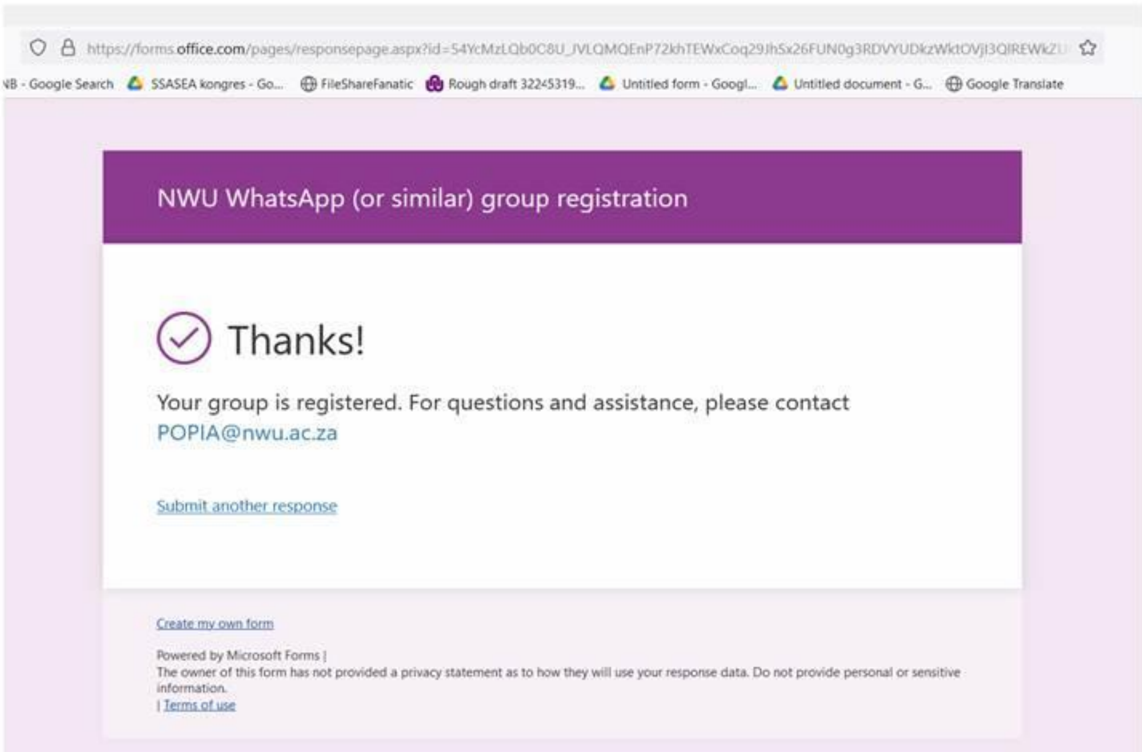
Message: Good afternoon everyone:

As you might already have noticed on similar groups, we also need to share a POPIA disclaimer, as all WhatsApp groups need to adhere to the Act from 1 July 2021.

The compliance due date for the Protection of Personal Information Act, 4 of 2013 ("POPIA"), being 30 June 2021, brings a few changes. One of these changes is that the administrators are required to obtain your consent for being part of this WhatsApp group. As such, you are herewith notified that you are entitled to refuse such consent and you may exercise such a right by leaving this group.

> Should you elect to remain in this group (which we hope you will do), it will be accepted that you have consented to being a part of this group and to your personal information (being your cell phone number and name) being noticeable to any person in this group.
>
> In this regard, we caution all members of this group not to make use of such personal information for whatsoever reason, without obtaining the consent of the relevant person.

Furthermore, this WhatsApp group had to be registered on the NWU data base.



ANNEXURE I: LANGUAGE EDITING

DR AMANDA KRUGER
(DLitt et Phil)
ACCREDITED LANGUAGE PRACTITIONER • GEAKKREDITEERDE TAALPRAKTISYN
(Afrikaans-English/English-Afrikaans)
SATI MEMBER NO • SAVI-LIDNR. 1000547
8 Johannes Dreyer St, Potchefstroom, 2531, RSA • Tel/Fax +27 (0)18 2943319 • Cell +27 (0)82 7414003 • amanda@languageworx.co.za

24 November 2022

Ms K Joubert
Faculty of Education
NWU
Potchefstroom Campus
2520

Dear Ms Joubert

Language editing

I confirm that I edited your thesis, *Improving Foundation Phase Mathematics teaching in rural contexts: A participatory action learning and action research approach*, and that I indicated the necessary editorial corrections. Please contact me if you have any queries or if I can be of further assistance.

Yours sincerely

AKruger

AMANDA KRUGER