UNIVERSITY OF MPUMALANGA

Creating Opportunities

INTEGRATING A SCHOOL FOOD GARDEN IN TEACHING MATHEMATICS GRADE 3 AT A SCHOOL IN THE LIMPOPO PROVINCE

by

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INTEGRATING SCHOOL FOOD GARDEN IN TEACHING mathematics GRADE 3 USING SCHOOL FOOD GARDEN AT A SCHOOL IN LIMPOPO PROVINCE

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M. A. Manaka

30 January 2023

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DEDICATION

I dedicate this to my late father Lesiba Samuel Kola and my uncle Maleka Frank Kola.

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I wish to thank GOD for his strength and wisdom throughout the study.

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ABSTRACT

The poor performance in mathematics at the foundation phase is generally known – a problem that resonates in the intermediate and secondary phases. Mathematics is one of the core subjects; if a learner fails mathematics, they cannot be promoted to the next grade. This study aimed to design a strategy that can be used to enhance effective teaching and learning of mathematics in Grade 3. Following from the study's three objectives it explored the challenges teachers experienced upon implementing this strategy. Theoretically, this study is grounded in Critical Emancipatory Theory (CER), which empowers learners' mathematical skills and knowledge to be competitive in the classrooms and societies. The use of food gardens as teaching resource aims to be emancipatory, since it enhances the performance of learners who struggle with mathematics. To ensure a learner-centred approach, the teaching strategy uses Problem-based Learning (PBL). The food garden is used to investigate problems that rely on mathematics for its solutions. This approach develops learner's problem-solving skills, and critical thinking. Collaboration and communication are core requirements for successful teamwork. The study adopted Participatory Action Research (PAR) as its research methodology. This methodology requires participants from the community to serve as co-researchers and change agents. Data was analysed using Critical Discourse Analysis (CDA), its role is to the language usage in the research. Findings unearthed Grade 3 teachers' challenges to effectively implement PBL involving an outside space such as a school food garden. Teachers experienced challenges with designing lesson plans that used the food garden, necessitating adjustments to their Pedagogical Content Knowledge (PCK); concretising the use of a school food garden by integrating sets of activities associated with PBL to teach mathematical concepts such as space and shapes; and assessing learners' learning. By forming a professional learning community (PLC) teachers could exchange ideas and find solutions that resulted in their own professional development. Through PLC, the teachers can build a strong relationship between teachers to achieve their main objective which is improving maths teaching.

Keywords: school food garden, mathematics, integration.

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LIST OF ABBREVIATIONS/ACRONYMS

CAPS	Curriculum and Assessment Policy Statement
CDA	Critical Discourse Analysis
CER	Critical Emancipatory Research
CRT	Critical Race Theory
DBE	Department of Basic Education
FPAR	Feminist Participatory Action Research
GBE	Garden-based Education
GBL	Garden-based Learning
HoD	Head of Department
LoLT	Language of Learning and Teaching
PAR	Participatory Action Research
PBL	Problem-based Learning
PCK	Pedagogical Content Knowledge
PLCs	Professional Learning Communities
POIA	Protection of Information Act
SACE	South African Council of Educators
SES	Subject Education Specialist

CHAPTER 1
INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

This research aims to develop a strategy that facilitates the seamless integration of a school food garden into the teaching of Grade 3 Mathematics. A school food garden (SFG) serves as a medium for disseminating knowledge about food production and cultivating a culture of food gardening (Ngumbela, Khalema & Nzimakwe, 2020:11). From the perspective of Pedro Da Silver and Vieira Alves De Assis (2021:40), a school food garden in essence comprises fruits and vegetables planted within the school premises. Monferrer, Lorenzo-Valentín, and Santágueda-Villanueva (2022:48) extend the concept of integration to encompass experiential learning processes that connect various aspects of students' lives, learning, and abilities. This definition resonates in the Ghanaian context, as noted by Christensen and Wistoft (2019:237). In South Africa, Burt, Luesse, Rakoff, Ventura and Burgermaster (2018:17) define integration as connecting different study areas through meaningful engagement in real-life situations. Conversely, in Australia, a school food garden is viewed as an experimental activity aimed at enhancing student performance and understanding of mathematics in conjunction with science (Monferrer et al., 2022:48); in Ghana, it is utilised to support the teaching and learning of mathematics (Mollineau, Bradshaw & Simonette, 2021:14). South African schools, on the other hand, employ food gardens for understanding mathematical concepts and their application in real-life scenarios (Mantenta & Mzini, 2021:131).

Grade 3 mathematics in Australia encompasses three content and four proficiency strands: numbers and algebra, measurements, and geometry. Similarly, in both Ghana and South Africa, Grade 3 mathematics focuses on four content areas: number operations and relationships, shapes and space, measurement, and number patterns and relations (Ali, 2021:17; DBE, 2011:3). In summary, various countries define integration as linking real-life activities through a school food garden to enhance understanding of Grade 3 mathematical concepts and skills.

However, several constraints impede the effective integration of a school food garden into Grade 3 Mathematics instruction. Worsley, Nanayakkara, and Burton (2019:48) highlight the challenge of aligning the mathematics curriculum with the activities and objectives of a school food garden. Teachers may struggle due to a lack of mathematics and agriculture/horticulture expertise, which is essential for seamless integration (Amponsah, Nalumu, Mensah, Takyi & Amponsah, 2021:130). Designing suitable assessment strategies that accurately measure students' mathematical understanding within the context of the school food garden is also identified as a complex task (Nalumu et al., 2021:221). Moreover, there is difficulty in balancing the time dedicated to mathematics instruction and school garden activities (Calamidas, Crowell, Engelmann & Watkins-Jone 2021:1). The effective integration of a school food garden is hindered by the need for appropriate lesson plans aligned with the garden.

According to Westwood et al., (2021:25), Australian teachers must ensure that garden-related activities are connected to specific mathematics learning objectives and standards. In Ghana and South Africa, collaborative efforts and interdisciplinary training are deemed necessary to develop competence in both domains for integrating a school food garden into teaching Grade 3 mathematical concepts such as measuring and number sentences (Nalumu et al., 2021:13; Grazioli, 2020:148). Developing fair and effective assessment methods is crucial for evaluating learner progress (Martinen & Montes, 2021:6498). Teachers must carefully plan and manage class schedules to ensure adequate attention to both subjects (Russell & Murphy, 2020). In conclusion, aligning the mathematics curriculum with the goals and activities of a school food garden, possessing expertise in both mathematics and horticulture/agriculture, designing appropriate assessment strategies and lesson plans, and balancing time dedicated to mathematics instruction are identified as challenges to the effective integration of a school food garden into Grade 3 Mathematics.

In Australia, the school food garden is seamlessly incorporated across the curriculum, with learners and teachers actively engaged in sustaining the food garden at both homes and schools while learning the four mathematical content areas (Kasumba, 2022:5; Lloyd & Paige, 2022:9). Ghana has initiated collaborative efforts in the form of Professional Learning Communities (PLCs) to sustain school food gardens, ensuring successful integration into teaching mathematical concepts (Taylor et al., 2021:405; Dushkova & Haase, 2020:19). Similarly, in South Africa, workshops and capacitation of teachers are seen as essential to understanding the importance of school food gardens in education and supporting teachers to use them as a resource in teaching mathematics content areas (Dushkova & Haase, 2020:19).

Australians view mathematics as another competency frequently found in school food garden literature, with learners applying problem-solving skills, measurements, and a range of other mathematical skills (Christian, Cameron & Pearce, 2022:139; McCarty, 2018:67). Ghana is witnessing an improvement in pass percentages in mathematics from 10% to 34% in schools where school food gardens are integrated into teaching and learning (Boateng, Ankrah & Manteaw, 2023:22). Similarly, in South Africa, Eco-Schools foster greater environmental awareness and motivate pedagogical practices, with both teachers and learners committed to integrating school food gardens into teaching mathematics (Rosenberg, 2020:291).

Globally, climate change negatively impacts the sustainability of school food gardens in Australia, Ghana, and South Africa. It poses challenges to maintain the school food gardens, which could hamper efforts to use them for pedagogical purposes such as teaching mathematics (Corrochano, Ferrari, Lopez-Lungo, Ortega & Queredo, 2022:3; Cisse, 2019:188). Inappropriately structured teaching methods can also impede the implementation of school food gardens in teaching Grade 3 mathematics. In conclusion, climate change and inappropriate teaching methods are identified as challenges that negatively affect the success of implementing and integrating school food gardens into teaching and learning mathematics.

Australia demonstrates evidence of the successful incorporation of school food gardens across the curriculum, with positive results in improving learners' cognitive levels and reducing the workload and stress of teachers and learners in teaching and understanding mathematical skills (Velardo, Fane & Jong, 2020:165). In Ghana, there is evidence of an improvement in pass percentages in mathematics for schools integrating school food gardens into teaching and learning (Boateng, Ankrah & Manteaw, 2023:22). South Africa's Eco-Schools show positive results in fostering environmental awareness and motivating both teachers and learners to integrate school food gardens into teaching mathematics (Rosenberg, 2020:291). Overall, integrating school food gardens into teaching and learning mathematics can yield positive results for teachers and learners, alleviating the workload and stress of teachers and fostering learners' interest in mathematics.

1.2 PROBLEM STATEMENT

The research aims to explore the utilisation of a school food garden to enhance the teaching and learning of Grade 3 mathematics through PBL. Legodu (2020:1) notes that nationally many learners perform below average in Grade 3 Mathematics. Several researchers, including Calamidas et al. (2021:1), Nalumu et al. (2021:130), and Worsley et al. (2019:48), have shared insights into the challenges teachers face when integrating a school food garden for teaching Grade 3 mathematics. Their findings indicate that aligning the mathematics curriculum with a school food garden, requires expertise in both mathematics and horticulture/agriculture, designing suitable assessment strategies, and managing the time dedicated to mathematics instruction. It also requires creating appropriate lesson plans that integrate the school food garden. Failing to do so hinders the effective integration of a school food garden when teaching Grade 3 Mathematics. Solutions include ensuring that gardening activities align with specific mathematical learning standards, fostering collaborative efforts and interdisciplinary training to enhance competency in both domains for integrating a school food garden and addressing challenges by developing fair and effective assessment strategies. Additionally, other solutions involve ensuring adequate attention is given to both subjects through proper planning and management of class schedules (Martinen & Montes, 2021:6498; Nalumu et al., 2021:13; Westwood et al., 2021:25; Grazioli, 2020:148; Russell & Murphy, 2020:248).

The study highlights the importance of creating a conducive environment by initiating teacher collaboration in Professional Learning Communities (PLCs) to sustain the school food garden for successful integration into teaching mathematical concepts. This includes the active involvement of both teachers and learners in maintaining the food garden, and to simplify the teaching of complex mathematical content areas such as fractions and divisions. Teachers are encouraged to capacitate themselves to create a conducive learning environment (Kasumba, 2022:5; Lloyd & Paige, 2022:9; Dushkova & Haase, 2020:19; Taylor et al., 2021:405). According to Corrochano et al. (2022:3) and Cisse (2019:188), threats to integrating a school food garden for teaching Grade 3 mathematics arise from climate change and inappropriate teaching methods.

In response to these challenges, the study has devised a strategy to assist teachers in effectively utilising a school food garden to teach Grade 3 mathematics. The school in question is a public primary school classified as quintile one. It is situated in the Limpopo Province. Five teachers teach 167 students who are spread across Grades R to 7.

1.3 THE AIM OF THE STUDY

The study aims to design a strategy involving PBL that would promote the effective integration of school food gardens to teach Grade 3 mathematics.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study are to:

1. Describe the challenges teachers experience when implementing PBL that relies on a school food garden.
2. Explore effective practices in response to challenges when implementing PBL that uses school food gardens.
3. Determine the effectiveness of strategies closely associated with PBL that uses school food gardens.

1.5 RESEARCH QUESTIONS

This study's main research question is: Using PBL, what strategies involving a school food garden do teachers employ to effectively teach Grade 3 mathematics?

Emanating from the outcomes, the following sub-questions are:

1. What challenges do teachers experience when implementing PBL that relies on a school food garden?
2. Which practices are effective in response to challenges when implementing PBL that uses school food gardens?
3. How effective is PBL that uses school food gardens to teach Grade 3 mathematics?

1.6 THEORETICAL FRAMEWORK

Mia (2023:436) asserts that a theoretical framework guide constructing arguments in one's work. Olivier, Archambault, De Clercq, and Galand (2019:330) define a theoretical framework as the structure supporting a theory, explaining the existence of the research problem. This study utilises the Critical Emancipatory Theory (CER) as the theoretical framework.

Critical Emancipatory Theory (CER) originates from Marxist thinking, particularly associated with the Frankfurt School in Germany. Pioneered by members like Herbert Marcuse, Theodor Adoro, Walter Benjamin, Erich Fromm, and Max Horkheimer, CER establishes a strong link between knowledge of the social world and social critique (Renault, 2020:190:19). Corbolino, Bisaccia Irato, and Santovito (2020:46) note that critical theory, within the CER framework, advocates for the use of a school garden not just as a typical garden but as a transformative learning environment.

CER emphasises social justice, democracy, and the strengthening of language and communication. It fosters a mutual relationship between researchers and participants, creating a positive and interconnected environment beneficial for social justice (Nkoane, 2012:98). CER promotes equity, social justice, freedom, peace, and hope (Motsoeneng & Mahlomaholo, 2015:120). In the context of social justice, CER enhances communication, respect, and dialogue, encouraging learners and teachers to engage equally in using a school food garden to learn mathematical concepts collaboratively. This involves working in groups or pairs, sharing resources, and critically analysing and solving mathematical problems (Msimanga, 2017:37).

Guided by CER, the researcher collaborates with participants, acting as a facilitator in developing a strategy to integrate a school food garden into teaching Grade 3 mathematics. This collaborative approach challenges the obstacles to effective integration teachers face, aiming for social transformation and embracing social justice (Wellmer, 2014:36). The school food garden becomes a resource and a safe learning environment for learners to acquire mathematical knowledge and skills in real-life situations.

Different stakeholders, including learners, Foundation Phase educators, parents, the Department of Basic Education (DBE), Agriculture, and the community, participate as co-researchers in identifying challenges, proposing solutions, sharing good practices, and providing evidence of achievements using a school food garden to enhance Grade 3 mathematics teaching.

CER is deemed the appropriate theoretical framework for this study, as it encourages collaborative involvement of stakeholders and emphasises positive contributions from co-researchers. It also minimises power relations, fostering equality between researchers and co-researchers. Effective communication and respect are crucial to meeting the ethical requirements of social justice, democracy, and equity (McGonagle, 2020:127; Nkoane, 2020:14). The collaborative nature of CER ensures that researchers and co-researchers become equal partners, actively engaged in the research process.

In the realm of mathematics teaching, CER involves learner participation and liberation, offering strategies to overcome barriers (Motha, Makgamatha & Swartz, 2019:75). The hope is that Grade 3 educators will continue using the strategic framework after the research, having been active participants in its development.

CER challenges the construction of truth and emphasises the application of critical reasoning to effect change. Co-researchers, particularly teachers, play a vital role in imparting knowledge, encouraging meaningful discussions, active involvement, and promoting an asset-based approach to research (Suarez-Balcazar, 2020:47). Active engagement of learners and teachers in using a school food garden in Grade 3 mathematics stimulates critical thinking and expands reasoning horizons through problem-solving.

CER questions the definition of mathematics and the contexts in which it occurs, such as classrooms and learning gardens (Carlone, Mercier & Metzger, 2021:10). Ontology, as the world view and assumptions about the nature of being and reality, rejects the notion of simply reproducing ideas and encourages a shift from the unknown to the known (Acharya, Budhathoki, Bjonness & Duwadi, 2023:141).

Rhetoric, as a persuasive tool affecting behaviour, is crucial within CER. The researcher's rhetorical character, credibility, and standing as co-researchers build trust and contribute to a strong, logical argument based on facts and evidence (Donovan, 2018:53-65; Rapp, 2002:109-112). Effective communication within the team involves various modes, fostering active engagement and collaboration among team members.

In conclusion, with its emphasis on collaboration, equality, and critical inquiry, CER provides a robust theoretical framework for this study, guiding the integration of a school food garden into teaching Grade 3 mathematics.

1.7 CONCEPTUAL FRAMEWORK

PBL serves as the conceptual framework for this study. PBL enhances critical thinking (Seibert, 2021:86), represents an innovative educational approach by providing a wide range of skills that are key to success in the 21st century (Legget & Harrington, 2021:1272). According to the PBL model, the teacher assumes the role of a facilitator rather than the primary instructor, allowing students to guide their own learning through inquiry. PBL is rooted in constructivist-based, student-centred learning (Savery, 2015:12; Hendry, Frommer & Walker, 1999:370), fostering student interaction, research, and project generation to demonstrate understanding. Incorporating PBL into mathematics instruction has improved students' problem-solving skills, mathematical reasoning, and overall engagement in the subject (Cruz, Viseu & Lencastre, 2022:953390).

This study aims to develop a framework for the effective integration of a school food garden in teaching Grade 3 mathematics through the lens of PBL. The co-researchers actively involved in the study will collaborate to devise solutions to challenges. Therefore, if educators are willing to implement school food gardens in their classrooms, it can potentially alleviate issues of low performance in mathematics by concretising concepts.

The PBL framework aligns with the study's focus on integrating a school food garden. Introduced by philosopher John Dewey, PBL originated as a constructivist theory (Eliyansi, Kenedi & Sayer, 2019:232) and found its way into medical schools in Canada as early as the 1950s (Tan, 2021:1251). PBL represents a shift from traditional classroom settings to systematic learning, engaging learners in real experiences to find information and knowledge. It has since expanded across various education sectors (Ramadhani et al., 2019:137).

The primary goal of PBL is to actively involve individuals in learning through high order thinking skills Eliyasni et al. (2019:231). This systematic learning approach encourages learners to seek information and knowledge based on real experiences, equipping them with critical thinking skills to adapt to the 21st century. Additionally, PBL aims to develop geographical understanding, spatial thinking abilities, and positive attitudes toward learning (Suh et al., 2021:162).

PBL aligns with using problems to drive learning in the 21st century, developing skills necessary for problem posing and solving (Tan, 2021). It also supports students' involvement in cooperative teamwork (Sormunen, Juuti & Lavonen, 2020:692).

Epistemology, examining learners' knowledge and practices by exploring their perceptions of learning, plays a role in PBL (Sadler, Zangori & Friedrichsen, 2020:1339). The ontology of PBL involves the formalization of knowledge elements and contextual elements (Sormunen et al., 2020:691).

Within the conceptual framework of PBL, participants in this study employ language that recognises others as equal human beings, reflecting mutual trust and valuing communicational activities and interactions (Saqr & Alamro, 2019:8). This approach allows participants to express their views freely, emphasizing the importance of their perspectives in the study.

1.8 LITERATURE REVIEW

This section will examine the literature on integrating school food gardens to teach Grade 3 mathematics in a school in Limpopo. The literature review emphasises best practices in Australia, Ghana, and South Africa regarding integrating school food gardens into Grade 3 mathematics instruction.

Landry, Van den Berg, Hoelscher, Asigbee, Vandyousefi, Ghaddar, Jeans, Waugh, Nikah, Sharma, and Davis (2021:3031) assert that transitioning from a traditional classroom to a school food garden produces positive outcomes. Christensen and Wistoft (2019:240) highlight the importance of collaboration and connections between indoor and outdoor teaching in simplifying subject content, stimulating students' senses, and enhancing their sense of humour.

Integration connects diverse study ideas to real-life situations using general capabilities, hands-on experiences, and experiential learning. The school food garden is an experimental activity to enhance students' performance and increase their understanding of mathematics through activities supporting teaching and learning. In this context, mathematics encompasses various aspects, such as general capabilities, signs and symbols, artefacts, and specialised content areas like numbers and operations, space and shape, pattern function and algebra, measurement, and data handling.

Mabena, Mokgosi, and Ramapela (2021:451) indicate powerful evidence of poor mathematics performance among learners in South Africa, specifically in Kwagga. They argue that without utilising a school food garden, there is little confirmation of improvement in mathematics results (Niyazova, 2020:18; Greer, Raivelle & Knausenberger, 2019:260). Research has shown that small-scale vegetable gardens in schools benefit standardised test scores in mathematics and offer opportunities for teaching mathematics (Ambusaidi, Alyahyai & Taylor, 2019:30). Despite challenges, learners overcome barriers and become actively involved, demonstrating that school food gardens provide teachers with more strategies for teaching mathematics actively (Hoover et al., 2021:595). In disadvantaged areas, evidence suggests that some schools have benefited from using a school food garden to make mathematical connections and solve mathematical problems (Kenedi, Helsa, Ariani, Zainil & Hendri, 2019:68).

This study acknowledges the challenges learners face when learning mathematics; the primary issue being understanding mathematics through a school food garden. Teachers struggle to find ways to integrate the school food garden into solving mathematical problems, such as representing arithmetic properties like adding and subtracting up to a thousand (Takahashi, 2021:1). According to Worsley et al., (2019:48), integrating a school food garden into the curriculum is a challenge in Ghana, particularly in teaching Grade 3 mathematics. Nalumu et al., (2021:20) support Bertrand and Namukasa (2020:48) in stating that Ghanaian educator face challenges in planning mathematical lessons, such as introducing multiplication and teaching place values. Oljayevna and Shavkatovna (2020:239) find teaching mathematics using a school food garden challenging, often limiting instruction to basic agricultural practices. Landry et al. (2021:398) mention that acquiring skills in numeracy and arithmetic is a significant challenge, leading to learners struggling to numerate in their early years of schooling. In South Africa, teachers lacking knowledge in horticulture pose a challenge to integrating the school garden into teaching Grade 3 mathematics (Noone, 2021:24).

Studies prove that school food gardens significantly enhance direct and indirect curriculum performance in teaching Grade 3 mathematics (Landry et al., 2021:3081). Based on poor primary mathematics performance, high dropout rates occurred when school food gardens were ineffective; however, there is no clear evidence of improvement in mathematics performance through the application of various methods and approaches, including the integration of school food gardens (Roothaert et al., 2021:62). Other researchers propose overcoming these challenges through participatory workshops to capacitate teachers (Grazioli, 2020:1480). Smith (2023:142) emphasises the need for awareness of using school food gardens in the curriculum, especially in teaching Grade 3 mathematics. Maximum support from different stakeholders, especially in high poverty-stricken schools, is crucial in acquiring necessary resources (García & Weiss, 2019:19).

If effectively utilised, a school food garden can improve learners' mathematics performance by engaging them through various activities. One example is creating smaller areas which require learners to measure correctly—a key skill in mathematics (Grant, 2021:5). According to Velardo et al., (2020:165), a school food garden can alleviate cognitive overload stress and simplify complex concepts.

Factors hindering the implementation of school food gardens include defined policies related to the curriculum, such as the time frame for curriculum coverage and notional time allocated for specific subjects (Hansman, 2021:145). Lack of support, insufficient time allocated to implementing school food gardens, and environmental hazards such as a lack of water can also negatively affect the strategy's implementation (Cisse, 2019:188).

The affirmation that a school food garden enriches mathematics teaching lies in learners developing an interest in studying mathematics (Wright, 2021:160). According to Carver, Thomas and Darling-Hammond (2019:3), a school food garden serves as a simple tool for teaching, making it easier for most teachers. Teachers become interested in teaching mathematics when they have a better tool (Hammond et al., 2019:39).

1.9 RESEARCH DESIGN AND METHODOLOGY

The research plan and processes for this study employ Participatory Action Research (PAR) to ensure the effective utilisation of a school food garden for teaching Grade 3 mathematics at a school in Limpopo. Notably, the teaching strategy involves using Problem-based Learning (PBL). PAR is chosen to gather the necessary input for the research topic and understand how to integrate a school food garden into teaching Grade 3 mathematics (Smith, Danford, Darnell, Larrazabal & Abdellatif, 2021:130).

According to Calabria and Bailey (2023:670), PAR is a pedagogical approach encompassing all learning areas as a learning process. It involves the active participation and control of individuals experiencing issues, with researchers joining in to generate new ideas (Cornish, Breton, Moreno-Tabarez, Delgado, Rua, de-Graft Aikins & Hodgetts, 2023:34). Its origins can be traced back to Aboriginal Communities (Warry, 1990:16). PAR operates on the idea that knowledge is socially generated and adopts a constructionist perspective (Armstrong, 2019:9; Beaton, 2018:33; Baldwin, 2012:35). PAR is chosen because it provides participants with the opportunity to be empowered and supported in re-evaluating and altering their practices within the educational system. It emphasises social change that promotes democracy and combats inequality (Chevalier & Buckles, 2019:23; Kemmis, McTaggart & Nikon, 2019:21; Riel, 2019:51). Participants will be able to collect and analyse data to bring about transformation through practical knowledge.

The PAR was conducted at a public primary school in Limpopo Province, situated in a rural area with a poor socioeconomic status, classified as quintile one. The school covers grades R to 7 with an enrolment of 167 students and five teachers. Conducting the research within the same community and school where both the researcher and co-researchers are actively engaged allows maximum participation in changing their situation as a marginalised community (Bhandari, 2020:9).

After obtaining ethical clearance from the University of Mpumalanga, the researcher approached the school principal to present the intention and importance of conducting the study. Additionally, a permission letter of request was sent to the circuit office and the Department of Basic Education’s (DBE) Head office. The researcher formed a research team consisting of two Grade 3 teachers, the Grade 3 class, the principal, one Departmental Head, 10 parents, one curriculum head, and one Agricultural staff member.

1.10 RESEARCH SITE

The research site for this study is a school in Vlakfontein Circuit in the Capricorn District, Limpopo Province. The school was chosen because it lacks resources in a deep rural area. It is a non-fee school with a low socioeconomic status, and there is evidence of poor performance in mathematics (Wright, 2021:160). A school food garden is a simple teaching tool, making teaching simple for most teachers.

1.11 GAINING ENTRY

The researcher requested permission from the school's principal, the school governing body (sgb), the circuit office and the DBE to continue research. The researcher asked the task team to be part of the study. Letters of consent were sent to parents to request permission for their children to participate in the research; assent forms were used since they are minors. The letters and forms were worded in a friendly tone; parents’ mother tongue was used. The rights associated with the research were also outlined. The task team elected the study coordinator and also identified a secretary, who took administered meetings, .e.g. sending invitations, drafting the agenda and keeping minutes of meetings.

1.12 THE RESEARCH TEAM

The method used to conduct the study was a focus group. Sim and Waterfield (2019:3005) explain that a focus group is a group discussion on a specific topic under the guidance of a trained group, which, of course, is the coordinator in this case. The focus group comprised all the Foundation Phase educators, ten children in the Grade 3 class, the principal, parents of the selected learners, DBE, and local farmers as they assisted with growing the vegetables. The minutes of each meeting were recorded as evidence that served as a record and demonstrated progress. Audio recordings were used during meetings. Collaboration is expected always to promote healthy practices and safety measures. Observation and feedback were prioritised during meetings to check progress. It was the team's responsibility to monitor progress and make follow-ups.

1.13 THE ROLE OF THE RESEARCHER

The researcher acted as a facilitator, guided the team, interpreted and promoted collaboration, built commitment, trust, and respect, and created an atmosphere of no power differentiation.

1.14 THE RELATIONSHIP WITH THE RESEARCHER

There is a mutual relationship between researcher and co-researcher that evokes reliability, trustworthiness epistemology and ethical considerations. I, together with the research team, collected data and used the school once we got ethical clearance from the University of Mpumalanga and permission from the school principal. The members abided by the ethical procedures and stipulated guidelines to ensure a successful data collection process. Permission to conduct research was requested and obtained from all stakeholders. The process of the study was outlined to all, and no incentives were offered or given to participants of the study.

1.15 VISION AND MISSION

The study's aim is to determine the effectiveness of PBL that uses a school food garden for teaching Grade 3 mathematics. The common vision for this integration seeks to establish a clear purpose and understanding of how a school food garden can enhance mathematics teaching when using a learner-centred approach such as PBL. This vision underscores the significance of mathematics instruction in developing numeracy and aims to ensure consistency in teaching mathematics across classrooms and grade levels. It also strives to align teachers' approaches, methodologies, and instructional strategies when integrating a school food garden into mathematics teaching. The shared vision is geared towards enhancing learners' achievements, requiring proficiency in mathematical skills such as addition, subtraction, multiplication, and division.

Furthermore, the common vision emphasises collaborative professional development among educators, fostering a culture of continuous learning and improvement involving educators engaging in shared practices, exchanging ideas, and enhancing their knowledge and skills in mathematics teaching. The ultimate goal is to promote differentiation and equal access to mathematics education. Educators and stakeholders are encouraged to work collaboratively towards the shared vision of improving mathematics teaching. This collective vision provides a framework for decision-making, instructional planning, and ongoing professional development in the field of mathematics education.

1.16 DATA GENERATION

As Karyono and Agustina (2019:68) outlined, the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis is the basis for prioritizing strategies and assessments when formulating the development plan. This SWOT analysis will be instrumental in assigning responsibilities to the Task Team within the study. The task team will employ this strategy to identify the strengths, weaknesses, threats, and opportunities, ensuring that each participant is equitably assigned responsibilities. This approach provides an overview of various activities to achieve strategic priorities while adhering to the specified time frame for monitoring changes (Education Statement of Strategy, 2021-2022).

The co-researchers are considered active agents in knowledge creation and data generation (Yanay-Ventura, Issaq & Sharabi, 2020:6). Their expertise will be evident in meetings, discussions, and the formulation of conclusions that contribute to the study's success. The team will collaboratively determine five activities that are aligned with the study's objectives. See Table 1.1. Data will be collected through various means, including meetings, observations, facilitated small group or focus group discussions, and the analysis of reports, policies, and curriculum documents.

Table 0.1: Action Plan

PRIORITIES	ACTIVITIES	RESPONSIBILITY	RESOURCES	TIME FRAMES	MONITORING
Priority 1 Capacitating teachers to make lesson plans	Initial planning and goal setting. Identify challenges and mitigation factors.	Coordinator and the team	Classroom	1 hour meeting over a period of two weeks	Engages in discussions
Priority 2 PCK	Come up with possible solutions to the challenges. The team meet fortnightly to develop the way forward.	Team members	Classroom	2 hours 1 -hour weekly for a period of three months	Discussions: The researcher outlines the importance of the study The team meets and engages in discussions to use the strategy.
Priority 3 Coordinate	Discuss the conditions favourable to	Grade 3 Educator, Foundation	School food garden	1 hour meeting every week for a period of	The teacher does lesson presentations;

activities to facilitate during the lesson using a school food garden.	the success of the strategy	phase educators		three months	the team reflects on the lesson.
Priority 4 Enabling teachers to assess learners using the school food garden.	Discuss the strategy and reflect on the success	Grade 3 Educator, Foundation phase educators	School food garden, learners' workbooks	1 hour meeting every week for a period of three months	Leaners' workbooks and tasks are assessed to check progress. Reflections. Plan for new activity
Priority 5 Concretizing the use of the school food garden to teach Grade 3 mathematics.	Learners learn through school food garden	Grade 3 educators, learners	School food garden	1 hour daily	Learners engage in lessons using a school food garden.

1.17 DATA ANALYSIS, INTERPRETATION AND REPORTING

The research will employ Critical Discourse Analysis (CDA) to scrutinise and interpret the collected data. This method draws upon a multidisciplinary approach, incorporating tacit theories and methods derived from traditions in rhetoric, cognitive science, sociology, and anthropology (Wodak & Meyer, 2009:19). CDA is grounded in interdisciplinary content, focusing on the development of participants' knowledge, problem-solving skills, self-confidence, self-efficacy, and a passion for learning, all while accommodating learners with diverse learning styles, backgrounds, interests, talents, and values. In this study, CDA is utilised to integrate a school food garden into teaching Grade 3 mathematics. The findings of this study may empower teachers and encourage others to use a school food garden for teaching Grade 3 mathematics.

Everyone possesses the right to analyse and interpret the findings within the PAR framework, implying that multiple interpretations are likely to emerge and be evaluated. This approach fosters respect and trust among participants while addressing their problems toward creating change. The data was analysed using scenarios, descriptive text, and photographs. Co-researchers own and approved transcripts, ensuring their commitment to application, reflection, and strategizing (Parameswaran, Ozawa-Kirk & Lantendresse, 2020:5). Data coding will involve using five distinct colours, corresponding to the five research objectives, to identify distinct themes and their relationships, forming a coding framework (Medelyan, 2019:79).

1.18 VALUE OF STUDY

The study will contribute to the community of Limpopo Province's goal of integrating the school food garden into teaching mathematics in Grade 3. Despite their socioeconomic background, the school food garden will enhance meaningful learning towards learners and commit teachers to collaborating with each other through active engagement and empowerment. It will further contribute to the DBE's integration of the school food garden across the curriculum. The community will learn the importance of environmental education by collaborating with educators in integrating school food gardens across the curriculum, improving Mathematical performance.

1.19 ETHICAL CONSIDERATIONS

The researcher and the research team collected data and used the school once we obtained ethical clearance from the University of Mpumalanga and permission from the school principal. The members abided by the ethical procedures and stipulated guidelines to ensure a successful data collection process. Permission was requested from all stakeholders by completing the consent forms for adults and the accented form for learners as minors. The study process was outlined to all informed that there would be no incentives to participate. The participants were ensured of their safety as well as the protection of their rights; all information, like video recordings, would be kept safe for a certain period and then discarded at a later stage according to rules and regulations of the University's Research Department. Participants were always treated with respect.

Before signing individual consent forms their rights were explained, namely that participation remained voluntary, participants were ensured of their anonymity, and they were welcome to withdraw at any time without coercion during the research process (Grant, 2021:4). The study setting was maintained using pseudonyms during the introductory phase (Jackson, Mazzei, Denzin & Lincoln, 2018:617). Report findings were communicated directly with the participants during meetings.

1.20 CONFIDENTIALITY

In this study, the co-researcher's confidentiality was essential and protected. There was no danger or harm during the study. Co-researchers were respected throughout the study. The findings were presented to co-researchers through their preferred method. Information was stored safely in password-protected computers and locked in a safe with controlled access.

1.21 ANONYMITY

According to Pain, Whitman, and Milledge (2019:204), keeping anonymity in PAR is difficult because researchers know each other. All participants were familiar with one another, and where possible, people's identities were impersonated, and pseudonyms were employed. Co-researchers' rights were clarified and protected. All the data was carefully conserved and eliminated following the University's research regulations. All co-researchers received letters of ascent and permission. All team members were treated with respect throughout the study, and no harm was expected. Social justice and democracy were prioritised.

1.22 RELEVANCY OF THE STUDY

PAR was chosen for this study since it allowed the researcher to be immersed together with the teachers, who served as co-researchers. This study aimed to develop a strategy to facilitate the effective integration of a school food garden for teaching Grade 3 mathematics. In mathematics education, utilising PAR fosters collaboration among educators, learners, and other stakeholders, enabling active participation in developing and enhancing mathematics teaching practices (Parameswaran et al., 2020:243). PAR provided a platform for educators and learners to engage in a collective process of reflection, experimentation, and problem-solving, leading to the creation of effective mathematics teaching methods tailored to the specific needs and circumstances of the learners (Sormunen et al., 2020:691).

1.23 LAYOUT OF CHAPTERS

Chapter 1 focuses on the introduction and background of integrating school food gardens in teaching Grade 3 mathematics in Limpopo Province. The study seeks to address the problem by exploring the challenges and success in answering the research question, objectives, and strategy design.

Chapter 2 focuses on the literature review, where existing literature and studies have been studied and outlines the theoretical framework and related literature.

Chapter 3 presents the research methodology using PAR as an approach and methods of generating and analysing data.

Chapter 4 presents the data analysis, results and interpretation towards designing a strategy for implementing the FSP at a primary school in the Limpopo district.

Chapter 5 presents the conclusions, a summary of the study's findings, and recommendations for implementation.

1.24 TIMELINE OF THE STUDY

The proposed timeline for this study are outlined below.

Table 0.2: Study Timeline

RESEARCH ACTIVITY	TIME IN MONTHS
Submission of Proposal	JULY 2023
Chapter 1 (Introduction and Background)	30 July 2023
Chapter 2 (Literature Review)	30 October 2023
Chapter 3 (Research Methodology)	30 November 2023
Chapter 4 (Data Generation and Analysis)	30 December 2023
Chapter 5 (Recommendations and Conclusions)	30 January 2024
Finalization of the first draft	15 February 2024
Submission for examination	March 2024

1.25 CONCLUSION

This study designs the strategy centred around PBL to integrate a school food garden when teaching Grade 3 mathematics at a primary school in the Limpopo Province. The study focuses on the Foundation Phase using the PAR approach. This chapter presents a brief introduction and background to the study as encompassed by the aim and objectives. Evidence of success in effectively integrating school food gardens in teaching Grade 3 mathematics is also explored. The study's theoretical framework, design, methodology, and data analysis have been elucidated. This study outlines ethical considerations and the value of this study, and the layout of the chapters has been outlined.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

The primary goal of this study is to formulate an effective strategy for teaching Grade 3 mathematics by utilising a school food garden. This chapter thoroughly discusses the theoretical framework, conceptual framework, and literature review that guide the study to fulfil the study's objectives. Subsequently, the operational principles and pertinent literature are examined, considering statutory requirements and policy directives concerning integrating school food gardens in South Africa, Africa, and globally. The chapter delineates the challenges teacher encountered when employing PBL that uses school gardens to teach Grade 3 mathematics, potential solutions to these challenges, optimal conditions fostering the successful integration of school food gardens for Grade 3 learners, anticipated threats along with mitigation strategies, and evidence of success in effectively integrating school food gardens for teaching Grade 3 mathematics.

2.2 THEORETICAL FRAMEWORK

According to Mia (2023:436), the theoretical framework serves as a road map for building the arguments you will use in your own work. It is a foundational review of existing theories. Olivier et al. (2019:330) mention that a theoretical framework is a structure that may hold or support a theory and describes why the research problem under consideration exists. In developing a suitable strategy, this study used Critical Emancipatory Research (CER) as a guiding lens and a standpoint for integrating school food gardens to teach Grade 3 mathematics.

2.2.1 The Origins of Critical Emancipatory Research (CER)

Critical Emancipatory Theory (CER) emerges from Marxist intellectual activity and has roots in Germany, particularly associated with the Frankfurt School. Pioneered by influential figures like Herbert Marcuse, Theodor Adorno, Walter Benjamin, Erich Fromm, and Max Horkheimer, CER establishes a robust connection between an understanding of the social world and social critique (Renault, 2020:190:19). This theoretical framework provides participants in this case, learners, with the opportunity to explore and gain a deeper understanding of their immediate social world, which, in this study, involves the school food garden. Corbolino et al. (2020:46) highlight that critical theory promotes the school garden as a dynamic learning environment, fostering observation and engagement beyond the ordinary garden setting. CER encompasses various forms, such as Marxism, postmodernism, and feminism, and its political orientation evolves based on cultural and social contexts, encompassing critical, progressive, or emancipatory aims (McArthur, 2022:81).

2.2.2 Objectives of CER

CER fosters a commitment to social justice and democracy by emphasizing the empowerment of language and communication. It establishes a reciprocal relationship between the researcher and co-researchers, fostering a positive atmosphere that contributes to social justice (Nkoane, 2012:98). CER advocates for principles like equity, social justice, freedom, peace, and hope, aligning with the work of Motsoeneng and Mahlomaholo (2015:120). In the context of social justice, CER enhances communication, respect, and dialogue, engaging both learners and teachers in collaborative activities within a school food garden to learn mathematical concepts involving group work, partnerships, resource sharing, and critical analysis of mathematical problems (Msimanga, 2017:37).

Guided by CER, the researcher collaborates with participants, taking on the role of a facilitator in developing a strategy to integrate the school food garden into Grade 3 mathematics teaching. The researcher and co-researchers work together to embrace strategies that address the challenges of effectively integrating the school food garden into Grade 3 mathematics, contributing to social transformation through a commitment to social justice (Wellmer, 2014:36). Moreover, the researcher and co-researchers possess the ability to disseminate information positively, reinforcing effective communication.

CER establishes a positive relationship between the researcher and co-researcher, focusing on social justice dynamics. Language and communication are integral components of the methodology, serving as mediums of expression. Additionally, the researcher acknowledges the importance of the co-researcher's voice in promoting social justice and democratic citizenship. The emphasis is on fostering a respectful relationship between the researcher and co-researcher, recognizing their voices and experiences (Nkoane, 2012:98). This alignment with principles of social justice is further echoed in the South African Constitution (Act 108 of 1996). CER promotes social justice and democratic citizenship by respecting co-researchers reinforcing humanity, social value, and equity.

2.2.3 Justification of CER

CER is the appropriate theoretical framework that underpins this study. According to McGonagle (2020:127), CER encourages the collaborative involvement of stakeholders and promotes agreement. Nkoane (2020:14) stresses the co-researcher’s positive contribution, the respect they should get and the extent to which they feel they belong and have a fair say in the research or knowledge construction. In addition, by minimising power relations, the researcher and the co-researchers worked closely together as a team. Communal power is essential to the ethics requirements for social justice, democracy, and equity. There is respect between researcher and co-researcher and a positive interaction. According to Machin and Mayr (2012:236), Mahlomaholo and Nkoane (2002 :70), Creswell (1998; 209), Guba and Lincoln (1998:120) and Carr and Kemmis (1986:70), researchers and co-researcher become equal partners and become more involved. Once the research is done, there is hope that the Grade 3 educators will continue using the strategic framework as they were part of all the deliberations. CER as a theoretical framework is a lens in this study (McGonagle, 2020:127).

2.2.4 Different formats

There are different forms of CER, but the most relevant for this study were language and communication.

2.2.4.1 Language

Nkoane (2020:14925) attests that language is a form of social practice. Additionally, using the power of language as a medium of communication between the researcher and participants, there is evidence of interaction between the researcher and participants through language. Issues of social justice and democratic citizenship become central. CER uses the power of language for participants and researchers to express themselves. Therefore, language is a product of communication.

2.2.4.2 Communication

Dlamini (2020:18) specifies that CER aims to enhance communication amongst community members because it is critical to human interaction. Communication is viewed as an influential research tool that builds our interpretation of the world and how others view us as individuals. Therefore, the role of CER is to expose such possibilities of distortion of reality. Consequently, I acknowledge that communication is essential in developing a strategy to integrate school food gardens to teach Grade 3 mathematics.

2.2.5 Epistemology

According to Obiageli (2023:13), CER transforms situations by using analytic awareness and critical thinking to see reality as a process in which people can intervene and impact change to direct themselves to their situation. It is also argued that co-researchers, as teachers, in this case, they impart knowledge, encourage meaningful discussion, active involvement, encouragement, promoting an asset and powerful base approach to research and enhancing relevant mediation (Suarez-Balcazar, 2020:47). Indeed, in understanding imparting knowledge, active engagement of learners and teachers in the use of school food garden in Grade 3 mathematics instil knowledge through critical thinking, analysing and also expand reasoning horizon through problem-solving.

2.2.6 Ontology

Kayumova and Strom (2023:86) highlight that ontology refers to world views and assumptions concerning the nature of being and reality. Bonnett's (2021:87) inquiry into "how one's relationship with the environment—especially with nature—is to be understood" has sparked our contemplation. Additionally, Young and Malone (2023:1077) suggest that using a school food garden allows learners to meaningfully connect with their reality, linking where they come from to the classroom setting. Consequently, this enhances the integration of the school food garden into Grade 3 mathematics teaching, fostering a deeper understanding of the world and its phenomena among teachers and learners.

Katan and Baart (2021:3) point out numerous realities, challenging the notion that research is primarily driven by the 'dominant or elite researcher' perspectives. From this perspective, it becomes evident that Critical Emancipatory Theory (CER) is advantageous for all participants, irrespective of gender, race, economic background, or sexual orientation. One could further argue that CER promotes inclusive innovation.

2.2.7 Language/rhetoric

Rhetoric serves as a means of persuading individuals to align with a specific viewpoint or take action that influences their behaviour (Batista, 2021:77). The researcher considers CER suitable because it allows the team to communicate openly, fostering active engagement and collaboration among team members through various modes of communication. The co-researchers are seen as dynamic individuals demonstrating a positive attitude toward the study. The researcher treats co-researchers respectfully, emphasising the importance of equity for everyone involved. The researcher's rhetorical character, standing, and credibility cultivated a sense of trust among the team members and others; it facilitated the construction of a robust, rational argument grounded in facts, data, and evidence presented logically. This resonated with the teams' emotions and thoughts in response to both spoken and written communication (Donovan, 2018:53-65; Rapp, 2002:109-112). Effective verbal or non-verbal communication may also involve using artefacts, signs, symbols, text, and oral expressions by teachers and learners.

2.3 CONCEPTUAL FRAMEWORK

It is essential to explore the model to comprehend the role that Problem-Based Learning (PBL) plays in integrating a school food garden into teaching Grade 3 mathematics. PBL, as defined by Mceleli (2019:10), is an instructional approach utilising challenging real-world issues instead of straightforward factual and conceptual instruction to assist learners in grasping concepts and ideas. This instructional strategy, known as problem based learning, involves collaborative student efforts to solve complex, real-world problems for learning (Mann et al., 2021:28). Moreover, it places a significant emphasis on problem-solving, active learning, critical thinking, and integrating information from various fields. Similarly, Bevan and Capraro (2021:654) affirm that PBL is a teaching strategy centred around presenting authentic, poorly structured problems for learners to solve, typically mirroring real-life scenarios. According to Davey, Elliot, and Bora (2020:3), learners are motivated to identify what they already know, determine what they need to know, and bridge the gap through collaborative learning, communication, and the application of knowledge to develop solutions.

2.3.1 Origins of PBL

PBL "was introduced in medical education as a substitute for traditional instruction because it was discovered that graduates had knowledge but lacked the necessary problem-solving skills to apply this knowledge" (Solano, 2023:136). PBL was first implemented at McMaster University in Canada and afterwards gained popularity in the USA and Europe. PBL was developed by Barrows, a professor of neurology, as an alternative to conventional training (Servant-Miklos, Norman & Schmidt, 2019:4).

Additionally, Don Woods' contribution to the development of PBL while working with chemistry students at McMaster University in Canada was recognised in the literature (Dirckinck-Holmfeld, 2009:4). Since this method drastically altered the medical curriculum, it meant that learning should concentrate on the patient's complaints and the problem they presented (Dirckinck-Holmfeld, 2009:4). It was assumed that, while learners were engaged in analysing the problem, which would be patient in the case of medical students, they would formulate questions, learning goals and learn in the process of solving the problem at hand. Other universities inspired by the success of the McMaster medical curriculum followed PBL, for example, the establishment of Aalborg University as centre for PBL in Denmark (Dirckinck-Holmfeld, 2009:4). The adoption of PBL had expanded into elementary schools, middle schools, high schools, universities, and professional schools (Savery, 2009:143). Middle and elementary schools joined the ranks of those embracing PBL because of Illinois mathematics and Science Academy's (IMSA) stated leadership in the field (Inman, 2011:44–45). Moreover, PBL has gained prominence in various disciplines, including mathematics (Erickson, 1999:518). The literature further claimed that PBL had spread to numerous other fields of education, although it has not been used extensively thus far in teacher education (Schmude, Serow & Tobias, 2011:678). Based on the claimed success of PBL, this study assumed that school food gardens could be enhanced by using PBL.

2.3.2 Objectives of PBL

PBL serves as an approach that empowers learners to actively engage with and solve authentic problems (Setyani & Susilowati, 2022:510). Using a school food garden, PBL is a powerful and engaging method for teaching various mathematical concepts (Harper & Kudaisi, 2023). Furthermore, PBL allows students to explore mathematical ideas in practical settings, deepening their understanding of mathematics while promoting sustainability and environmental awareness. This study concentrates explicitly on incorporating school food gardens as a context for PBL in mathematics education. School food gardens offer a diverse, interdisciplinary learning environment where students can apply mathematical concepts to address real-world issues related to planting, harvesting, budgeting, and sustainability. Integrating school food gardens into mathematics instruction through a PBL approach has the potential to be a transformative educational experience for students. This method encourages interdisciplinary learning, nurtures environmental consciousness, and enhances mathematical proficiency. Despite existing challenges, the advantages of this approach indicate its potential as a valuable addition to mathematics education.

2.3.3 The role of the researcher

The role of the researcher encompasses conducting the study, providing guidance, communicating, and sharing knowledge with co-researchers. The researcher serves not only as a leader but also as a facilitator, collaboratively analysing data with all other participants. Additionally, the researcher delegates power to participants to enable them to express their thoughts. Collins (2022:14) emphasises various researcher roles in research, including gathering and comparing resources, verifying facts, conducting necessary fieldwork, and maintaining the confidentiality of critical information.

2.3.4 The relationship between researcher and co-researchers

A reciprocal and mutual relationship exists between the researcher and the co-researcher, fostering reliability, trustworthiness, and ethical considerations. Bovill (2020:1023) acknowledges that co-researchers contribute to positive relationships, co-creation, engaging in deeper discussions, and consistently co-presenting. The collaboration between the researcher and co-researcher is characterised by reciprocity and mutual support.

2.4 LITERATURE REVIEW

This section analyses literature covering Australia, Ghana and South Africa to understand how teachers from other countries integrate school food gardens when teaching Grade 3 mathematics. This study’s objectives include identifying challenges teachers face when having to integrate a school food garden for pedagogical purposes. It also explores possible solutions by investigating conditions that are conducive to the effective integration of the school food garden. Ways to mitigate problems are offered together with proof of success to highlight the benefits of using a school food garden to teach Grade 3 mathematics.

2.4.1 Definition and discussions of operational concepts

This section aims to define and discuss the operational concepts underpinning this study. Integrating school food gardens will be discussed and contextualised at a school in Limpopo to develop a strategy to incorporate school food gardens to teach Grade 3 mathematics.

2.4.1.1 Integration

According to the Oxford English Dictionary (2024), integration is the action or process of combining two or more things to make them function together. Collins Dictionary (2024) defines integration as the act of combining or adding parts to create a unified whole. Margot and Kettler (2019:16) describe integration as teaching subjects in an approach that requires learners to apply content knowledge to solve real-life problems. This approach, observed in Australia and Ghana, involves experiential learning processes that establish connections between aspects of learners' lives, learning, and capabilities (Monferrer, 2022:48; Wistotf, 2019:237). This study's integration pertains to teaching Grade 3 mathematics using a school food garden. However, in South Africa, integration is understood as connecting different areas of study through meaningful engagement in real-life situations (Burt et al., 2018:17).

2.4.1.2 School

According to the Collins Dictionary (2024), a school is an educational institution created to offer learning spaces and environments for students' education under teachers' guidance. The Oxford English Dictionary (2024) defines a school as a place where children go to receive an education. Webster (2023:13) describes a school as an organization that provides instruction. In the context of this study, the school is a primary school categorised as a quintile one due to its disadvantaged socioeconomic status. It operates as a no-fee school, offering education from Grade R to 7, with an enrolment of 167 students and five teachers.

2.4.1.3 School Food Garden

School gardens involve children cultivating flowers and vegetables as an extension of their school work. This study is guided by the CER theoretical framework, shaping the strategy to integrate school food gardens into Grade 3 mathematics instruction. As defined in this study, school food gardens, often called kitchen gardens, produce vegetables and fruits for human consumption (Mantenta & Mzini, 2021:409). In Australia, school food gardens are utilised to enhance students' performance and deepen their understanding of mathematics within the context of science (Monferrer et al., 2022:48). These gardens also serve as learning laboratories across various subjects (Christian et al., 2022:17). In Ghana, school food gardens support teaching and learning for better comprehension (Mollineau et al., 2021:14).

In South Africa, school food gardens are indicators for understanding mathematical concepts and their applications (Mantenta & Manzini, 2021:131). These gardens offer an experiential, hands-on learning environment where children can engage in real-world activities, exploring and reasoning independently while smelling and even consuming garden produce (Shafer, 2018:15). Despite challenges in South Africa, where school food gardens are used for food security, they are still recognised as valuable for integration into mathematics teaching (Kasumba, 2022:1). School food gardens provide practical demonstrations for understanding Grade 3 mathematics, offering a tangible approach to teaching complex concepts, such as counting seeds or measuring plot sizes. School food gardens make mathematics learning more accessible and engaging for learners.

2.4.1.4 Grade 3 Mathematics

According to the Oxford English Dictionary (2024), mathematics is a field of knowledge encompassing numbers, shapes, spaces, formulas, structures, and quantities with their variations. In Australia, the Grade 3 Mathematical curriculum centres on general capabilities, achievement studies, and related criteria (Kwon, 2020:17). Meanwhile, in Ghana, Grade 3 mathematics emphasises basic operations, artefacts, instruments, tools, technologies, and signs and symbols (Ali, 2021:17). In South Africa, Grade 3 mathematics covers number operations and relationships, measurement, space and shape, patterns, functions, and algebra (DBE, 2011:3).

2.5 RELATED LITERATURE

This study aims to design a strategy to effectively teach Grade 3 mathematics using a school food garden. The related literature is reviewed to expand an understanding of challenges, foreseeable threats, and ways to achieve this. Lastly, the conducive factors and evidence of success in the implementation.

2.5.1 Challenges integrating a school food garden to teach Grade 3 mathematics

2.5.1.1 Grade 3 geometry lesson plans without using school food garden

Lesson plans are crucial tools, providing teachers with the structure and guidance necessary for imparting knowledge and skills to learners. These tools enhance effective teaching and learning, emphasising the need for teachers to possess Pedagogical Content Knowledge (PCK) to prepare impactful lesson plans (Moh'd, Uwamahoro & Orodho, 2022:1162). However, creating and incorporating units and projects into the classroom using a school food garden can be challenging, as Dring, Lee, and Rideout (2020:369) noted. In Australia, attempts to integrate school food gardens face difficulties in aligning them with the school curriculum and incorporating them into regular lessons. Similarly, teachers encounter challenges in Ghana during practical lessons, even though they can implement school food gardens. In South African schools, while developing and enhancing school gardens is beneficial, creating numeracy lessons related to school gardens poses a challenge, particularly in disciplines like algebra and geometry (Niyazova 2020:18; Greer et.al., 2019:260).

Teachers often find it challenging to capture learners' attention when dealing with the abstract nature of mathematical concepts such as division (Oljayevna & Shavkatovna, 2020:236). Despite school food gardens being integrated into the curriculum, teachers in Australia face a knowledge and skills gap in effectively teaching complex concepts like division, which requires abstract thinking (Worsley et al., 2019:48). In Ghana and South Africa, teachers' knowledge, and skills in using school food gardens are primarily limited to basic number operations, such as addition and subtraction (Nalumu et al., 2021:130221). Additionally, South African teachers encounter challenges incorporating algebraic word problems and basic arithmetic using a school food garden (Makgakga, 2023:140). In Ghana, although gardens and kitchens were considered interactive in classrooms since the late 20th and 21st centuries, full implementation in teaching arithmetic remains questionable (Monferrer et al., 2022:35). Teachers often resist the implementation of specified curriculum content in mathematics (Nicol et al., 2020:190). Monferrer et al., (2022:47) highlight a lack of a direct link between school food gardens, assimilating abstract mathematical concepts to learners, and experimental science and mathematics.

Explicit links to curriculum objectives are lacking, making the implementation of Garden-based Learning (GBL) challenging, with few methods and programs available for integrating it into the curriculum (Love, Booth, Margerison, Nowson & Grimes, 2023:1292; Hoover et al., 2021:592).

2.5.1.2 Challenge on Pedagogical Content Knowledge (PCK)

According to Shulman (1986:60), PCK is the capacity of educators to integrate pedagogical understanding with subject-matter expertise. Zaidi and Ali (2022:505) attest that numerous factors, such as improper training of teachers, untrained or half-trained thought processes of the learner, misperceptions, and demographic prejudices, can affect the understanding and teaching of mathematics. Still, teachers stand at the tip of everything to facilitate the process of teaching and learning. There is a relationship between knowledge of mathematics and representation, whereas knowledge of teachers and learners is related to pedagogical knowledge. According to Abramczyk and Jurkowski (2020:197), teachers are challenged to apply educational theories, best practices and techniques for effective subject teaching. Suppose teachers are not conversant with the subject matter. In that case, they cannot develop a strategy to convey the knowledge productively (Charalambous, Hill, Chin & McGinn, 2020:580) attest that many subjects are complex and multifaceted, as a result, it makes it challenging to grasp the subject matter and understand all the details and distinction. Most educators find it challenging to know how to teach, what to assess, and what forms to use in mathematics assessment, which indicates a lack of PCK.

2.5.1.3 Teaching space and shape without using a school food garden

Teachers encounter challenges in utilising the school food garden to address complexity creatively (Austin, 2022:380). Furthermore, addressing the need for prerequisite knowledge, Hoover et al. (2021:595) affirm that the school food garden promotes health strategies, indicating a lack of centralised organization in its incorporation into the curriculum. The activities in which learners engage during mathematics lessons should not merely serve as a means to keep them busy but should align with the mathematics curriculum (Pepin & Kock, 2021:310). Teachers struggle to devise relevant strategies for teaching mathematics using the school food garden and often rely on traditional teaching methods and resources rather than incorporating the school food garden.

2.5.1.4 Assessment strategies for space and shape without using a school food garden

Assessment serves as a tool to enhance teaching and learning (Noonan & Duncan, 2020:17). Designing assessment activities that are precise is crucial to emphasise the objectives and measure the effectiveness of the lesson (Denton & Borrego, 2021:2). According to Koh, Chapman, and Lam (2022:20), the design and use of assessment tasks by teachers become a point of concern when integrating the school food garden into Grade 3 mathematics. Hoover et al. (2021:591) confirm that numerous studies have recognised the benefits of school food gardens, although a prevalent challenge exists, namely the lack of centralised organization of assessment strategies related to the school food garden. In conclusion, it is imperative to create assessment strategies that align with learners' understanding and application of mathematical concepts.

2.5.1.5 Concretising the use of school food garden to teach Grade 3 mathematics

The successful implementation of the Garden-based Education (GBE) program significantly enhances academic achievement in most basic education curricula. While there are no set guidelines for its implementation due to variations in settings and educational systems, incorporating school garden learning into teaching and learning activities is essential for achieving more sustainable learning outcomes (Picardal, Paño & Jumao-as, 2022:142). However, many teachers still consider incorporating environmental education into the educational process time-consuming (Brown, Boda, Lemmi & Monroe, 2020:175). Despite this, they face challenges in making mathematics tangible in real-life situations. The difficulty arises from the need for prerequisite knowledge, as learners may struggle with mastering certain concepts, such as addition and subtraction, without a solid foundation before attempting division. The diverse instructional approaches also play a significant role in teaching, and teachers find it challenging to accommodate various learning styles (Brugggeman, Tondeur, Struyven, Pynoo, Garone & Vanslambrouck, 2021:100772). Consequently, concretising the integration of the school food garden becomes a challenging task.

2.6 POSSIBLE SOLUTIONS TO THE CHALLENGES GRADE 3 MATHEMATICS TEACHERS FACE WHEN USING SCHOOL FOOD GARDENS

The following section outlines practical strategies to address the challenges that hinder implementation. As proposed by Westwood et al. (2021:25), these strategies involve leveraging expertise to enhance skills and knowledge in utilising a school food garden as a learning lab and teaching Grade 3 mathematical content areas, including number operations and relationships, shapes and space, measurement and number patterns and relations, geometry, and data handling. In both Ghana and South Africa, professional development and workshops play a crucial role in equipping teachers with the knowledge and skills required to integrate school food gardens into the teaching of Grade 3 mathematical concepts, covering areas such as measuring length, number sentences, space, and shape (Nalumu et al., 2021:13; Grazioli, 2020:148). Teachers demonstrate commitment to balancing mathematical activities with the instructionalgoals of a school food garden (Suh, Matson, Seshaiyer, Jamieson & Tate, 2021:162).

2.7 CONDUCIVE CONDITIONS TO INTEGRATING A SCHOOL FOOD GARDEN TO TEACH GRADE 3 MATHEMATICS

Incorporating school food gardens across the school curriculum is well-established in Australia, fostering active engagement from learners, teachers, parents, and the community. This integration is pivotal in teaching and learning the four mathematical content areas (Kasumba, 2022:5; Lloyd & Paige, 2022:9). Mathematics is recognised as a critical competency in the context of school food gardens, with learners applying problem-solving skills and measurements, encompassing a broad range of mathematical skills (Christian et al., 2022:139; McCarty, 2018:67).

Progressively, Ghana has responded by embracing the concept of stakeholder collaboration to sustain school food gardens, ensuring their successful integration into the teaching of mathematical concepts such as measurement, number operations and relationships, shapes and space, and number patterns and relations (Taylor et al., 2021:405; Dushkova & Haase, 2020:19). Similarly, South Africa is making strides through Environmental Education, capacitating stakeholders like parents and the community to better understand mathematical concepts, particularly in measurements (Tlhabanelo, 2020:5). According to Sessa (2020:7401), students enjoy visiting the gardens and easily grasp mathematical lessons, such as counting seedlings and weighing harvests, providing valuable insights into fractions and decimal points.

While in South Africa, the school food garden primarily focuses on school nutrition, the Department of Basic Education (DBE) is encouraging schools to integrate it into classroom activities, prompting a growing number of schools to implement these initiatives (Dushkova & Haase, 2020:19). The inclusive approach of integrating school food gardens into the school curriculum, coupled with the active participation and collaboration of stakeholders, contributes significantly to the effective integration of food gardens in improving Grade 3 mathematics.

2.8 THREATS TO THE INTEGRATION OF A SCHOOL FOOD GARDEN TO TEACH GRADE 3 MATHEMATICS

Globally, climate change exerts a detrimental impact on the sustainability of school food gardens, posing challenges to their effective integration into mathematics education in Australia, Ghana, and South Africa (Corrochano et al., 2022:3; Cisse, 2019:188). Additional impediments to implementing school food gardens include established policies related to the curriculum in Ghana and South Africa, which may hinder seamless integration (Hansman, 2021:145; Hoover et al., 2021:3).

Moreover, the lack of support from relevant stakeholders, insufficient administrative backing, exclusion of school food gardens from classroom curriculum policies, and limited time allocation for their use are identified as significant barriers to integration in Ghana and South Africa (Taylor et al., 2021:405; Dushkova & Haase, 2020:19). In summary, climate change acts as an unavoidable obstacle to the successful implementation and integration of school food gardens into mathematics education, and the lack of support exacerbates the collective challenges faced in overcoming these barriers.

2.9 EVIDENCE THAT A SCHOOL FOOD GARDEN IS EFFECTIVELY USED WHEN TEACHING MATHEMATICS TO GRADE 3 LEARNERS

In Australia, there is compelling evidence that school food gardens are seamlessly integrated into the overall school curriculum, with mathematics being recognised as a critical competency within the context of food gardens. This integration has shown positive outcomes, contributing to enhanced cognitive levels among learners and alleviating the workload and stress teachers and students face in comprehending and teaching mathematics skills more effectively (Velardo et al., 2020:165). Moreover, there is substantial evidence indicating that learners not only develop a keen interest in learning mathematics but also that teachers find the use of school food gardens as an effective tool for teaching complex mathematical concepts (Wright, 2021:160; Carver-Thomas & Darling-Hammond, 2019:36-38).

In Ghana, as reported by Boateng, Ankrah, and Manteaw (2023:22), there is evidence of a significant improvement in pass percentages, rising from 10% to 34% in mathematics for schools that have integrated school food gardens into their teaching and learning practices. Additionally, in South Africa, the implementation of Eco-Schools has demonstrated greater environmental awareness. It has motivated pedagogical practices, fostering the commitment of both teachers and learners to the integration of school food gardens into mathematics education. Eco-schools further support schools systematically through meaningful partnerships with external agencies (Rosenberg, 2020:291).

Integrating school food gardens into teaching and learning mathematics can yield positive outcomes for teachers and learners. This approach not only eases the workload and stress associated with explaining complex mathematical concepts but also instils a greater interest in mathematics among learners and inspires teachers to teach the subject more effectively. This integration highlights the development of various general capabilities.

2.10 CONCLUSION

In this chapter, the researcher carefully examined pertinent literature concerning the teaching of Grade 3 mathematics through the utilization of a school food garden. The literature review is conducted within the critical emancipatory theory and the conceptual framework of PB). Additionally, the chapter explored other pertinent literature, aligning with the five objectives of the study. It delved into the challenges encountered during the implementation of the proposed strategy, proposed solutions to these challenges, potential threats impeding progress, favourable conditions, and indicators of success.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology and design employed for effectively teaching Grade 3 mathematics through a school food garden. The chapter's primary goal is to gather data that will contribute to formulating a comprehensive strategy. PAR is the chosen approach, facilitating data generation for planning, implementation, reflection, and monitoring. The data collection process involves document analysis, establishing a research team, and delineating the roles and responsibilities of each team member, along with their credentials.

3.2 PARTICIPATORY ACTION RESEARCH (PAR)

PAR has been selected as the research approach in this study for integrating a school food garden into the teaching of Grade 3 mathematics, specifically focusing on space and shape. This method is defined as a framework that involves those affected by the research in shaping questions, design, methods, and modes of analysis (Jacquaez & Vaughn, 2020:2). Additionally, PAR is employed as a means to include individuals in the design and execution of research (Smith et al., 2021:130). Its significance lies in emphasizing experiential knowledge to address challenges posed by unequal and destructive social institutions and to envision and implement alternatives. PAR involves the active participation and leadership of those facing challenges to bring about emancipatory social change through systematic study for generating new knowledge. It employs collaborative, ongoing, often open-ended, and flexible research procedures that value the knowledge of those experiencing a social issue (Cornish et al., 2023:34). PAR can lead to important transformations in the mathematics classrooms by engaging and empowering curriculum to be translated into meaningful classroom practice (Wright, 2021:160) Auriacombe and Sithomola (2020:50) assert that community challenges can only be effectively addressed by empowering citizens to identify and tackle problems within their communities. In this context, researchers and co-researchers are empowered to collaborate in research and decision-making. Promoting collaboration between researchers and co-researchers finds its optimal expression through using PAR. Teele, Nkoane, and Mahlomaholo (2020:14749) highlight PAR's use as a strategy due to its anthropological, compassionate, and supportive aspects. According to Calabria and Bailey (2023:670), PAR is a pedagogical framework encompassing all aspects of learning as a continuous learning process. Systematic research procedures are employed in PAR, a collaborative, continual, often open-ended, and flexible effort that values the knowledge of those experiencing a social issue to generate new ideas. It requires involving and controlling individuals facing challenges who actively participate with researchers to generate new insights (Cornish et al., 2023:34) In PAR all participants are collaborative researchers and work along with the whole team of researchers. PAR prioritises the importance of experiential knowledge for attempting problems that arises as unequal social systems and bringing change.

3.2.1 Origins of Participatory Action Research (PAR) and its Connection with Critical Emancipatory Theory (CER)

Established as an authoritative approach to conducting studies in the 1970s and 1980s, PAR has a diverse origin marked by four principles: the authority of direct experience, knowledge in action, the transformation process, and collaboration through dialogue (Cornish et al., 2023:34). According to the literature, its roots can be traced back to Aboriginal Communities (Warry, 1990:16).

PAR's origin is not singular but a convergence of multiple traditions, incorporating academic fields such as social work, public health, and education, and influence from popular social justice movements (Berman, 2014:519). The lineage of PAR is associated with psychologists like Kurt Lewin, who viewed it as a study of a social problem to bring about change. It is also influenced by the thinking of Paulo Freire, who perceived it as a response to the domination of masses by elites, rooted not only in the polarization of control over the means of material production but also over the means of knowledge production, including control over social power to determine what constitutes valuable knowledge (Berkman, 2014:518).

3.2.2 Objectives of Participatory Action Research (PAR)

PAR encompasses various objectives, but I will concentrate on those most relevant to this study. One of PAR's central goals is to promote social change that advocates for democracy and combats inequality (Chevalier & Buckles, 2019:23; Kemmis et al., 2019:21; Riel, 2019:51). Within the framework of PAR, participants are empowered to collect and analyse data, facilitating transformative outcomes through practical knowledge. This approach provides an opportunity for participants to reassess and modify their practices within the educational system, fostering empowerment and support (Armstrong, 2019:9; Beaton, 2018:33; Baldwin, 2012:35). Moreover, PAR aims to effect change in communities, organizations, or programs, enhancing the practices and effectiveness of individuals and teams. Through the application of PAR, decision-making structures and procedures within local government become more accessible to community members (Auriacombe & Sithomola, 2020:56). Pourzakarya and Bahramjerdi (2021:105416) highlight that community participation, utilising social cohesion and cultural place-making, is increasingly employed as a bottom-up approach in urban regeneration plans. The focal point of PAR is the subjectivity and real-world experiences of the research subjects (Orlowski, 2019:31).

3.2.3 Formats of Participatory Action Research (PAR)

This subsection discusses different forms of PAR.

3.2.3.1 Feminist Research

Feminist Participatory Action Research (FPAR) functions as both a conceptual framework and a methodological approach, aiming to foster a critical understanding of women's perspectives, particularly addressing challenges like the double jeopardy faced by black women. FPAR also advocates for inclusion, participation, and action while scrutinizing the underlying assumptions researchers bring to the research process (Reid, Tom & Frisby, 2006:18). The circumstances faced by black women involve various aspects, including racial and patriarchal oppression. For example, black women often experience higher rates of poverty compared to other women and men, revealing gender-based subordinate status regimes and persistent gaps in wealth, employment, and health (Houh & Kalsem, 2015:262). FPAR emphasises active women's participation "in all stages of the research process, including identifying the problems to be explored" (Reid et al., 2006:318). While the specific objectives of this study may not directly address FPAR's fundamental concerns focused on women's issues, voicelessness, and historical exclusion, the broader themes of equality, social justice, freedom, and hope align with FPAR's goals. Some women participate in FPAR to build community connections, reduce social isolation, and find a sense of belonging and support (Reid et al., 2006:318), which resonates with the experiences of Grade 3 mathematics teachers, who initially felt helpless and isolated but found a platform to communicate with co-researchers about their shared experiences.

3.2.3.2 Critical Race Theory (CRT)

Considering the socio-political context of the study's location is imperative to fulfil its objectives. As articulated by Kincheloe (1995, cited in Manfra, 2009:40), all research possesses inherent political characteristics and dispels the illusion of objectivity concealed by rhetoric. Politics encompasses awareness of the global state and access to education for individuals of diverse races. Critical action research operates on the premise that society is inherently biased but can be mitigated or transformed through intentional action (Davis, 2008:140). This form of research challenges conventional, positivist, and divisive research approaches that imply a political stance. Instead, it aligns with the critical theory approach by fostering a practical and politically visible critical consciousness to instigate change, challenging established norms like power and authority. It is inherently political, disrupting and undermining the portrayal of traditional knowledge production and social science research as objective (Houh & Kalsem, 2015:263).

Critical action research underscores the importance of participation and social analyses within the critical tradition, exposing disempowerment and injustice in industrialised societies (Kemmis & McTaggart, 2007:273). Critical Race Theory (CRT), as a form of Participatory Action Research (PAR), emerges as a relevant approach to critically explore contextual factors and conditions for successfully implementing the strategy to enhance school food gardens using PBL. CRT, originating in law and extending to education, acts as a race-equity methodology to eliminate racial prejudice and dismantle unjust racial hierarchies (Ford & Airhihenbuwa, 2010:30).

The schools involved in this study, classified in quintile one, are underprivileged due to the deliberate design by the former apartheid regime. The study acknowledges that "the research and the action must be participatory" (Houh et.al., 2015:263). It emphasises including individuals impacted by the actions in decision-making processes at all research levels. This approach aims to restore the dignity and hope of teachers, promoting critical pedagogical behaviours and fostering social justice in the classroom (Mack, 2012:421). CRT emphasises understanding the influences of racism on both outcomes and research processes (Ford & Airhihenbuwa, 2010:30). According to this perspective of PAR, coresearchers possess unique knowledge and experiences essential for framing research questions, design, data analysis, interpretation, and the creation of meaningful products and actions (Torre, 2019:214). As a PAR format, CRT integrates critical analyses of lived experiences and disciplinary conventions to gain a deeper understanding of imbalances (Ford & Airhihenbuwa, 2010:31).

In alignment with CRT principles, the study recognises the importance of integrating lived experiences to enhance the relevance of findings for communities and provide fresh perspectives on persistent issues (Ford & Airhihenbuwa, 2010:31). In the context of deeply rural black schools, where South African black schools are believed to have been deliberately disenfranchised, CRT, as a PAR format, is considered the most suitable approach for this study.

3.2.3.3 Ontology

Ontology explores existence or being (Kayumova & Strom, 2023:86). It delves into world views and assumptions regarding the nature of being and reality. The consideration arises as to "how one's relationship with the environment—especially with nature—is to be stimulated” (Bonnett, 2021:87). Additionally, Young and Malone (2023:1077) assert that utilising a school food garden enables learners to connect with their reality more meaningfully; they gain a deeper understanding of their origins by linking their classroom settings to the school food garden. When engaged with mathematics, the school food garden helps to facilitate a deeper understanding of the world and its phenomena. Katan and Baart (2021:3) suggest that there are multiple realities, and research should not be solely influenced by the 'dominant or elite researcher'. From the points mentioned above, it is apparent that Critical Emancipatory Research (CER) proves advantageous to all participants, regardless of gender, race, economic background, or sexual orientation.

3.2.3.4 Epistemology

Epistemology is the examination of knowledge and its acquisition (Sol & Heng, 2022:80). As stated by Obiageli (2023:13), CER transforms situations by employing analytical awareness and critical thinking to perceive reality as a process in which individuals can intervene and effect change, directing themselves toward their circumstances. It is further argued that co-researchers, particularly teachers in this context, contribute to knowledge dissemination, foster meaningful discussions, encourage active involvement, and promote an asset and power-based approach to research (Suarez-Balcazar, 2020:47). Undoubtedly, comprehending disseminating knowledge, and actively engaging learners and teachers in utilising a school food garden for Grade 3 mathematics instils knowledge through critical thinking, analysis, and broadens the horizon of reasoning through problem-solving.

3.3 ROLE OF THE RESEARCHER

The role of the researcher holds a central position in the research process, necessitating a clear understanding (Unluer, 2012:1). The researcher's decisions, such as selecting research topics, framing questions, and applying theories, are guided by philosophical beliefs or world views. These choices are integral to the research process (Ngulube, 2015:127). The chosen theoretical framework significantly shapes the researcher's responsibilities. The researcher can adopt an outsider's perspective, remaining a stranger to the community under study, or be an insider, fully immersed in the community being investigated (Unluer, 2012:1). In the positivist paradigm; the researcher primarily focuses on accurately reporting and describing real-world occurrences, maintaining a sense of objectivity (Postholm & Madsen, 2006:49). However, the claim of neutral and interest-free knowledge is challenged, with critics asserting that such claims are inherently impossible (Lather,1986:73). Kemmis and McTaggart (2007) argue against an overly objective stance, emphasizing that practice embodies various realities experienced differently by participants. In participatory action research (PAR), the researcher's role is reconceptualised as a catalyst working collaboratively with local participants to understand and address local issues (Noonan, 2015:196; Lather,1986:73). The PAR approach shares expertise, with the researcher as a facilitator rather than an authoritative expert. In this study, the researcher adopted the role of an inside facilitator within the study team, aligning with the CER perspective that challenges the relevance of positivism.

Upon addressing three connected challenges as proposed by Heron and Reason (2006, cited in Hawkins, 2015), the researcher oriented co-researchers through induction, encouraged participatory decision-making discussions, and fostered an open and trusting environment. PAR challenges the authority-centric nature of traditional research by placing those directly affected by the research gaps in control. The research project is viewed as the participants' inquiry, with the researcher serving as a facilitator and co-researchers actively involved in shaping the research process (Hawkins, 2015:7). In implementing the investigation, the researcher invited a diverse group of participants to contribute to the solution formulation, adhering to the ontological stance of multiple realities. Interactive meetings were facilitated to collectively identify aspects of integrating the school food garden for teaching Grade 3 mathematics. The research team proposed and enacted strategies to address challenges, with subsequent cycles of actions informed by data interpretation and analysis. Driven by an epistemological stance valuing collaborative actions and embedded knowledge in social relationships (Hawkins, 2015:6), the researcher constantly emphasised the importance of all co-researchers' perspectives. Reflecting Mahlomaholo's (2013:318) multiple perspectives, the research team acknowledged the unknown nature of solutions but believed that collective diagnosis and understanding would lead to emergent solutions.

3.4 THE RELATIONSHIP BETWEEN THE RESEARCHER AND CO-RESEARCHERS

The interaction between the researcher and the co-researcher establishes a reciprocal relationship based on reliability, trustworthiness, such as credibility, transferability, and dependability. It involves also the epistemology, and ethical considerations. Once ethical clearance was obtained from the University of Mpumalanga and the school principal granted permission, the research team commenced with collecting data at the research site. All team members strictly adhered to ethical procedures and specified guidelines to guarantee a successful data collection process. Permission requests were extended to all relevant stakeholders, and the study's procedures were communicated to everyone involved. The degree of confidence in the study is encouraged for all co researchers. It was emphasised that no incentives were provided for participating in the study.

3.5 RHETORIC/LANGUAGE

Rhetoric serves as a method of persuading individuals to align with a specific viewpoint or take actions that influence their behaviour (Batista, 2021:77). The researcher found the CER theory appropriate as it fosters open communication, encouraging active engagement and collaboration among team members through various modes of communication. Co-researchers, recognised as dynamic individuals displaying a positive attitude toward the study, are treated with respect, ensuring equity for all. The researcher's rhetorical character, standing, and credibility as a co-researcher establish trust among team members and others, allowing for constructing a compelling argument grounded in facts, data, and evidence. This logical approach elicits emotional and thoughtful responses to spoken and written communication (Donovan, 2018:53-65; Rapp, 2002:109-112). Effective communication in the study may also involve using artefacts, signs, symbols, text, and oral expression, encompassing verbal and non-verbal elements.

3.6 RESEARCH SITE

The research was conducted in the Capricorn North District, specifically in the Vlakfontein Circuit, situated in the Limpopo Province. The selected school is located in a remote rural area within the Aganang Municipality and has a very low socio-economic status. This school was chosen due to its potential to contribute to the development of the surrounding community. Moreover, most of the community members are either involved in or have an interest in farming, presenting an advantage for their participation. The school falls under quintile 2, indicating its socio-economic status. As a no-fee school, it caters to the local community's needs with limited financial resources.

This small-sized school has an enrolment of 163 learners from grades R-7 and is facilitated by a team of five qualified teachers. The teachers hold recognised qualifications from the South African Council of Educators (SACE), with most having completed teacher diplomas and a few possessing degrees. The medium of instruction in the school is both English and Sepedi, catering to the linguistic needs of the learners. All students at the school are native Sepedi speakers. The choice of this school is deemed suitable for the study, offering relevance in addressing research problems and achieving the set research objectives.

3.7 GAINING ENTRY

The Provincial Education Department was approached to seek permission to continue the study. After obtaining approval, the principal was briefed on the study's purpose, emphasizing the potential benefits to the school and the broader community. The School Governing Body (SGB) was also kept informed. Through collaborative efforts, the team devised solutions to the identified problems.

The co-researcher then provided consent letters to the relevant stakeholders for their signatures. Parents of the concerned learners were also required to sign letters of assent. These consent letters outlined their roles, indicated their right to withdraw if they chose not to proceed, and clarified the intended use of videos. Co-researchers were assured of the respect they would receive and that no harm would be involved.

3.8 ESTABLISHING THE COORDINATING / RESEARCH TEAM

The principal assisted in coordinating the research team that formulated the logistics. The purpose of establishing the team was to initiate discussions addressing the challenges faced in integrating a school food garden to teach Grade 3 mathematics at the school.

Invitations were distributed to the team, outlining the study's title and co-researchers' expectations. In the initial meeting, the coordinating team comprised one principal, one Foundation Phase Educator, one mathematics teacher, one community farmer, and one parent. They were oriented on ethical considerations, including confidentiality, anonymity, and the right to withdraw. During this meeting the coordinator and scribe were elected. The coordinating team was responsible for ensuring that aims and objectives were achieved.

A second meeting was held to elaborate on the aims, objectives, and methodology. All team members received consent forms and had their expectations, roles, and responsibilities clarified. The purpose was emphasised, stressing that their participation would benefit the study. A mutual relationship among team members was encouraged.

3.9 CREDENTIALS AND ROLES OF THE RESEARCH TEAM

The team was established to address the challenges encountered by teachers when integrating a school food garden to teach Grade 3 mathematics. Invitations were extended to the co-researchers through the Circuit Manager. The study adhered to ethical standards, ensuring confidentiality and anonymity and obtaining signed informed consent forms. The first meeting was arranged with the co-researchers, where the aims and objectives were outlined. The team subsequently discussed each ones roles and responsibilities.

3.9.1 Credentials of the Learners

The researcher considered it essential to incorporate learners as part of the study. The team included 20 learners from a Grade 3 class, comprising eleven boys and nine girls, all Black and between the ages of 8-9. Letters of assent were distributed to the parents, explaining the study's procedure. Upon agreement with the parents, they signed the letters and returned them to the school for record-keeping purposes, always adhering to the POIA Act.

3.9.2 Credentials of Teachers

All the teachers in the school, regardless of their subject, were involved. These teachers held basic teacher's diplomas, and most had over 30 years of teaching experience. There were five female teachers and one male teacher, all Black. This encouraged collaboration among the teachers. All teachers had diploma entry qualifications, with three teachers holding Senior degrees. Their participation in the study aimed to enrich their knowledge and understanding of teaching methods. Confidentiality and anonymity were ensured, and they signed letters of consent.

3.9.3 Credentials of Subject Heads for Mathematics

The subject heads were relevant for the study, as they could engage teachers, monitor and support in terms of pedagogical knowledge, supply necessary suitable material, and liaise with the Department of Education on behalf of the school to provide feedback on the progress of the study. Confidentiality and anonymity were maintained to ensure ethical standards. The subject advisor also signed consent forms to confirm their agreement to participate in the study. They were briefed on operational procedures and informed that they could freely withdraw from the study if they wished to do so.

3.9.4 The Principal’s Credentials

The principal's role was to maintain discipline and produce solutions to problems encountered. The principal has 35 years of service. The principal gave directives to parents to build trust in the study by outlining the purpose. The principal helped maintain discipline and devised strategies to create a friendly environment for proper implementation. She also provided feedback to the Circuit office.

3.9.5 The Parents’ Credentials

The parents involved were from the community, representing the entire community. Some of them were guardians, as the school was from low socio-economic status, and some biological parents were away for work. They signed the assent form to allow their children or grandchildren to take part in the study. The parents were proud to be part of the team; their interest resulted in encouraging their children to engage fully with their school work.

3.9.6 The Researcher’s Credentials

The researcher is qualified teacher with 20 years’ experience and 15 years in teaching Mathematics. The researcher had to ensure that all participants' roles and responsibilities were adhered to and had to oversee the project. The researcher also ensured that all the resources and guides were available and facilitated proceedings. The researcher reconciled the data generated.

3.10 COMMON VISION

All the co-researchers met to formulate an action plan to integrate a school food garden for teaching Grade 3 mathematics. They also devised strategies to initiate the school food garden as a resource for teaching Grade 3 mathematics. The shared vision was to empower teachers to teach Grade 3 mathematics effectively using a school food garden.

3.11 STRENGTH, WEAKNESS, OPPORTUNITIES AND THREATS (SWOT) OF THE STUDY AND ACTION PLAN

The research team convened to develop strategies for addressing the challenge of integrating a school food garden for mathematics instruction. Each member contributed ideas on how they could contribute to successfully integrating the school food garden. Parents involved in local farming were seen as potential contributors to establishing the garden, though some might not have prior experience with a school food garden. The evidence of opportunities emerged during discussions, where parents' experiences indicated their capability to initiate a garden for teaching Grade 3 mathematics. The identified threats included a lack of experience utilising a school food garden for teaching mathematics, potential resource constraints, and challenges related to an unstable climate and expertise.

3.12 PRIORITIES

Priorities involved were:

1. Capacitating teachers on how to plan their mathematics lessons in Grade 3 effectively using a school food garden.
2. Coordinate activities to facilitate during the lesson using a school food garden.
3. Enabling teachers to assess learners using the school food garden.
4. Capacitating educators to understand PCK.
5. Concretising the use of the school food garden to teach Grade 3 mathematics.

Table 0.3: Action Plan

PRIORITIES	ACTIVITIES	RESPONSIBILITY	RESOURCES	TIME FRAMES	MONITORING
Priority 1 Capacitating teachers to make lesson plans	Initial planning and goal setting. Identify challenges and mitigation factors.	Coordinator and the team	Classroom	1 hour meeting over a period of two weeks	Engages in discussions
Priority 2 Pedagogical content knowledge	Come up with possible solutions to the challenges. The team meet fortnightly to develop the way forward.	Team members	Classroom	2 hours 1 -hour weekly for a period of three months	Discussions: The researcher outlines the importance of the study The team meets and engages in discussions to use the strategy.
Priority 3 Coordinate activities to facilitate during the lesson using a school food garden.	Discuss the conditions favourable to the success of the strategy	Grade 3 Educator, Foundation phase educators	School food garden	1 hour meeting every week for a period of three months	The teacher does lesson presentations; the team reflects on the lesson.
Priority 4 Enabling teachers to assess	Discuss the strategy and reflect on the success	Grade 3 Educator, Foundation phase	School food garden, learners' workbooks	1 hour meeting every week for a period of three months	Leaners' workbooks and tasks are assessed to

learners using the school food garden.		educators			check progress. Reflections. Plan for new activity
Priority 5 Concretizing the use of the school food garden to teach Grade 3 mathematics.	Learners learn through school food garden	Grade 3 educators, learners	School food garden	1 hour daily	Learners engage in lessons using a school food garden.

3.13 ETHICAL CONSIDERATION

The research team and I collected data and utilised the school once we obtained ethical clearance from the University of Mpumalanga and permission from the school principal. The team members adhered to ethical procedures and stipulated guidelines to ensure a successful data collection process. We requested permission from all stakeholders by completing consent forms for adults and assent forms for learners as minors.

The study's process was outlined to all participants, and it was clarified that there would be no incentives for participating. Participants were assured of their safety and that their rights would be protected. All information, including video recordings, would be securely stored for a certain period, and then discarded later, following the rules and regulations of the University Research Department. Respect was maintained at all times.

Furthermore, participants were informed that their involvement was voluntary. They could remain anonymous or withdraw without coercion before signing individual consent forms and during the research process (Grant, 2021:4). The study setting was maintained through pseudonyms during an introductory phase. It was made known to the public throughout the process, as participants in PAR needed to develop confidence and recognition in making changes in the lives of communities (Jackson et al., 2018:617). The findings were communicated directly to the participants during meetings.

3.14 DATA ANALYSIS THROUGH CRITICAL DISCOURSE ANALYSIS (CDA)

CDA was employed in this study to analyse and interpret the data. When properly applied (Van Dijk, 2013:1), it is attested that CDA would provide a significantly more comprehensive analytical statement than statement analysis if properly executed.

Three layers of data analysis were used in this investigation.

3.14.1 Textual Level

This level uses certain linguistic features such as grammar like pronouns, specific vocabulary, scientific words, and technical words, which aims at including the team members and involves the use of linguistic features and semantics of the dialogue of that time (Niemela & Naukkarinen, 2020:36).

3.14.2 Social Level

On a social level, all forms of social interaction are connected to specific previous events and are a means by which present-day social interactions are reproduced or questioned, and different interests are served (Hopster, 2021:101750).

3.14.3 Discursive Level

The discursive level examines texts or other discourse formats to offer detailed descriptions considering language, syntax, and structure literary devices such as rhetoric and intertextuality (Taranenko, Kedych, Dudko & Poltoratska, 2023:1120).

The team concentrated on the lesson preparations and presented the mathematics workbooks of the Grade 3 learners when analysing the texts. It also covers the written and oral material gathered in the classroom to investigate the teaching and learning process, the interactions between the teacher and the learners and the learners themselves.

3.15 VALUE OF THE STUDY

The study is important because it enhances the integration of the school food garden to teach Grade 3 mathematics. It provides the strategies to be employed for practical use. The study will benefit the researcher and co-researchers as it will help improve the teaching of Grade 3 mathematics using the school food garden. The understanding of mathematics will be enhanced using the school food garden as a teaching aid. The study may help develop learners into critical thinkers who are creative and innovative whilst collaborating, communicating, and being compassionate.

3.16 CONCLUSION

The main topics of this study were the methodology and research design used to conduct the study. PAR was employed as a relevant approach because it aimed to design a strategy for integrating a school food garden to teach Grade 3 mathematics. The research team was identified, and methods were determined. Ethical considerations were considered, especially since the learners were minors. Entry was requested, and upon approval, the study proceeded. All participants were provided with consent, and a thorough explanation was given to ensure confidentiality. Participants could withdraw at any time if they lost interest in the study. Throughout the study, anonymity and confidentiality were maintained.

The researcher acknowledged relevant material about teaching Grade 3 mathematics using a school food garden in this chapter. The literature was reviewed using the theoretical framework of critical emancipatory theory and PBL as a conceptual framework. The chapter also reviewed other relevant literature informed by the five objectives of the study, challenges encountered in implementing the strategy, solutions to those challenges, possible threats, conducive factors, and indicators of success.

CHAPTER 4
ANALYSIS OF DATA, PRESENTATION, AND INTERPRETATION OF RESULTS

4.1 INTRODUCTION

This study aims to develop a strategy to promote the effective integration of school food gardens to teach Grade 3 mathematics at a school in Limpopo. The chapter analyses and presents data in the form of scenarios, words, and pictures along with presenting results to develop a strategy to promote effective mathematics teaching. The data are examined using the theory, previous study, and legislative framework.

The data were classified while being mindful of this study's objectives. CDA provided the tools to analyse the data at three levels: text, discursive and social structure (Van Dijk, 2001:352). CER was used as the theoretical framework through which to interpret the analyse data; PBL was used as the conceptual framework for grounding the use of the school food garden as a way to teach Grade 3 mathematics.

4.2 CHALLENGES TO TEACH GRADE 3 MATHEMATICS WITHOUT THE USE OF A SCHOOL FOOD GARDEN

The following challenges were identified because they were most prominent as revealed by previous research, learning theories and policies: (i) Designing Grade 3 mathematics lesson plans without effectively integrating them with the school food garden, (ii) Lack of PCK, (iii) Teaching space and shape without the help of the activities of a school food garden like garden apparatus, garden produce and garden layout, (iv) Designing appropriate assessment strategies for space and shape without capitalising different apparatus, garden produce and garden layout within the context of the school food garden, and (v) managing the time dedicated to teach space and shape mathematics with integration of school food garden activities.

4.2.1 Grade 3 Geometry Lesson Plans without Using a School Food Garden

A well-structured lesson plan encompasses objectives, resources, guided instruction, methodology, closure, and assessment (Zhu, Bonk & Doo, 2020:2075). According to CAPS, lessons focusing on space and shape aid students in identifying various shapes, understanding their characteristics, and recognizing their properties (DBE, 2011:19). Unplanned lesson strategies can lead to frustration for both teachers and learners, causing the teacher to lose direction and waste time figuring out class content. Previous research indicates challenges in integrating a school food garden into Grade 3 geometry lessons (Dring et al., 2020:369).

Constructivism, a learning philosophy, emphasises that learning occurs when learners actively participate in creating meaning and knowledge rather than passively absorbing information (Yakar, Ayfer, Porgali & Caliş, 2020:56). Learners are actively engaged in constructing their knowledge using a school food garden to explore different shapes, making the teaching approach learner centred.

Beard (2021:636) emphasises that the curriculum should address basic, abstract topics in mathematics classes and include social justice as a central theme. When teachers design lessons integrating a school food garden, they should do so with empathy. Learners should be encouraged to explore geometry through a shift in power distribution (Bartell, Yeh, Felton-Koestler & Berry III, 2022:10123). Through the lens of CER, equity is incorporated in the lesson by considering the background socio-economic status, regardless of race, gender, and class (Ocay, Agaton & Villote, 2021:50). According to Ramzan, Javaid, Kareem, and Mobeen (2023:2298), teachers need to create an enjoyable and stimulating learning atmosphere.

PBL, when integrated into learning, can foster creative, innovative, and critical thinking in learners (Triana, Anggraito & Ridlo, 2020:182). Furthermore, PBL encourages learners to collaboratively develop solutions, establish facts, and enhance communication skills (Inganah, Darmayanti & Rizki, 2023:220). PBL contributes to improving learners' problem-solving skills and reasoning.

The provided lesson plan lacks evidence of incorporating a school food garden. It has limitations regarding the utilisation of technology; for instance, video could have been employed to introduce the lesson. The resources used, such as scrap paper and old magazines, are generic and unrelated to the school food garden. Concrete objects like garden tools (e.g., spade) and produce from the garden could have been utilised to illustrate concepts better. For instance, the teacher could have showcased the spade, resembled the shape of a rectangle, or employed garden layout shapes to allow learners to engage their senses (touch, sight, smell, hearing, and taste) while learning. Integrating the school food garden would cater to diverse learning styles among the learners. Moreover, the lesson requires learners to describe, sort, and compare 2-D objects, but the lesson presentation does not specify or address these aspects.

Figure 0.1: Learners using fingers for mental mathematics

Contrary to good practice, the co-researchers highlighted the following after the lesson presentation.

Mrs Matlala:

> *"Colleague, why are you letting learners to do mental maths using the fingers instead of concrete objects from the garden?"*

Teacher:

> *"I am using the resources as stipulated in the lesson plan; I am following the lesson plan as is. I don't see any other way to incorporate the school food garden into the lesson."*

Mrs Dibete:

> *"I am also surprised to see how my colleague uses the resources. I thought she should be integrating the topic with the school food garden."*

Ms. Dihangwane:

> *"I think it was going to be better for learners to understand easily with the use of garden produce."*

The study's findings affirm that the integration of school food garden remains a challenge where the educator was unable to integrate it into the lesson plan. Using the resources was not appropriate as demonstrated; for counting, instead, learners used their fingers and not the garden produce, such as carrots, beetroot, or tomatoes. Using CDA to analyse this finding, the lesson plan does not set required goals and activities using a school food garden. After the learners' presentation, the lesson's objectives would not have been covered. The learners thus continue to lack knowledge about some of the content areas. The learners will be disempowered by how the teacher brings the content to the learners.

4.2.2 Challenge on Pedagogical Content Knowledge (PCK)

According to Shulman (1986), Pedagogical Content Knowledge (PCK) is a form of knowledge that arises from how teachers integrate their understanding of teaching with their subject matter expertise. PCK represents teachers' collective comprehension of how to facilitate learning (Liljekvist, Randahl, Van Bommel & Olin-Scheller, 2021:725). According to the CAPS document, learners are expected to explore the properties of 3-D and 2-D objects by sorting, classifying, describing, and naming them (DBE, 2018:12). It also emphasises that learners should recognise and describe shapes and objects in their environment resembling mathematical shapes.

The research findings indicate that many educators struggle with how to teach, what to assess, and the assessment forms (cf. section 2.5.1.3). Foundation Phase educators were found to operate at level 1, contrary to the expected levels 3 and 4 (Bailey & Lee, 2020:180).

Piaget (1952) argued that children's geometric understanding develops with age, and to foster ideas about shapes, children need physical interaction with objects. Teachers should concretise concepts for better learner understanding. Moreover, teachers' planning should be structured to guide learners in discovering concepts through investigation, incorporating strategies like open-ended questions.

Figure 0.2: Teacher theorising

Figure 0.3: Teacher using cue cards

In Figure 4.2, the teacher employs a teaching approach solely relying on writing on the board, neglecting visual aids, indicating a lack of appropriate teaching methods. In Figure 4.3, she attempts to explain using cue cards, revealing limitations in the use of resources. Individualization is not incorporated into her teaching approach, potentially resulting in many learners not fully grasping the content by the end of the lesson. Learners typically benefit from engaging their four senses for effective learning.

In line with PBL principles, learners should actively participate in investigations and problem-solving. However, the teacher disempowers the learners by adhering to traditional teaching methods and not allowing sufficient involvement.

During their meeting, the research team made the following remarks:

HoD:

> *"Madam, I thought when we are trying to implement the strategy, we need to see change in our teaching, but why are we still experiencing the same traditional method."*

Ledwaba:

> *"This is what I also experience here."*

Modiba:

> *"Indeed, the lesson is teacher centred."*

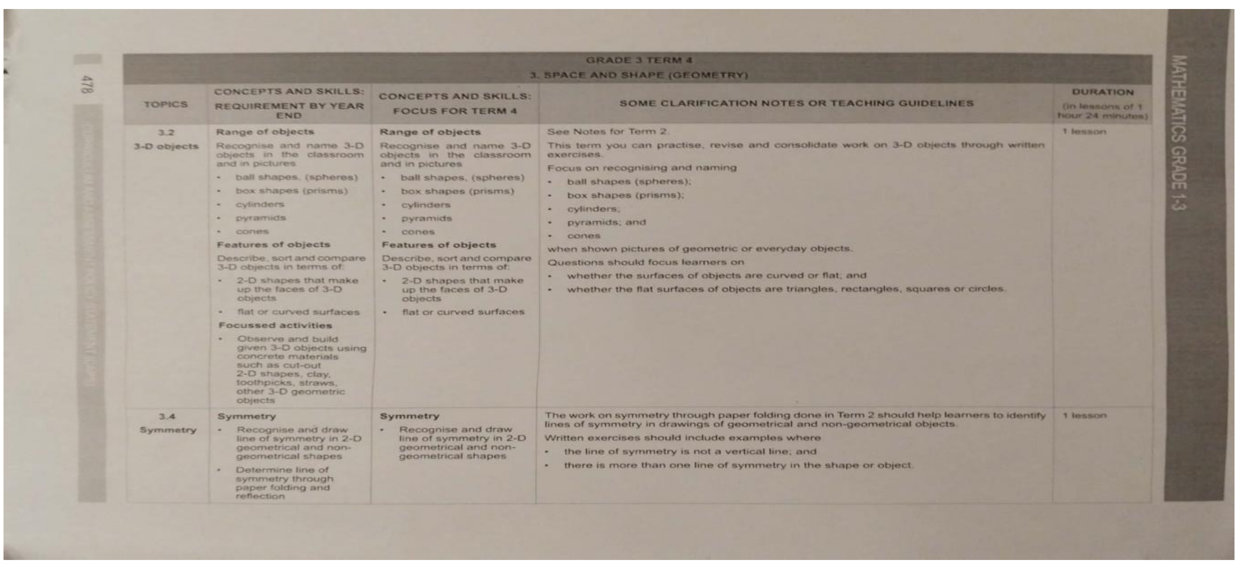
Analysing data through CDA shows the absence of studies on specific topics, which implies that the teacher cannot formulate conclusions. The teachers lack appropriate teaching methods, showing the teacher is not empowering learners but the one taking the lead. The learners remain passive participants in the whole lesson.

4.2.3 Teaching Space and Shape without Using a School Food Garden

The CAPS document emphasises that learners should concentrate on three-dimensional (3-D) objects and 2-D shapes, engaging in sorting, classifying, describing, and naming them. Learners are encouraged to explore the properties of these shapes, draw them, recognise, and describe the position of objects, as well as follows and give directions (DBE, 2011:35). However, Hoover et al., (2021:595) highlight a lack of centralised organization in incorporating the school food garden into the curriculum, despite its potential in promoting health strategies.

In a CER approach, learners affirm mathematical concepts or problems, providing evidence to support their assertions and offering reasoning for their conclusions (DiNapoli & Miller, 2022:100965). Emphasising social justice in mathematics education involves equipping learners to recognise and address injustices beyond the classroom, promoting equity within the mathematics learning environment (Alexander, Teymuroglu & Yerger, 2021:195). Despite the potential benefits, the learners in the mathematics lesson appeared passive, and there was no integration of the school food garden, evidenced by the absence of garden produce, garden apparatus, or garden layout. PBL advocates for lesson design that actively engages learners, building a foundation for advanced mathematics and preparing them for real-life situations (Rege, Hanselman, Solli, Dweck, Ludvigsen, Bettinger, Crosnoe, Muller, Walton, Duckworth & Yeager, 2021:755). PBL also enhances problem-solving skills, metacognition, reasoning, and motivation to participate in group activities (Lukitasari, Hasan, Sukri & Handhika, 2021:950).

In the context of CDA, the identified challenge lacks collaboration with the school food garden, urging the curriculum to incorporate activities related to a school food garden. The findings underscore the absence of collaboration between the school food garden and the mathematics curriculum.



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MATHEMATICS GRADE 1-3

GRADE 3 TERM 4

3. SPACE AND SHAPE (GEOMETRY)

TOPICS	CONCEPTS AND SKILLS: REQUIREMENT BY YEAR END	CONCEPTS AND SKILLS: FOCUS FOR TERM 4	SOME CLARIFICATION NOTES OR TEACHING GUIDELINES	DURATION (in lessons of 1 hour 24 minutes)
3.2 3-D objects	**Range of objects** Recognise and name 3-D objects in the classroom and in pictures • ball shapes, (spheres) • box shapes (prisms) • cylinders • pyramids • cones **Features of objects** Describe, sort and compare 3-D objects in terms of: • 2-D shapes that make up the faces of 3-D objects • flat or curved surfaces **Focussed activities** • Observe and build given 3-D objects using concrete materials such as cut-out 2-D shapes, clay, toothpicks, straws, other 3-D geometric objects	**Range of objects** Recognise and name 3-D objects in the classroom and in pictures • ball shapes, (spheres) • box shapes (prisms) • cylinders • pyramids • cones **Features of objects** Describe, sort and compare 3-D objects in terms of: • 2-D shapes that make up the faces of 3-D objects • flat or curved surfaces	See Notes for Term 2. This term you can practise, revise and consolidate work on 3-D objects through written exercises. Focus on recognising and naming • ball shapes (spheres); • box shapes (prisms); • cylinders; • pyramids; and • cones when shown pictures of geometric or everyday objects. Questions should focus learners on • whether the surfaces of objects are curved or flat; and • whether the flat surfaces of objects are triangles, rectangles, squares or circles.	1 lesson
3.4 Symmetry	**Symmetry** • Recognise and draw line of symmetry in 2-D geometrical and non-geometrical shapes • Determine line of symmetry through paper folding and reflection	**Symmetry** • Recognise and draw line of symmetry in 2-D geometrical and non-geometrical shapes	The work on symmetry through paper folding done in Term 2 should help learners to identify lines of symmetry in drawings of geometrical and non-geometrical objects. Written exercises should include examples where • the line of symmetry is not a vertical line; and • there is more than one line of symmetry in the shape or object.	1 lesson

Figure 0.4: The Grade 3 curriculum stipulated by CAPS

During their meeting, the research team recapped and found the following challenges.

Teacher:

> *"I don't know how to integrate the school food garden activities into the stipulated curriculum."*

Matlala:

"Yes, it may also be challenging for me."

Ledwaba:

"I might think of substituting some of the items from the given curriculum."

Teacher:

"How, madam, maybe you can come to my rescue."

HoD:

> *"Yes, it needs one's creativity to do that."*

Ledwaba:

> *"I don't think it can be a bad idea to come up with new innovations."*

4.2.4 Assessment Strategies for Space and Shape Without Using a School Food Garden

This section focuses on the indication of curriculum knowledge when integrating assessment with lesson development. The policies and assessments outlined by the Department of Basic Education (DBE, 2011:155) monitor learning, offering valuable feedback to teachers and learners for tracking progress and achieving goals.

Pogonowski (2023:85) asserts that assessment serves not only learners but also informs teachers, aiding them in improving their planning and selecting appropriate teaching methods. Assessment integrated into instruction helps teachers document skills and knowledge, utilising data to enhance student learning (George & Wooden, 2023:196; Williams, Morton & Christian, 2023:740).

As per DBE (2011:178), assessment plays a crucial role in monitoring learning progress and providing feedback to teachers and learners, assisting them in monitoring their progress and goals. CAPS (DBE, 2011:155) advocates for integrating a school food garden through content analysis and various methods, such as deductive, inductive, and abductive approaches, that can facilitate the implementation of a school food garden. Previous research indicates that teachers may lack creativity in designing assessment strategies using different methods (Hebe, 2020) (cf. section 2.2.2). The van Hiele theory posits that learners acquire geometry through geometric thinking involving visualization, analysis, abstraction, formal deduction, and rigour, progressing step by step.

Figure 0.5: The assessment from the workbook

Figure 4.5 illustrates the type of assessment the teacher uses to assess the learners. The assessment does not involve the leaner's critical thinking. During the meeting, the co-researchers evaluated the assessment:

Ms. Modiba:

> *"But, mam, we heard you saying the learners should use critical thinking."*

Ledwaba:

> *"Exactly my point. This type of assessment is only normal and straightforward. Maybe, colleague, you should think of a better strategy. But I think learners will not be able to tackle abstract assessment. I do it for the sake of evidence that I assessed."*

After discussions, the team agreed that the teacher should enhance the assessment strategy. They proposed activities to stimulate learners' critical thinking and foster collaboration and communication. The assessment design should involve learners investigating problems, discussing potential solutions in groups, and generating their own solutions. The strategies should promote critical thinking, through activities such as comparing the properties of different shapes.

Data analysis through CDA revealed that the current assessment lack's reliability and fails to challenge learners to think critically.

4.2.5 Concretising the Use of School Food Garden to Teach Grade 3 Mathematics

School food gardens offer an excellent opportunity to supplement meals for learners and serve as valuable teaching resources, enhancing comprehension through multisensory learning. Learners can benefit from the garden produce, layout, and apparatus, facilitating a concrete understanding of concepts.

CAPS facilitates the initiation of school gardens, ensuring that learners acquire essential knowledge and derive valuable life lessons while enjoying the gardening process. Simple activities, such as calculating the area of a rectangular garden bed, can be incorporated.

Jablonski and Ludwig (2023:685) highlight that teaching Geometry can be challenging, often resulting in instructors providing only basic ideas without delving into the details (cf. section 2.2.5).

Constructivism, the theory applied in teaching space and shapes, emphasises active learner involvement in constructing their knowledge rather than passively receiving information. However, in this context, the teacher does not actively engage learners in generating ideas during the learning process.

During the review session, the research team recognised the difficulty of integrating a school food garden into the teaching and learning process, with the researcher facing challenges in implementation.

Researcher:

> *"Honestly, it is stressing me to bring the school garden into reality."*

Matlala:

> *"I am also puzzled not seeing the integration of the school food garden."*

According to the data above, CER encourages the empowerment of learners, which shows that the leaners are disempowered in the sense that they are not taught according to the relevant method, using the appropriate teaching aids. The learners were not involved in the learning process. They remain passive in the study; there is no engagement.

According to CDA, the lesson presentation shows no integration, and there is a possibility of not including the different learning styles, meaning that the learners may not understand or follow the lesson's topic. The teacher lacks individualisation.

4.3 SOLUTIONS FOR THE CHALLENGES GRADE 3 MATHEMATICS TEACHERS FACE WHEN INTEGRATING A SCHOOL FOOD GARDEN

This section outlines the solutions to the challenges when designing a strategy to integrate school food gardens to teach Grade 3 mathematics, as discussed in section 4.2.

4.3.1 Using Practical Examples and Concrete Objects

The team and co-researchers in this study convened in multiple meetings to devise strategies for integrating the school food garden into the curriculum for effective mathematics teaching. To achieve this goal, it is crucial to establish a connection between the curriculum and the activities of the school food garden. The team scrutinised the curriculum design and devised activities aligning with the school food garden. Practical examples utilising concrete objects sourced from the school food garden were incorporated into activities that involved identifying shapes, such as recognizing a carrot as a cylinder.

Instead of solely relying on the prescribed teaching materials from the DBE the teacher employed creativity and utilised real objects. This included produce from the school food garden and apparatus like a spade. In this way the teacher illustrated the shape of a rectangle. Garden-related activities, including creating plots and measuring the growth of seedlings, meant that content could be covered creatively using a real-life context. By aligning the mathematics curriculum with the school food garden, the lessons became enjoyable for the learners.

Figure 0.6: The teacher demonstrating the different shapes using garden produce

4.3.2 Establishing a Professional Learning Community (PLC)

A Grade 3 teacher, Mrs Ledwaba, designed a lesson that integrates the school's food garden. The lesson was about counting backwards and forwards. The teacher used the spinach leaves, where learners started by adding the number of leaves and counting them backwards and forward. The lesson was interesting, and the struggling learners were more engaged. Williams et al. (2023:13) state that meaningful and enjoyable experiences are essential in children's education.

Figure 0.7: The teacher uses the garden produce as counters

After a week, the research team visited the class to check whether their inputs were valuable.

Matlala:

> *"I am so impressed by the active participation of learners."*

Modiba:

> *"The strategy is really working."*

4.3.3 An Interdisciplinary Learning Domain for Effective Assessment

Assessment is used to evaluate the effective use of different teaching methods and measure learners' understanding (Makransky, Borre-Gude & Mayer, 2019:691). It becomes stressful for teachers to implement assessment strategies using school gardens. The research team must innovate to bring various assessment strategies.

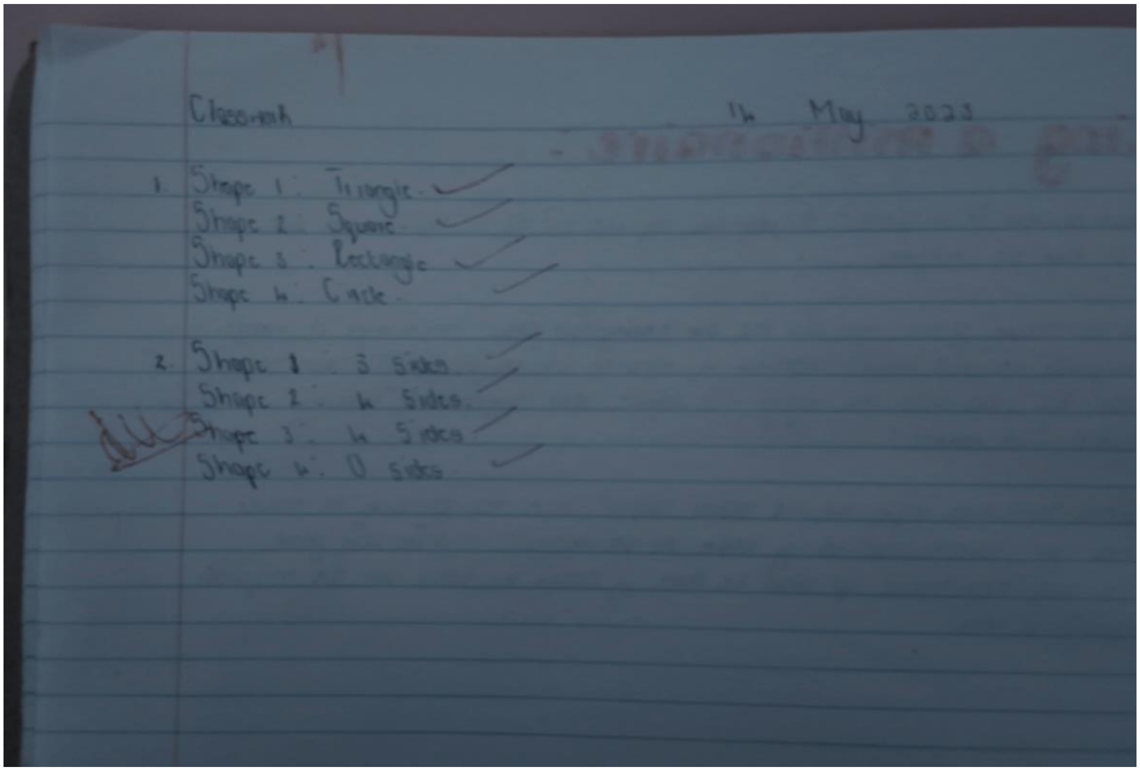

Figure 0.8: Learners' assessment showing improvement

4.3.4 Ongoing workshops, monitoring, and support for Teachers

Figure 0.9: Intervention of subject specialist developing educators

Figure 4.9 shows the intervention of the research team with the subject specialist in developing better strategies to integrate school food gardens to teach mathematics.

SES:

> *"You need to be creative in making your lessons interesting."*

Researcher:

> *"Sir, I am trying my best but have no luck."*

SES:

> *"Do not worry; that is why I am here to support."*

The SES explained how school food gardens can be effectively used in class.

SES:

> *"The garden produce, garden layout and apparatus can give a very practical example if you want to teach different properties of shapes. The learners will be able to understand the concept through their senses. They can differentiate them by looking at their shapes. For example, looking at a tomato, it is circular. The plot is rectangle."*

Matlala:

> *"We really appreciate your intervention. We are starting to get an understanding of what we are supposed to do."*

Modiba:

> *"It will really help us to teach easily to get leaners 'understanding quickly."*

4.3.5 Capacitating Teachers Through Workshops

After Mrs Ledwaba's presentation, the Head of Department (HoD) was invited so that she could help to mitigate the problem. The team analysed the problem of being unable to concretise. The HoD presented the whole lesson, trying to close the gaps discovered from the teacher's previous lesson. She demonstrated the lesson by excitingly introducing the lesson by singing a song to gain learners' interest. The learners were actively involved throughout the lesson by taking an active role in their groups. The HoD designed enjoyable activities that arouse their critical thinking. The learners were expected to complete a puzzle into a particular shape. For the assessment, she asked learners to identify different shapes in their classroom.

Matlala:

> *"Wow, this is so interesting to see the learners' participation."*

Modiba:

> *"Now I see how easy it is to integrate the school food garden into the classroom."*

4.4 CONDITIONS CONTRIBUTING TOWARDS THE INTEGRATION OF A SCHOOL FOOD GARDEN TO TEACH GRADE 3 MATHEMATICS

The research team emphasised the study's objectives and deliberated on the following outcomes: Teachers recognise the school food gardens as effective resources for teaching Grade 3 mathematics. The school food garden serves as a conducive space for learning, enhancing both the teaching and learning experiences. Teachers exhibit increased enthusiasm when entering the classrooms, and the topics become more engaging for learners. There is evident progress in differentiating and understanding the properties of shapes. Teachers benefit from practical strategies implemented through interdisciplinary teaching and learning, contributing to enhanced confidence, knowledge, and skills in the classroom.

4.4.1 Teachers Value the School Food Gardens as a Powerful Tool to Teach Grade 3 Mathematics

The teachers realised the school food garden's value in teaching space and shape (Geometry). There is improvement in understanding, and it helps learners grasp the content easily.

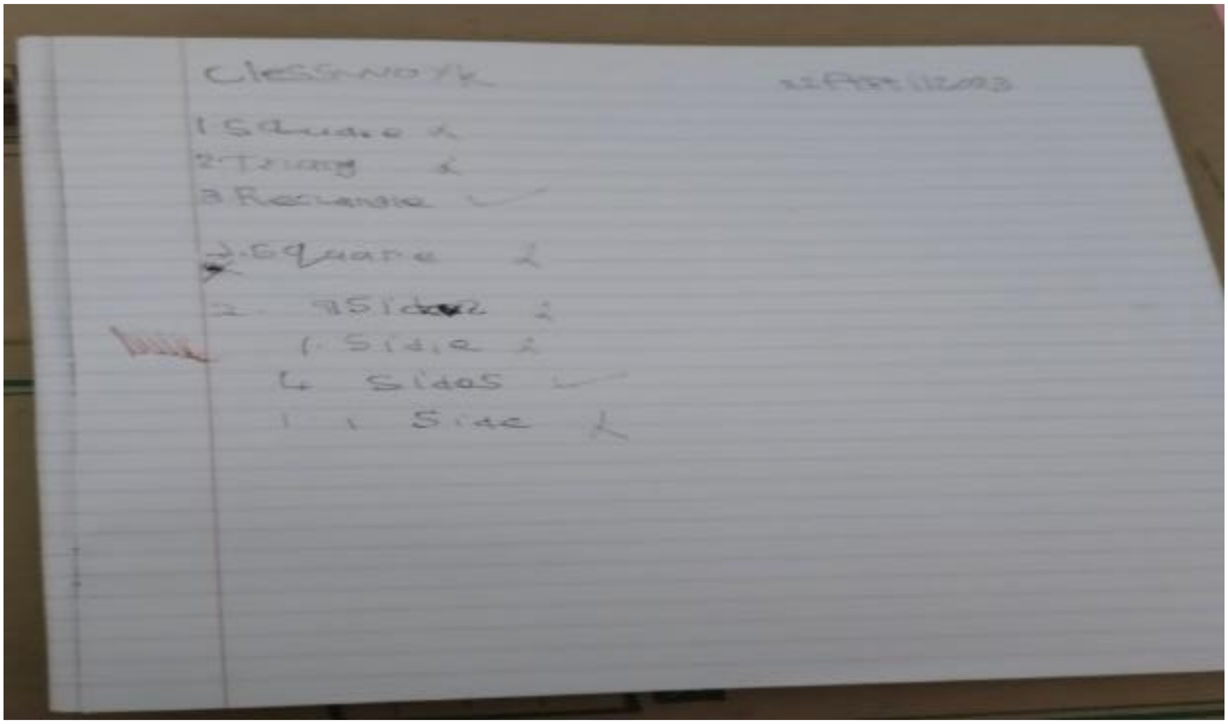

Figure 0.10: Learners' work before integration of school food garden

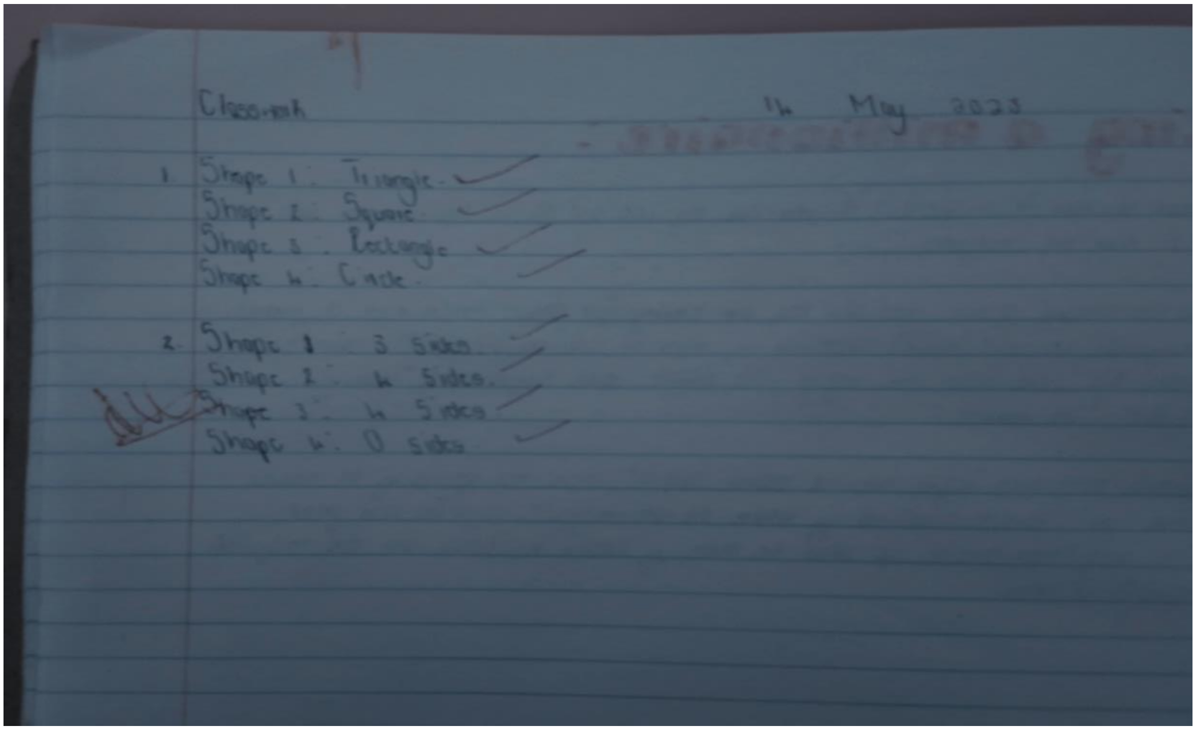

Figure 0.11: Learner's work after integration of school food garden

Figures 4.10 and 4.11 show how integrating the school food garden brought improvement.

4.4.2 The School Food Garden Provides an Arena for Learning

According to Oljayevna and Shavkatovna (2020:235), gardens offer teachers with a tangible resource to help students become engaged. Hands-on, inquiry-based garden projects offer learning possibilities in every classroom. The learning becomes simple and interesting to the leaners.

4.4.3 Food Gardens Encourage Teacher Enthusiasm

Frommelt, Schiefele and Lazarides (2021:5) attest that the school food garden demonstrates enjoyment in instruction and learning. When teachers enter classrooms, their enthusiasm increases. They confidently enter the classrooms, knowing what they will do.

4.4.4 More Engaged Learners who Immerse with Topics

School food garden influences learners' positive attitudes and increase potential in critical thinking; they are structurally and ideologically integrated into the curriculum. (Tireli & Jacobsen, 2023:55). The school food garden creates a favourable environment for social learning. Teachers use the school foo garden to develop hands-on lessons whilst teaching basic mathematical concepts like geometry.

4.4.5 Benefits of Effective Strategies

Through the school food garden, the teachers and learners develop self-sufficiency and gardening concepts and skills (Holmes, Campbell, James & Matthews, 2021:140). Children are more engaged, more attentive and more motivated to learn. School food gardens promote social connections and habits. The skill of cooperation is enhanced.

4.5 POSSIBLE THREATS WHEN INTEGRATING A SCHOOL FOOD GARDEN TO TEACH GRADE 3 MATHEMATICS

This section addresses the potential challenges in implementing the strategy and explores ways to mitigate them. Despite positive outcomes observed with the use of a school food garden, there is resistance among teachers toward embracing transformation (Alanoglu, Aslan & Karabatak, 2022:3450), negatively impacting the implementation of the strategy. This resistance stems from negative attitudes, lack of confidence, and self efficacy. However, research findings indicate that school food gardens can yield positive results.

4.5.1 Teachers are Resistant to Change

Teachers prefer traditional or basic teaching methods in the Foundation Phase mathematics classroom instead of incorporating the school food garden. Traditional teaching typically follows a teacher-centred approach, where learners passively listen without active participation (Fuentes-Cabrera, Parra-González, López-Belmonte & Segura-Robles, 2020:1586). One significant drawback of traditional teaching is that teachers' statements are accepted without challenge, and learners are expected to believe them unquestioningly. Teachers are resistant to integrating the school food garden into mathematics teaching. The CAPS document does not recognise the school food garden as a designated resource.

4.5.2 Negative Attitudes towards PBL

Teachers have confidence and self-efficacy in traditional teaching. Self-efficacy impacts the learning environment they create. Conventional strategies are different from PBL; it discourages learners from investigating problems and devising with solutions.

4.6 SUCCESS WHEN INTEGRATING A SCHOOL FOOD GARDEN TO TEACH GRADE 3 MATHEMATICS

4.6.1 The Value of School Food Gardens to Teach Grade 3 Mathematics

As Zuiker and Riske (2021:1160) outlined, Garden-based Learning (GBL) is an instructional approach that leverages the school garden as a valuable teaching resource. Integrating the school food garden into teaching enhances learners' understanding of various mathematical concepts, making the teaching process more effective and accessible for educators and students. Teachers can utilise the school food garden as a relevant resource to illustrate concepts related to space and shape, highlighting the different shapes found in the garden produce. Hence, teachers are encouraged to recognise the school food garden as a valuable and appropriate teaching resource.

4.6.2 Evidence that a School Food Garden Adds Value

School gardens play a vital role in the learners' diets (Austin, 2022:705). However, South African schools support the National school nutrition program, and the school food garden helps sustain healthy eating. School food gardens provide learning laboratories for hands-on learning. Therefore, learning may occur while, at the same time, learners experience their immediate environment.

4.6.3 Increased Engagement and Enthusiasm

Teachers exhibit increased enthusiasm when entering classrooms for teaching. Although no distinguishing factors are observed between high- and low-achieving schools, school food gardens contribute to a resourceful and enjoyable learning environment. Resources play a significant role in making learning more engaging, allowing learners to incorporate play into their educational experience. Recognizing the importance of resources in the learning process, it becomes evident that they play a crucial role in capturing learners' interest and facilitating comprehension. Using the school food garden enables learners to engage their senses, enhancing their understanding. In summary, resources are indispensable tools for eliciting learners' interest and promoting a better understanding of concepts.

4.6.4 Learner Progress When Having to Differentiate Between Shapes' Properties

When teachers incorporate the school food garden into their teaching, learners actively engage in the classroom. The school food garden empowers learners to express their opinions and discuss topics they are learning. This active participation boosts learners' confidence and transforms them from passive recipients to active contributors, enhancing their comprehension. In summary, the school food garden is crucial in encouraging learners to participate in lessons actively.

4.6.5 Teachers Benefit from a Boost in their Confidence, Knowledge, and Skills

In the United States, school gardens have been utilised to enhance and enrich the learning experiences of elementary students (Hershey & Parks, 2022:3). Furthermore, there has been an increase in the use of school food gardens since their introduction. However, following World War II, the utilization of school food gardens declined due to contextual factors. Nevertheless, in the 1970s, school food gardens resumed, yielding positive educational results. The learning opportunities generated by school food gardens enhance inquiry-based learning through real-world experiences. Integrating school food gardens into the classroom has yielded positive educational outcomes.

4.7 CONCLUSION

The chapter examined the strategy for practical Grade 3 mathematics teaching using a school food garden at a school in Limpopo. It also presented and interpreted the findings and conclusions of the data analysis. Data was used from research team meetings involving the research team in the discussions. The information revealed the challenges in mathematics teaching using a school food garden. The solutions to the challenges and the threats impeding the strategy, including the threats that hinder the strategy and conducive factors when implementing the strategy and indicators of success, were also discussed.

CHAPTER 5
SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 INTRODUCTION

The study aims to develop a strategy for enhancing the effective teaching of Grade 3 mathematics by integrating the school food garden. This chapter summarises the findings derived from the study, including conclusions and recommendations based on the various components of the research. Additionally, the chapter addresses the study's limitations, value, and relevance. Furthermore, it outlines the steps for implementing the strategy in the future.

5.2 FINDINGS

The findings are guided by the study's three objectives which include describing the teachers experience when implementing PBL that relies on a school food garden, exploring effective practices in response to challenges when implementing the PBL that uses school food garden and determining the effectiveness of strategies strongly associated with PBL that uses school food gardens.

The section below will present the findings, conclusions, and recommendations for each issue that will help make the strategy effective.

5.2.1 Planning Grade 3 Geometry Lessons without Using a School Food Garden

From the findings, it was observed during the research team meeting that the teacher struggles to integrate the school food garden into the lesson plan. There is limited incorporation of resources, and the teacher did not utilise appropriate materials. Resources play a significant role in aiding learners' understanding of concepts. In the lesson, the teacher used fingers, which may not be suitable for all learners, as some may struggle with numeracy. Learners comprehend and learn best when utilising their senses.

The teacher's lesson fails to spark learners' interest and does not encourage active participation, leaving the learners in a passive state during the learning process.

Additionally, the teaching methodology employed is deemed inappropriate for learners to grasp the content effectively. The chosen teaching methodology holds great importance in the teaching process, and its neglect can hinder the achievement of lesson objectives. The way the teacher introduced the lesson clearly shows her struggles.

5.2.2 Challenges with Expanding Pedagogical Content Knowledge (PCK)

The findings indicate that many educators struggle with how to teach, what to assess, and the various assessment forms (cf. section 2.5.1.3). It was observed that Foundation Phase educators operated at levels 1, contrary to the expected levels 3 and 4 (Piaget, 1952, in Bailey & Lee, 2020:180). Piaget argued that children's geometric understanding develops with age, emphasizing the need for physical interaction with objects to create ideas about shapes, requiring the teacher to concretise for better learner understanding.

The teacher's main challenge is using effective strategies in the classroom. The teacher lacks a suitable teaching method and relies on an old, traditional, teacher-centred approach that does not actively involve the learners. Consequently, learner participation is limited.

The teacher should consider the learner-centred approach of PBL. The lesson should be structured to engage learners more, encouraging critical thinking throughout the learning process.

5.2.3 Teaching Space and Shapes without Using a School Food Garden

The study's findings reveal a deficiency in integrating the school food garden into the curriculum. The teacher relies solely on given activities, facing a challenge to infuse creativity by introducing new activities to complement the existing ones.

5.2.4 Designing Assessment Strategies for Space and Shapes without Using a School Food Garden

The findings revealed that there is a challenge in designing appropriate assessment strategies. The teachers could not produce a variety of assessment strategies. They find it challenging to incorporate school food gardens into assessment. The teachers rely on DBE workbooks for assessing the learners, or even if they can design their own, they do not meet the cognitive levels or evoke critical thinking for learners. From the findings, Ms Ledwaba cannot create her assessment activities, primarily related to the school food garden.

5.2.5 Concretising the Use of a School Food Garden to Teach Grade 3 Mathematics

The study discovered that teachers faced challenges in integrating the school food garden into teaching Grade 3 mathematics. Teachers struggled to utilise garden produce, apparatus like a spade, and garden layout to teach space and shape concepts.

5.3 CONCLUSIONS

5.3.1 Planning Grade 3 Geometry Lessons without Using a School Food Garden

The lesson plans should be designed in such a way that it engages learners, by making them actively involved and designing activities to evoke critical thinking.

5.3.2 Expanding Teachers' Pedagogical Content Knowledge (PCK)

The ongoing teacher workshops should be implemented and foster PLC's so that educators can help each other and introduce better teaching strategies rather than traditional method.

5.3.3 Teaching Space and Shapes without Using a School Food Garden

Involving expertise to capacitate the teachers to include activities of a school food garden. The school food garden activities would help ease learners understanding of mathematics.

5.3.4 Assessment strategies for space and shapes Without Using a School Food Garden

The assessment strategies should be integrated to different apparatus of the garden to make learners to understand easily. This will involve all the different learning styles.

5.3.5 Concretising the Use of a School Food Garden to Teach Mathematics Grade 3

Suitable teaching aids to teach mathematics will make mathematics easier and makes teachers to be able to expatriate and define concepts without challenges.

5.4 VALUE OF THE STUDY

The study is important because it enhances the integration of the school food garden to teach Grade 3 mathematics. It provides the strategies to be employed for practical use. The study will benefit the researcher and co-researchers as it will help improve the teaching of Grade 3 mathematics using the school food garden. The understanding of mathematics will be enhanced using the school food garden as a teaching aid. The study may help develop learners to be critical thinkers, creative and innovative whilst collaborating, communicative and compassionate.

5.5 RECOMMENDATIONS FOR FUTURE RESEARCH

The research took place in a public school with a low socioeconomic status in the Limpopo province. Various stakeholders collaborated to develop a strategy for effectively utilising a school food garden in teaching Grade 3 mathematics. While the study focused on one school in the region, expanding it to other schools could address the issue of inferior performance in mathematics and impart gardening skills. The research demonstrated that a school food garden can be a potent teaching tool to enhance Grade 3 mathematics instruction. The Participatory Action Research (PAR) methodology employed in the study is particularly relevant, allowing the research team to devise solutions to challenges and actively engage in the study.

For mental maths, the teacher can incorporate produce from the garden, such as counting spinach leaves. Learners can actively engage by touching, smelling, feeling, and seeing the produce. To introduce the lesson, the teacher may include songs or use downloaded videos to pique learners' interest. Using videos can stimulate curiosity as learners will be eager to hear the sounds and witness the movement in the videos. This approach caters to different learning styles, with visual learners benefiting significantly. The research team suggests improving the methodology, introduction, and utilization of resources to enhance the effectiveness of integrating the school food garden.

It is recommended that PLCs be established whereby the team meet every fortnight to share the challenges and help each other draw solutions to them. There is no way a teacher can prosper without understanding the content herself. The experts should be involved in developing the teachers to master what they are teaching.

The teacher should consider an interdisciplinary approach to redefine problems outside the typical classroom and reach solutions based on a new understanding of complex situations. The teacher should not only stick to the stipulated curriculum activities. She should go the extra mile to devise alternatives to accomplish the objectives. The resources given in the curriculum can be substituted or integrated with the concrete objects from garden produce, like different shapes that can be demonstrated with tomatoes, beetroot, or the shape of apparatus and the garden layout.

The team suggested that there should be ongoing monitoring and support and continuous workshops from experts to close the gap. The research team should always meet to determine if the team is progressing in implementing the strategy.

The study recommends using concrete objects from the garden, like the number of tomatoes where they can differentiate the type of shape demonstrated and shape of square fence holes. The lesson preparations should be well planned, including the objectives of the teaching aids, which are from the school food garden. Learners will understand better if teachers follow the correct notable features of a lesson plan. The lessons will be enjoyable and cater to all learners; in that way, the teacher will address the method of individualisation.

5.6 SUMMARY OF THE STUDY

The study aimed to design a strategy to teach Grade 3 mathematics by integrating a school food garden. Chapter 1. Summarised the problem statement and the background of the study. It also covered the study's aim, objectives, and research question. Solutions to the challenges were discussed with recommendations. The strategy was enhanced through collaboration with co-researchers.

In Chapter 2, the theoretical framework, Critical Emancipatory Theory, was discussed in detail, exploring its origin, formats, and objectives. The chapter also examined PBL as the conceptual framework, considering its origin and formats. Furthermore, the literature was reviewed, guided by the study's objectives, encompassing challenges, solutions, conducive conditions, potential threats, and evidence of success. The literature review drew from experiences in the African continent, international countries, and South Africa.

Chapter 3 defined PAR as the methodology followed in the study. The historical background and its characteristics were discussed. The action plan and operational activities were outlined in this chapter. Additionally, co-researchers’ credentials were captured, and the resources used to generate data were clarified. The strategy used to analyse data, CDA, was discussed at discursive, social, and textual levels.

In Chapter 4, the findings were analysed, results were interpreted, and discussions were held toward a successful strategy to enhance Grade 3 mathematics teaching using a school food garden. The data were analysed based on the five objectives of the study concerning literature in Chapter 2.

In Chapter 5 the findings are outlined, and the conclusions drawn from the findings made with some recommendations.

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APPENDICES

APPENDIX 1: ETHICAL CLEARANCE FROM THE UNIVERSITY OF MPUMALANGA

UNIVERSITY OF MPUMALANGA

Creating Opportunities

Prof Mahlomaholo Geoffrey MAHLOMAHOLO

School of Early Childhood Education (SECE)

Siyabuswa Campus.

Dear Manaka, MA 222360852

Protocol Reference Number: UMP/Manaka222360852/SECE/MEd/2023

Project Title: Integrating school food garden in teaching mathematics grade 3 at a school in Limpopo Province

Approval Notification: In response to your application received on **11/10/2023**, The Research Ethics Committee of the Faculty of Education has considered the above mentioned application and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interviews Schedule, Informed Consent form, Title of the project, Location of the study, Research Approach and methods must be reviewed and approved through the amendment/ modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be stored securely in the School/ division for a period of 5 years.

The Ethical Clearance certificate is only valid for a period of 3 years from date of issue. Thereafter, Recertification must be applied for on an annual basis.

Wishing you the best with your study.

Yours faithfully,

Prof MG Mahlomaholo

Name of Chairperson (Chair FREC)

Cc: Research Office Administrator: Mr N Kashe and Ms T Mlambo

Cc: BEd Hons and MEd Co-Ordinators: Dr L Nyakundi and Dr A du Plessis

Cc: Faculty Research Committee Chair: Prof H Israel

DECLARATION OF INVESTGATOR(S)

I/We fully understand the conditions under which I am/we are authorised to carry out the abovementioned research and guarantee to ensure compliance with these conditions. I agree to completion of a yearly progress report.

.... 19/10/2023

APPENDIX 2: LESSON PLAN WITH NO SCHOOL FOOD GARDEN INTEGRATION

LESSON 19: 2-D SHAPES: STRAIGHT OR ROUND EDGES

Teacher's notes

CAPS topics: 1.1 Count objects, 1.2 Count forwards and backwards, 1.16 Mental mathematics, 3.3 2-D shapes

Lesson vocabulary: 2-D shape(s), straight side(s), curved side(s), cylinder, cone, pyramid, sphere, prism/box

Prior knowledge:

In Grade 2 the learners should have learnt how to:

- Count forwards and backwards from 0 to 200.
- Recognise and name 3-D objects in the classroom and pictures – ball shapes (spheres), box shapes (prisms), cylinders.
- Describe, sort and compare 3-D objects in terms of: size, objects that roll and objects that slide.

Concepts

- Describe, sort and compare 2-D shapes in terms of: *shape, straight sides* and *round sides*.

Resources: Scrap paper, 2-D shapes and shape name cards, old magazines/adverts, 3-D shapes: cylinder, cone, pyramid, sphere, prism/box (collect and keep as resources)

DBE workbook activities relevant to this lesson:

- DBE worksheet 11 (pp. 24 and 25).

Assessment: Refer to the tracker for today's formal/informal oral, practical or written assessment activity

Remediation:

- Give learners old magazines. Ask them to cut out the following shapes: a *triangle*, *square* and a *rectangle*.
- Ask them to use their fingers to show you the *straight sides*. Ask them to now cut out a shape that only has *round sides*. (circle)

Enrichment: See enrichment activity cards.

APPENDIX 3: LESSON INTEGRATING SCHOOL FOOD GARDEN

Lesson Plan:

Space and Shape

Objective: - Learners will develop their understanding of 3D objects and their features.

Materials: - A variety of 3D objects (e.g., cubes, cylinders, pyramids, sphere, garden tool like, spade, garden produce like carrots, pomegranate, oranges) - Chart paper - Markers - Paper - Pencils - Scissors – Glue

Procedure: 1. Introduction (10 minutes): - Begin the lesson by asking students what they know about 3D objects and their features. Write down their responses on the chart paper. - Explain to students that 3D objects are objects that have length, width, and height, whereas 2D objects only have length and width. Show some examples of 3D objects (e.g., a cube, a cylinder, a pyramid, a sphere) and discuss their features.

1. Activity 1: Exploring 3D Objects (20 minutes): - Distribute a variety of 3D objects to each group of students. - Instruct students to examine their objects and identify their features, such as faces, edges, and vertices. - Have students discuss their findings within their groups and record the features on a piece of paper. - Bring the groups together and have each group share their findings with the class, while you record their responses on the chart paper. - Discuss any similarities or differences in the features of the objects.
2. 3. Activity 2: Creating a 3D Artwork (30 minutes): - Provide each student with a sheet of paper, scissors, and glue. - Instruct students to choose one 3D object from the objects they explored in the previous activity and draw its net (2D representation). - Once students have drawn the net, they should cut it out and fold it into its 3D shape. - After creating the 3D shape, students should glue it onto their sheet of paper and label the object's features (e.g., faces, edges, vertices). - Encourage students to be creative in decorating their artwork. - Provide time for students to share their artwork with the class, explaining their chosen object and its features.
3. 4. Activity 3: 3D Objects in Real Life (20 minutes):
4. - Show images or examples of objects that resemble the shapes students explored earlier (e.g. A spade that resembles object with height and width, an orange and pomegranate shaped like a sphere, a carrot, shaped like a cone).
5. - Have students discuss in pairs or small groups how each object resembles a certain 3D shape and identify the features of each object.

6. - Encourage students to think about how these objects are used in everyday life and share their ideas with the class.
7. - As a closing activity, ask students to reflect on their understanding of 3D objects and their features and discuss any new insights or questions.
8. Assessment:
9. - Observe students' participation and engagement during the activities.
10. - Review the students' written responses about the features of 3D objects.
11. - Evaluate the accuracy and completeness of the students' 3D artwork and their ability to explain their chosen object and its features.

APPENDIX 4: REQUEST TO THE PRINCIPAL FOR PERMISSION TO CONDUCT RESEARCH

APPENDIX 2: REQUEST TO THE PRINCIPAL FOR PERMISSION TO CONDUCT RESEARCH

Request to conduct Research

Name and Surname

Contact Number

Supervisor

Contact number

Date: July 2023

Capricorn District

Mothemane D.D.

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

Dear Principal

I, Manaka Manape Aletta, a master's degree student at the University of Mpumalanga doing research under the supervision of Professor G. Mahlomaholo, humbly request for consent to conduct my master's research study at your School. My student number is 222360852.

I am requesting you to partake in the study entitled Integrating School food garden to teach Mathematics Grade 3 at your school. Your school was selected because it is an ideal place for gathering data about Integrating School Food Garden to teach Mathematics grade 3. The aim of the research is designing a strategy to Integrate School Food Garden to teach Mathematics Grade 3.

The study will entail working together with Educators, community farmers; principal, parents, community farmers, subject education specialist and the experts from the department of agriculture. There is no level of discomfort or any possible danger that would be involved in the study; there are no benefits from participating in the study. Participation is voluntary and participants are free to withdraw from the study at any time. There will be no incentives for participating in the study. Progress with the study and the final study will be given in a form of emails, WhatsApp messages, verbally and also by phone call to the co-creators.

Thanking you in advance

Yours sincerely

Ms Manaka M.A.

DEPARTMENT OF EDUCATION
MAPHUTHA PRIMARY SCHOOL
07 AUG 2023
P.O. BOX 836 JUNO 0748
LIMPOPO PROVINCE

APPENDIX 5: CONSENT FORM FOR THE PRINCIPAL, EDUCATORS AND EDUCATION SPECIALIST

Request for you to participate in a research study

Dear prospective co-researcher

I, Manaka Manape Aletta, a master's degree student at the University of Mpumalanga doing research under the supervision of Professor Mahlomaholo, humbly request you to partake in a research study I am conducting. My student number is 222360852. I request you to partake in the study entitled 'Integrating School food garden to teach Mathematics Grade 3 at your school. You are selected because you are the perfect candidate for gathering information about the use of school food garden to integrate Mathematics teaching in Grade 3. The study aims to Integrate school Food Garden to teach Mathematics Grade 3 at a school in Limpopo.

The study will entail working together with principal, Educators, parents, farm owners, community farmers, and businesspeople. There is no level of discomfort or any danger that is foreseen in the study. It will be explained to co-researchers that they have a right withdraw from the study any time. There will be no incentives for participating in the study. Feedback to participants will be given using all forms of communication and I can also be contacted on at; manapemanaka74@gmail.com

Thanking you in advance

Yours sincerely

Ms Manaka M.A.

APPENDIX 6: ASSENT FORM FOR MINORS

My name is Manaka Manape Aletta a master's degree student at the University of Mpumalanga doing research under the supervision of Professor G Mahlomaholo, humbly request you to partake in the research study that I am doing. My student number is 222360852.

The topic of the study is; 'Integrating School food garden to teach Mathematics Grade 3 at your school. Your child's school was selected because it is perfect for gathering information about the use of school food garden to promote healthy nutrition practices.

The study will entail working together with principal, educators, children, businesspeople, farm owners and community farmers. This study will show no level of discomfort or any possible danger that would be involved; there are no benefits from participating in the study. Participation is voluntary and participants are free to withdraw from the study at any time. There will be no incentives for participating in the study. Feedback will be given using all forms of communication.

You should know that;

- You are at liberty to withdraw from the study at any time
- You may stop being part of the study anytime if you feel no longer comfortable
- Your parents were asked to consent for you to partake in the study; even though they did, it is still your right to say no if you feel you are not interested to partake in the study.
- You can raise any concern or questions now or at a later stage.
- Your parents or you can contact me any time if you need any clarity on any issues regarding the study.

Sign this form only if

- Understand the contents of this study
- Have all your queries addressed
- Have communicated with your guardian or parents about this study
- Agree to partake in this study.

Child signature	Name Kobo Dokah	Date 15/08/2023
Parents signature	Name [illegible]	Date 18/08/2023
Researchers signature	Name [illegible]	Date 13/08/2023

APPENDIX 7: CONSENT FORM FOR PARENTS

Dear parent

My name is Manaka Manape Aletta a master's degree student at the University of Mpumalanga doing research under the supervision of professor Mahlomaholo, humbly request your child to partake in the research study that I am doing. My student no is 222360852.

The topic of the study is study entitled 'Integrating School food garden to teach Mathematics Grade 3 at your school.

Your child school selected because it is ideal place for conducting the research about using school food garden to promote healthy nutritional studies. The aim of the study is to devise a strategy to Integrate school food garden to teach Mathematics Grade 3 at a school in Limpopo.

The study will entail working together with the principal, educators, parents, children, businesspeople and community farmers. There's no level of discomfort or any possible danger that will involve. They are no benefits from participating in the study, participation is voluntary and participants are free to withdraw from the study anytime, they will be no incentives for participating it the study, feedback will be given using all forms of communication. Will gladly appreciate that our plea can be granted, if they are any question or any clarity you are able to contact the principal or the ministry. I may also be contacted on my email address manapemanaka74@gmail.com .

You are doing an agreement as you permit your child to contribute in the study, the signature is an indication that you are fully informed and had read the information below. You can have a copy for this letter.

Name of child Rachabedi katlego

Rachabedi Mable

Parent/guardian name

parent / guardian signature

Manaka M.A.

Researcher's name

Researchers signature

Date: 18/08/23

APPENDIX 8: CONSENT FOR COMMUNITY FARMERS

Request for you to participate in a research study

Dear prospective co-researcher

I, Manaka Manape Aletta a master's degree student at the University of Mpumalanga doing research under the supervision of professor Mahlomaholo, humbly request you to partake in a research study that I am conducting. My student number is 222360852.

The study will need the participation of farm owners and community. I am requesting you to participate in the study entitled. You are chosen because you are a perfect candidate for conducting research on the above-mentioned topic.

The study will enable the working together with the principal, and practitioners. The study in safe, no harm can happen during the study, if the participants feel they want to withdraw from the research they are most welcome. Feedback will be shared to the participants will be given, in any form of feedback.

Thank you

Yours sincerely

Ms Manaka M.A.

APPENDIX 9: CONSENT FORM FOR BUSINESSPEOPLE

Dear prospective co-researcher

I Manaka Manape Aletta, a master's degree student at the University of Mpumalanga doing research under the supervision of professor Mahlomaholo, humbly request you to partake in a research study that I am conducting. My student number is 222360852.

The study will need the participation of businesspeople. I am requesting you to participate in the study entitled ‘Integrating School food garden to teach Mathematics Grade 3 at your school. You are chosen because you are a perfect candidate for conducting research on the above-mentioned topic.

The study will enable the working together with the principal, and care givers. The study in safe, no harm can happen during the study, if the participants feel they want to withdraw from the research they are most welcome. Feedback will be shared to the participants will be given, in any form of feedback.

Thank you

Yours sincerely

Ms Manaka M.A.

APPENDIX 10: LETTER FROM LANGUAGE EDITOR

Carmen
Nel
BA INF SCIENCE

EDITING SERVICES

072 377 5585

carmen@ufs.ac.za

CERTIFICATE OF LANGUAGE EDITING

This certifies that I have edited the work detailed below below for language.

Title:

"INTEGRATING SCHOOL FOOD GARDEN IN TEACHING MATHEMATICS

GRADE 3 AT A SCHOOL IN LIMPOPO PROVINCE"

by

MANAKA MANAPE ALETTA

Student no. 222360852

Regards

Carmen Nel

29 January 2024

Professional editing of articles, thesis, dissertations and books

APPENDIX 11: PLAGIARISM (TURN IT IN) REPORT

INTEGRATING SCHOOL FOOD GARDEN IN TEACHING MATHEMATICS GRADE 3 AT A SCHOOL IN LIMPOPO PROVINCE

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